TECHNICAL REPORT ON THE

SALAR DE OLAROZ LITHIUM-POTASH PROJECT

JUJUY PROVINCE, ARGENTINA

NI 43-101 REPORT PREPARED FOR
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3. SUMMARY

Orocobre Ltd, through its wholly owned Argentine subsidiary Sales de Jujuy S.A. (formerly Orocobre S.A.) hold interests in just over 700 km^2 of mining tenements over, and in the vicinity of, the Salar de Olaroz in northwestern Argentina. These properties cover aquifers that host a brine body with elevated levels of lithium, potassium and boron.

This Technical Report details the investigation that forms the basis for the Indicated and Measured Resource estimates. In addition the report provides a summary of the Definitive Feasibility Study, a separate document, including an economic assessment of the project. This report is prepared according to the requirements of the Canadian Securities Commission National Instrument 43-101 and the Canadian Institute of Mining Best Practice Guidelines. It is authored by John Houston and Mike Gunn, who are Qualified Persons under NI43-101, and independent of Orocobre Ltd and its subsidiary.

The Salar de Olaroz is located in the high altitude Puna region of northwest Argentina, an area renowned for its lithium- and potassium-rich brine resources (for example, the existing lithium production operation at FMC's Hombre Muerto Project). Brine resources are unlike most mineral deposits for one obvious reason: they are fluid. Thus they have the potential to move and mix with adjacent fluids once abstraction, or exploitation begins. Their evaluation requires special considerations not normally applied to mineral resource evaluation. There are three key factors that determine an in-situ brine resource: the geometry of the host aquifer, its specific yield, and the concentration of the elements of interest. In addition there are two further key factors required in order to determine a recoverable resource: the permeability of the host aquifer, and the fluxes of fluids into and out of the salar.

An investigation program was developed in 2009 to enable all relevant aspects of the salar, the host aquifer, its specific yield, brine chemistry, permeability and water balance to be evaluated. The program consisted of the following elements:

- Satellite image interpretation to assist with geological mapping, surface hydrology and evaporation zonation.
- Surface geophysics to evaluate the geometry of the basin and brine body.
- Sonic drilling twenty wells to 54 m depth to investigate the geology and obtain core and brine samples.
- Triple tube diamond drilling six wells to 197 m depth to investigate the geology and obtain core and brine samples.
- Core logging of geology and testing for porosity parameters.
- Geophysical logging to support lithological characterization, correlation and porosity evaluation.
- Brine sampling and analysis to determine chemistry and concentration.
- Pumping tests of up to five months duration to investigate flow conditions, determine aquifer properties, and to confirm the ability of wells to produce stable grades.
- Off-salar well drilling, water sampling and monitoring to assist with the analysis of the water balance and production forecasting.

The philosophy behind the investigation program was to ensure that all samples were truly representative of in-situ conditions, and the results were repeatable. A great deal of attention was applied to the field sampling program since very few, if any immature clastic salars have been previously investigated in the Altiplano-Puna, and they are rather different to the mature halite salars that are already under development in the region. Sonic drilling, whilst slow, was perceived as the best technique for acquiring the majority of undisturbed samples with a high recovery rate. Triple tube diamond drilling was used as the next best method for drilling at depths up to 200 m. Core samples retrieved at the surface must be undisturbed for reliable porosity measurement. Brine samples must be representative of the depth at which they were sampled and not contaminated with over or underlying formation fluids. Furthermore, laboratory analyses of porosity and brine chemistry were reliable and repeatable. The details of the sampling methods, and quality controls exercised are fully described in this report, and clearly demonstrate sample provenance, repeatability and reliability. Once the database was fully validated, the resource was estimated according to the CIM definitions of Measured and Indicated Resource, based on data density that was adequate to demonstrate geological and grade continuity for the former and to be reasonably certain of geological and grade continuity in the latter case.

The Salar de Olaroz is underlain by a deep basin (gravity data suggests up to 1.2 km deep) bounded by a pair of N-S reverse faults that thrust Cretaceous and Ordovician basement rocks over the basin margins. The basin is infilled with Cenozoic sediments. Pliocene to Recent sediments form a multilayered aquifer that acts as a host to the brine that has probably taken many tens of thousands of years to develop. Drilling has demonstrated that the aquifer is present to depths of 200 m, and is probably significantly deeper. The brine contains elevated levels of dissolved elements in solution that are of economic interest: lithium, potassium and boron. Whilst the ultimate origin of the lithium and other species is not known, they are likely to be associated in some way with the Altiplano-Puna magma body that underlies the whole region, and will not be replaced during the project lifecycle. Hence, extraction by pumping from wells is equivalent to mining.

The aquifer may be subdivided into seven lithostratigraphic units that can be correlated throughout the basin. Within the nucleus the units are composed of coarse- to fine grained sands, silts and clays, with varying amounts of evaporitic halite and ulexite, as well as calcite as calcrete or travertine. Evaporitic beds dominate the basal and upper units of the nucleus. To the north, these beds interdigitate with coarse sediments of the Rio Rosario fan-delta. To the south, they interdigitate with coarse sediments of the Archibarca alluvial fan, although this is a relatively recent feature of the basin, having been active only during the deposition of the upper four units of the nucleus. Internally, the basin has subsided on marginal growth faults that were largely active prior to the initiation of the Archibarca alluvial fan.

Recovery of undisturbed core has enabled the laboratory determination of total porosity, effective porosity and specific yield on all units. When coupled with continuous wire-line geophysical logs, a detailed database has been established. Determination of specific yields at the research laboratories of the British Geological Survey gave mean values ranging from 0.13 for sand dominated lithologies, to 0.02 for clay dominated lithologies, and with a full spectrum between. Halite dominant units gave mean specific yield values of 0.04, similar to those previously determined at the halite dominant salars of Atacama and Hombre Muerto.

The brine body is rather homogeneous, extending throughout the salar nucleus at the surface and expanding somewhat at depth. Its chemistry suggests that it has been formed by the evaporation of inflowing dilute waters of only one type that initially saturate in and precipitate calcite, followed by gypsum. Halite saturation is only just reached at the highest brine concentrations, but lithium and potassium continue to concentrate demonstrating that these species remain in solution and do not precipitate as solid phase minerals. Within the nucleus, mean concentrations are 690 mg/L for Li, 5,730 mg/L for K, and 1,050 mg/L for B. Peak values exceed 1,000 mg/L, 8,000 mg/L and 1,200 mg/L for Li, K and B respectively. A production wellfield will be initially located and designed to extract these higher grades.

A summary of the Measured and Indicated Resource estimates is given below:

	Measured Resource million tonnes	Indicated Resource million tonnes	Total Measured+Indicated million tonnes
Li	0.27	0.94	1.21
K	2.08	8.02	10.10
B	0.39	1.46	1.85

The Olaroz brine is suited to application of the ‘Silver Peak’ processing method used at the lithium brine treatment operation in Nevada, modified to suit the differences in brine chemistry and climatic conditions at the Olaroz Project. A development program analyzed the performance of each stage of the process to develop produce battery grade lithium carbonate. Test work has been undertaken on a pilot scale at the Project site and at commercial and university laboratories. The modified process incorporates a number of proprietary innovations.

Initial work focussed on evaporation to understand the phase chemistry of the brine during an annual month weather cycle, followed by lime addition test work to remove magnesium. Battery grade specification lithium carbonate from Olaroz brines was then produced from the pilot scale purification plant. Analysis shows the material to be of greater than 99.9% purity and to exceed specifications of battery grade material sold by existing producers.

The production of potash and boric acid has been a secondary focus. Test work has shown that potash of commercial grade can be produced by flotation of mixed halite and potash (Sylvite) salts. Higher sulphate concentrations at depth has impacted on expected potash recoveries with the current process route now expected to produce approximately 0.6 tonnes of potash per tonne of lithium carbonate or 10,000 tonnes per annum.

The Company plans to undertake additional process development work with the aim of reducing the impact of the increased levels of sulphate and increasing potash production. As the potash circuit is required two years after the lithium carbonate production has commenced, it is expected that this work will be completed well in advance of this deadline. The potential to recover boron has been successfully tested and development of this process is continuing.

Roskill Consulting Group Ltd was contracted to provide independent advice on the lithium and potash markets and future pricing forecasts. This was required under the Toyota Tsusho agreement. They advise that between 2000 and 2010 lithium demand increased at a 5.8% annual growth rate, with battery driven demand growing at 21.6%. Total demand in 2010 was 116,000 tonnes lithium carbonate, of which battery related demand was 25,100 tonnes.

Roskill has provided Orocobre with a forecast of annual high, low and average price forecasts for lithium carbonate and potash for years 2011 to 2025. The average price forecast for battery grade lithium carbonate is US$6160 per tonne and US$592 per tonne for Potash. Roskill forecast overall demand for lithium to increase by 6.3% per annum from 2010, reaching 215,150 tonnes LCE in 2020. The best case scenario envisages lithium demand to increase by 8.0% per annum to reach 264,460 tonnes LCE in 2020. The worst case scenario suggests a growth rate of 4.3% per annum to reach 176,040 tonnes LCE in 2020.

Global potash consumption has been rising over the last decade from 42.3 million tonnes in 2000 to 50 million tonnes in 2010. Potash consumption is predicted by Roskill to rise to 54 million tonnes in 2011.

The brine will be extracted from the salar by a wellfield, initially designed with twenty, 200 m deep wells producing at 10 L/s each. At any one time eighteen wells will be in operation producing a total of 180 L/s. Initial brine concentration is forecast at 12% above the average resource grade, reflecting the extraction from the high grade nucleus. Brine will be pumped from the wellfield to the solar evaporation ponds located on the south-west margin of the salar.

Magnesium will be removed by the addition of lime, precipitating gypsum. After evaporative concentration, the brine is processed through the lithium carbonate plant. Impurities are removed by a number of purification stages using a proprietary process route resulting in the production of battery grade lithium carbonate. Potash will be produced through flotation from the mixed halite and potash salts harvested from the solar evaporation ponds.

The Feasibility Study base case considers a design production of 16,400 tonnes per annum of battery grade lithium carbonate. Construction is estimated to take 15 months, with production in the first year of approximately 10,500 tonnes of lithium carbonate rising to design rate thereafter. As an option, production of 10,000 tonnes per annum of potash by-product has been considered from the third year. This production rate has not been optimised and further test work may result in a significant increase in this rate.

A summary of the capital cost estimate is given below. It is based on a conventional EPCM implementation methodology and is estimated, at an accuracy of +/-15%, except for the potash plant, which is estimated to an accuracy of +/-35% at this stage. The capital cost estimate allows for EPCM, construction and owner’s costs (working capital) through the development period to positive operational cash flow. A further US$48m of capital expenditure, additional to that tabulated above, is allowed over the currently modelled project life. The capital cost estimates are currently being reviewed by a major South American based construction company, and their preliminary advice is that capital costs may be reduced by design optimisation and alternative implementation methodology. Reporting of this work is expected to be available during the current quarter, Q2 2011.

CAPITAL COST ESTIMATE 16,400 tpa Lithium carbonate	US$million
Direct costs (wellfield, ponds, plant, utilities, infrastructure)	125.7
Indirect costs (EPCM, third party services, owners costs)	58.8
Contingency	22.1
TOTAL	206.7
Potash plant option	14.5

Operating costs have been estimated by Sinclair Knight Merz in conjunction with local cost data provided by the Company. At the forecast production rate, the operating cost is estimated at US$1,512 per tonne of battery grade lithium carbonate. If a potash production of 10,000 tonnes per annum is incorporated, with an forecast price of US$592 per tonne, the operating cost decreases to US$1,230 per tonne of lithium carbonate. These low operating costs are competitive with existing brine producers and materially less than those reported by hard rock minerals projects.

An economic analysis has been undertaken using a model jointly developed by the Company and an Argentine specialist consultant. The analysis does not consider cost inflation, and assumes a constant exchange rate of US$1 = ARG$4. It is based on the measured and indicated resources of the Company described in this announcement over a 40 year project life. Using the Roskill price forecast, the base case for lithium carbonate only production gives an internal rate of return as 26%, on an un-geared, after tax basis with a Net Present Value at 7.5% discount rate of US$415 million. Assuming the debt to equity ratio contemplated in the Toyota Tsusho Corporation agreement, the internal rate of return increases to 52% and the Net Present Value at 7.5% increases to US$449 million. The Net Present Value sensitivity after tax is shown below:

Discount rate	Un-geared US$million	Geared US$million
0.0% (=cumulative cash flow)	1902	1903
5.0%	652	678
7.5%	415	449
10.0%	273	314
15.0%	121	172

The economic analysis allows the various investment provisions under the Argentina Mining Code including accelerated depreciation, corporate tax at 35%, royalties at 3%, export duties at 5% and bank transaction tax at 1.2%.

At the end of 2010, the Company received approval from the Jujuy provincial government of the Environmental Impact Statement for the development and exploitation of the Salar de Olaroz lithium-potash project. Approval by the Provincial Director on Mines and Energy Resources was received following the recommendation by the Unit of Mining Environmental Management in November, 2010. As part of the approval, the Company is obliged to comply with various monitoring obligations, provide additional information on its planned construction works as the project design is finalized, and keep the local communities informed about its activities. The Company has since provided the additional materials requested in compliance with the EIS approval. On 4 March 2011, the provincial government of Jujuy issued a decree that declared lithium a strategic mineral resource and introduced a secondary approvals process for lithium projects. In addition to an EIS approval, exploration and exploitation level projects now require assessment by a Committee of Experts and following a positive recommendation from this Committee, approval by the joint resolution of the Minister of Production and the Secretary General of the Provincial Government. Since the announcement was made, the relevant committee has been established but has yet to commence deliberations. It is not possible to provide guidance as to the likely timing of the additional approval process at this stage.

In order to purchase its 25% equity interest in the Olaroz Project, Toyota Tsusho is obliged to arrange government guaranteed debt finance. Since March, with the impending completion of the Feasibility Study, the Company has been working closely with Toyota Tsusho and the relevant Japanese banking and government departments regarding the financing and associated due diligence processes. Based on these discussions, it is expected that the financing process will take approximately nine months. Earlier conditional approvals are likely which will speed up project development, subject to provincial government approvals. Joint venture agreement negotiations with Toyota Tsusho will be undertaken concurrently.

Detailed engineering will be undertaken and engineering design and construction contractors will be selected during the same period together with the order of long-lead time items. Wellfield development will be undertaken as soon as provincial government and conditional finance approvals have been received. The construction period for the project is estimated at 15 months.

The Authors recommendation is that the project be brought into development subject to final approval of the necessary regulatory requirements.

4. INTRODUCTION

4.1 Authorship and Terms of Reference

The authors, John Houston and Michael Gunn, were contracted by the Company to prepare a Technical Report in compliance with NI 43-101 on the Olaroz Project.

The first author, John Houston, author is also contracted as an expert hydrogeological consultant by the Company to advise on the methodology for the assessment of the Salar de Olaroz Project, and is responsible in this role for provision of technical advice including hydrogeological and resource aspects. The author has spent several months on-site between April 2009 and February 2011. He is responsible for all chapters of this report, except for Chapters 18 and 20, prepared by Mike Gunn. The author's experience with similar brine resource projects in the area is highly relevant to the current Orocobre project.

The second author, Michael Gunn, has not been involved in the project development prior to this assignment. In March 2011. he spent one week in Jujuy with the Company's process development team and management. During this visit, time was spent at the project site and process development facilities as well as at the University of Jujuy laboratory where the lithium purification pilot plant was operating.

The authors are supported by Consulting Processing Engineer, Peter Ehren, who is also a Qualified Person, in relation to the brine chemistry, brine processing and feasibility study in the preparation of this report. Peter Ehren has been responsible for the design and development of the test work programs conducted at the Olaroz site, the University of Jujuy and various other commercial laboratories. He remains closely involved with the ongoing work in regard to potash and boron production.

The authors would like to acknowledge the support and assistance of the following Orocobre staff at all stages of the project: Richard Seville, Managing Director; Jose Castro, General Manager; Marcelo Sanchez, Project Manager; Fernando Martin, Geologist; Pablo Gomez, Hydrogeologist, Jorge Andreani, Chemical Engineer, and the many field staff and technicians who worked very hard to ensure the success of the project.

Previous exploration and evaluation data were reported in the NI 43-101 Technical Report entitled Technical Report on the Salar de Olaroz Lithium-Potash Project, Jujuy Province, Argentina, dated 30 April, 2010.

The format and content of this report is prepared in accordance with the requirements of National Instrument 43-101 – *Standards of Disclosure for Mineral Projects,* including Form 43-101F1 - Technical Report and Companion Policy 43-101CP – To National Instrument 43-101Standards of Disclosure for Mineral Projects, of the Canadian Securities Administrators ("NI 43-101"). It is also based on technical judgment of the Author relating to minerals in solute form in brines hosted in aquifers as outlined in section 4.2, and discussed in depth in Houston et al. (*in press*).

4.2 The uniqueness of brine prospects

It is vital to understand the difference between brine and base/precious metal prospects. Brine is a fluid hosted in an aquifer and thus has the ability to move and mix with adjacent fluids once abstraction starts. A resource estimate is based on knowledge of the geometry of the aquifer, and the variation in porosity and brine grade within the aquifer. This relates to the brines as it is in-situ. In order to assess what may be recovered from the resource over time (the reserve), further information on the permeability and flow regime in the aquifer, ***and its surroundings*** are necessary in order to predict how the resource will change over the project life. These considerations are examined more fully in Houston et al. (*in press*).

As a consequence, in this and past reports on the Salar de Olaroz Project, section 10 (Deposit Types) deals with the host aquifer, and section 11 (Mineralization) deals with the brine and the water balance, including aspects relating to brine extraction.

4.3 Definition of terms

The estimation of resources for a brine deposit requires three essential elements: the host aquifer volume, the specific yield in order to calculate the contained brine volume, and the concentration of the elements of interest. Resources should be clearly differentiated from reserves, which require knowledge of the aquifer permeability in addition, in order to estimate the recovery factor.

It is important to understand the terminology relating to porosity. **Total porosity** (P_t) relates to the volume of pores contained within a unit volume of aquifer material. Except in well-sorted sands some of the pores are isolated from each other and only the pores that are in mutual contact may be drained. This interconnected porosity is known as the **effective porosity** (P_e). Assuming that the P_e is totally saturated, only part may be drained under gravity during the pumping process. This part of the porosity is known as the **specific yield**, or sometimes the drainable porosity (S_y). A portion of the fluid in the pores is retained as a result of adsorption and capillary forces and is known as **specific retention** (S_r). These parameters are related thus:

$$P_t > P_e \qquad\qquad P_e = S_y + S_r \qquad\qquad S_y \gtrless S_r$$

The relationship between S_y and S_r depends largely on lithology. In fine grained sediments $S_y \ll S_r$, whereas in coarser grained sediments $S_y \gg S_r$. Neutron logging in wells allows N-Pt to be directly measured. The N-Pt log is a measure of the hydrogen ion content of the matrix adjacent to the borehole wall, and therefore closely reflects the water (H_2O) content in saturated strata.

In addition, the following terms and definitions are used here: **concentration** is expressed as mg/L or kg/m^3, both of which are independent of fluid density; **brine grade** incorporates the specific yield of the material, as the product of concentration and S_y, and since S_y is dimensionless, is expressed either as kg/m^3, or as kg/m^2 when it is summed over a specific Unit thickness. Also, where the word **Unit** starts with a capital letter, it refers to a stratigraphic Unit that is capable of being correlated across the salar, using geophysical, lithological, mineralogical or other techniques. A Unit does not necessarily have the same lithology everywhere; facies changes are frequent in this environment. Hence **hydrostratigraphic Units** are only partly lithologically determined, but rely to a large extent on their geological correlation and physical properties (continuity, porosity and permeability) for their delineation. The word **layer** refers to the two resource layers (0-54 m and 54-200 m) and has no geological or hydrogeological connotation.

4.4 Current program

4.4.1 Resource Evaluation

The design of the current geological and resource evaluation program for the Salar de Olaroz Project was prepared by the author in September 2009 and reported in NI 43-101 Technical Report entitled Technical Report on the Salar de Olaroz Lithium-Potash Project, Jujuy Province, Argentina, dated 30 April, 2010. A summary of the investigation program that was proposed is provided below:

- **Objectives**

The objective of the current phase of work is to develop a Definitive Feasibility Study requiring the resources to be established with a greater level of confidence. The program outlined below is intended to move towards a Measured Resource and/or a Probable Reserve under NI43-101/JORC terminology for the original claim area (where the previous resource estimate was made).

This means that for the original claim area a reliable in-situ resource estimate will be established with sufficient additional information to estimate the recoverable reserves and to identify any likely issues that require further investigation or might prove problematical during the life of mine. The program will also provide adequate information to be able to prepare a draft design for a wellfield capable of meeting the required brine feed specifications.

It is not intended that this next phase of work will provide sufficient information to be able to predict potential brine grade changes during operation and hence further work would be required before final well sites are defined. Nor will the next phase provide enough information to be able to design any works that might be required in the future to maintain an appropriate brine feed.

- **Scope of work required for resource evaluation**

Aquifer geometry and boundary conditions
It is planned to establish the reserve estimate to a depth of 50 m within the central claim blocks. An estimate of the depth of the basin is required, as well as boundary conditions to establish the limits of the reservoir, and the possible interactions between the contained brine and surrounding groundwater.

Lithological variations and nucleus hydrostratigraphy
Within the nucleus of the salar, the lithology of the aquifer is known to vary widely, from evaporitic halite and gypsum, to siliclastic and potentially volcanic sediments. The distribution of these units requires better definition, especially with regard to the movement of brine under both natural and pumping regimes.

Porosity

Fundamental to the reserve evaluation is a detailed knowledge of the porosity of the aquifer. Without going into further details here, total and effective porosity needs to be established, as well as the specific yield and specific retention of the aquifer.

Brine grade
Also fundamental to the reserve estimate is a detailed three-dimensional knowledge of the distribution of the major ions and species of economic interest. Additional hydrochemical parameters such as density, pH, temperature and total dissolved solids are required.

Permeability
The permeability of the major lithologies is required in order to assess likely flow regimes under natural and pumped conditions.

Catchment hydrometeorology, geology and hydrology
The nucleus does not exist/operate in isolation from its surroundings, so a broad understanding of the catchment characteristics are required in order to establish how the brine reservoir has become established, is maintained, and will react to future changes as a result of pumping.

Water balance and monitoring
Quantification of the catchment hydrology in space and time will allow a water balance to be established. A monitoring program to measure hydrometeorological parameters, surface water and groundwater flows, levels and quality is required to establish baseline conditions against which future changes can be compared.

- **Methodology**

Drilling
Drilling is required to obtain details of the lithology and hydrostratigraphy of the nucleus and its boundaries, and to obtain detailed porosity and brine grade data. Drill sites within the claim areas will be on approximately 2.5 km grid spacing. At one site within the nucleus a deep exploration hole to 300-400 m will investigate possible deeper targets and establish a baseline hydrostratigraphy for the salar. Four additional sites outside the nucleus will be drilled to depths of 100-200 m to evaluate the hydrogeological boundary conditions.

Core logging and testing
All logging of cores will be done on-site by an experienced geologist. Innovative core sampling techniques have been developed to obtain undisturbed samples at 100 mm and 35 mm diameter for the determination of effective porosity on-site and specific yield in a world class hydrogeological laboratory.

Geophysical logging
All holes will be logged using, natural gamma, neutron, density and sonic, to compliment the geological core logging and porosity testing.

Brine sampling
Discrete brine samples will be obtained every 6 m during drilling to obtain uncontaminated samples. Density, pH and temperature will be measured in the field. Full major ion analyses plus Li and any other species of interest will be determined in a recognized laboratory. Sampling of off-nucleus surface and groundwater will also be undertaken and a regular (twice yearly) monitoring program set up for a selected network of sites.

Pumping tests
Three pumping test sites have been selected with the claim areas. Test wells will be completed at 200 mm diameter to a nominal 50m depth. Slotted PVC casing will be installed from surface to full depth. At each test site a minimum of four and maximum of six narrow diameter observation wells will be drilled at varying distances, with piezometers set at different depths. The pump used for testing will be capable of operating over a range of flows from 5-25 l/s. Discharge of the pumped water will be >500 m away to minimize recirculation

and a “V-notch” weir tank with an automatic water level monitor installed at the discharge point to measure flow rates. Each test will initiate with a 4-step 8 hour test followed by recovery and then pumped at a constant rate for a minimum of 20 days.

Surface geophysics
Gravity survey to be conducted across the salar to provide an indication of the basin geometry and depth. Audio-magnetic tellurics surveys will be used to provide information on boundary conditions, and the location of the brine-freshwater interface.

Satellite image interpretation
Two images representing maximum wet and dry conditions are required. The dates of such imagery will be determined by analysis of historical meteorological data. Digital image processing will be required to assess the extent of marginal evaporating zones for input to water balance studies, as well as for assessing operating project logistical issues.

Regional water sampling and monitoring
A small network of monitoring points are being established for surface and groundwater. For surface water simple flow measuring equipment (flumes or stage boards) will be used, whilst for groundwater, a selection of the drilled wells (inside and outside the claim blocks) will be converted to long-term monitoring points by the installation of piezometers. A regular measuring program for flow, water level and quality will be established. A simple meteorological station, measuring precipitation, Class A pan evaporation, and max/min temperatures will be established to provide input data for the water balance analysis.

In the event, this program was extended to include investigations down to a nominal 200 m depth. The results of the additional work are included in this Technical Report.

4.4.2 Process Development

The objective of the current process development activities has been to develop a route for the brines from the Salar de Olaroz based on the “Silver Peak” type process used on brines of similar chemistry at the Clayton Valley operation in Nevada, USA, which has been in operation for over 40 years. Although in a general sense the chemistry is similar (a low magnesium to lithium ratio and elevated sulfate) there are a number of significant differences including saturation levels, grades of lithium and potassium, and difference in boron levels compared to lithium and potassium. In addition, there are significant differences in climate.

This development program and its results have been reviewed by the second author, Michael Gunn. The program was designed and supervised by Consulting Process Engineer, Peter Ehren in conjunction with other consultants and the Company’s employees. This has involved, and will continue to involve both laboratory test work at local university facilities and test work at Olaroz. This work has been designed to address:

- Evaporation rate and brine concentration
- Magnesium removal by lime addition
- Boron removal and recovery
- Lithium carbonate precipitation and purification to achieve battery grade specifications
- Differential flotation for potash recovery.

5. RELIANCE ON OTHER EXPERTS

The authors rely on the following experts:

- Santaigo Saraivia Frias, independent lawyers, of Salta for information regarding the legal status of the properties, the property agreements, permits and environmental status.
- Peter Ehren, MAusIMM, Consulting Processing Engineer, regarding various matters relating to brine characterization, brine processing and project development.
- Dr. Noel Merrick, BSc, MSc, PhD (Member, International Association of Hydrogeologists and Australian Society of Exploration Geophysicists) for the digital simulation modeling of the resource/reserves.
- Frederick Reidel, BSc, independent Consulting Hydrogeologist for the water supply investigations.
- Sinclair Knight Merz, regarding engineering design, capital and operation cost estimates
- Roskill Group Consulting Ltd regarding lithium carbonate and potash market and price forecasts.

6. PROPERTY LOCATION AND DESCRIPTION

6.1 Location

The Salar de Olaroz project is located in the Puna region of the province of Jujuy (Figure 6.1), at an altitude of 3900 m above sea level, 230 km northwest of the capital city of Jujuy.

The project site is adjacent to the paved highway which passes through the international border with Chile, 45 km to the southwest (Jama Pass), continuing on to the major mining center of Calama, and the port of Mejillones, near Antofagasta in northern Chile.

Approximately 15 kms to the north of the salar, there is a gas pipeline running from northern Argentina to Chile. There is a dehumidifying and compression station where the pipeline crosses the N-S road along the west side of Salar de Olaroz.

Approximately 70 kms to the south of the project site a railway crosses from northern Argentina to Chile, providing potential access to a number of ports in northern Chile. There are a number of local villages within 50 kms of the project site and the regional administrative centre of Susques (population 2000) is within half an hour's drive.

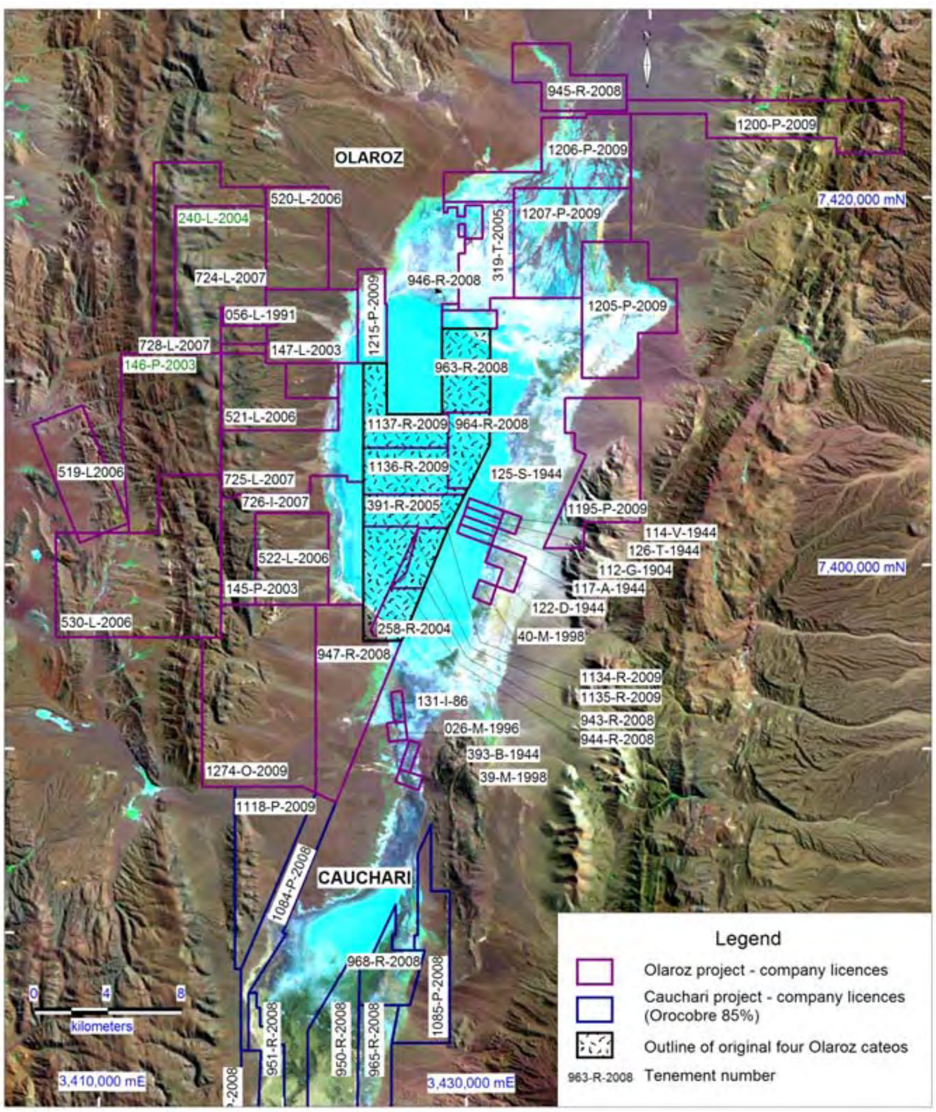
Figure 6.1 Location of the Orocobre tenements in Northern Argentina. Small squares indicate villages in the area. Orocobre Olaroz properties are shown with a red outline.

6.2 Exploration and exploitation licenses

6.2.1 Types of licenses and co-ordinate system

The location of the Company properties is shown in Figure 6.2, with additional information presented in Table 6.1. Tenement co-ordinates (and all other co-ordinates used in this report) are given in the Argentine coordinate system, which uses the Gauss Krueger Universal Transverse Mercator (UTM) projection, and the Argentine Posgar 94 datum. Claims "In process" refers to those that have been submitted to the regulatory authorities, the applications have been registered and are awaiting approval following other procedural matters. This is standard procedure and no problems are anticipated with the granting of such claims.

Figure 6.2 Tenements held by the Company in the Olaroz Salar and by 85% owned South American Salars in northern Cauchari.
Co-ordinates are in Gauss Krueger Zone 3, POSGAR94 datum.



There are two types of tenure under Argentine mining regulations; *Cateos* (Exploration Permits) and *Minas* (Mining Permits). Exploration Permits are licenses which allow the property holder to explore the property for a period of time following grant that is proportional to the size of the property. The basis of the timeframe is that an Exploration Permit for 1 unit (500 hectares) has a period of 150 days. For each additional unit (500 hectares) the period is extended by 50 days. The largest Permit is 20 units (10,000 hectares) and has a period of 1,100 days. The period commences 30 days after grant of the permit. The canon due is a single payment of ARG$400 per 500 hectares which has to be done at the moment of filing the pertinent application asking for the exploration permit.

Mining Permits are licenses which allow the holder to exploit the property subject to regulatory environmental approval. They are unlimited in duration so long as the holder meets its obligations under the Mining Code which include paying the annual canon (rent) payments, completing the survey, submitting a mining investment plan, and meeting the minimum investment commitments which is equal to 300 times the annual canon payment which must be spent within five years of the filing of a capital investment plan. The canon varies according mineral occurrence. For brines it is an annual canon of ARG$800 per 100 hectares.

The type of mineral the holder is seeking to explore and exploit must be specified for both types of tenure. Permits cannot be over-staked by new applications specifying different minerals and adding mineral species to a claim file is relatively straightforward.

The Olaroz tenement package includes both types of tenements.

6.2.2 The Olaroz tenement package

The Olaroz properties cover approximately 63,000 hectares. The Company has rights to these properties either through right of title or through a contractual right (a purchase contract where payments are made over time). Details of these property rights are set out in Table 6.1.

The property package originated as four cateos of 7,487 hectares over the salar nucleus with purchase terms set out in an agreement entered into by the Company on 27th October 2006. Subsequent to this agreement, additional property rights have been acquired through outright purchase or through purchase contracts, or applications for vacant ground. Rights to additional properties have also been acquired through applications for vacant ground under the provisions of the original contract. Total payments to complete the purchases on these properties if the contracts continue for the full term, and other smaller contracts on properties not already owned outright by the Company, are U$ 4.78 million.

There are two main agreements in terms of financial materiality. These are discussed below.

Table 6.1 Individual tenements of the Olaroz project showing the areas in hectares. Co-ordinates are in Gauss Krueger Zone 3, POSGAR94 datum.

Property Name	Title Holder	Property Right By	Tenement ID	Location	Area (Ha)	Status
CATEO	S Rodriquez	Contract	257- R- 2004	Olaroz	2,000	Granted
CATEO	S Rodriquez	Contract	258 - R - 2004	Olaroz	996	Granted
CATEO	S Rodriquez	Contract	390 - R- 2005	Olaroz	2,402	Granted
CATEO	S Rodriquez	Contract	391 - R - 2005	Olaroz	1,993	Granted
Total original 4 Olaroz cateos					**7,391**	
CATEO	S Rodriquez	Contract	947-R-2008	Olaroz	2,988	In process
CATEO	Orocobre S.A.	Title	1274-P-2009	Olaroz	5,972	In process
Analia	M Moncholi	Contract	131-I-1986	Olaroz	100	Granted
Demian	M Moncholi	Contract	039-M-1998	Olaroz	98	Granted
Ernesto	V Blanco SRL	Contract	112-G-04	Olaroz	100	Granted
Huberto	V Blanco SRL	Contract	117-A-44	Olaroz	44	Granted
Josefina	V Blanco SRL	Contract	114-V-44	Olaroz	100	Granted
Juan Martin	M Moncholi	Contract	40-M-1998	Olaroz	100	Granted
La Nena	M Moncholi	Contract	029-M-1996	Olaroz	100	Granted
Lisandro	V Blanco SRL	Contract	126-T-44	Olaroz	100	Granted
Maria Norte	M Moncholi	Contract	393-B-44	Olaroz	100	Granted
Maria, Pedro y Juana	V Blanco SRL	Contract	112-D-44	Olaroz	300	Granted
Mario	V Blanco SRL	Contract	125-S-44	Olaroz	100	Granted
Mercedes III	Termoboro SRL	Title	319-T-2005	Olaroz	1,473	In process
Oculto Norte	S Rodriquez	Contract	946-R-2008	Olaroz	400	In process
Potosi	Los Andes Compania Minera S.A.	Contract	056-L-1991	Olaroz	560	Granted
Potosi II	Los Andes Compania Minera S.A.	Contract	519-L-2006	Olaroz	2,000	In process
Potosi III	Los Andes Compania Minera S.A.	Contract	520-L-2006	Olaroz	2,000	In process
Potosi IV	Los Andes Compania Minera S.A.	Contract	521-L-2006	Olaroz	2,000	In process
Potosi IX	Los Andes Compania Minera S.A.	Contract	726-L-2007	Olaroz	2,890	In process
Potosi V	Los Andes Compania Minera S.A.	Contract	522-L-2006	Olaroz	2,000	In process
Potosi VI	Los Andes Compania Minera S.A.	Contract	147-L-2006	Olaroz	1,928	Granted
Potosi VII	Los Andes Compania Minera S.A.	Contract	724-L-2007	Olaroz	3,336	In process
Potosi VIII	Los Andes Compania Minera S.A.	Contract	725-L-2007	Olaroz	2,940	In process
Potosi X	Los Andes Compania Minera S.A.	Contract	727-L-2007	Olaroz	3,117	In process
Potosi XI	Los Andes Compania Minera S.A.	Contract	728-L-2007	Olaroz	3,182	In process
Cateo	Los Andes Compania Minera S.A.	Contract	530-L-2006	Olaroz	6,200	In process
San Antonio Norte	S Rodriquez	Contract	943-R-2008	Olaroz	564	In process
San Antonio Oeste II	S Rodriquez	Contract	1136-R-2009	Olaroz	1,199	In process
San Antonio OesteI	S Rodriquez	Contract	1137-R-2009	Olaroz	1,200	In process
San Antonio Sur	S Rodriquez	Contract	944-R-2008	Olaroz Chico	432	In process
San Fermin Norte	S Rodriquez	Contract	1134-R-2009	Olaroz	896	In process
San Fermin Sur	S Rodriquez	Contract	1135-R-2009	Olaroz	1,171	In process
San Juan Norte	S Rodriquez	Contract	963-R-2004	Olaroz Chico	1,195	In process
San Juan Sur	S Rodriquez	Contract	964-R-2008	Olaroz Chico	800	In process
San Miguel II	S Rodriquez	Contract	945-R-2008	Olaroz Chico	1,494	In process
Rio Litio	Orocobre S.A.	Title	1205-P-2009	Olaroz	2,985	In process
Rioros I	Orocobre S.A.	Title	1206-P-2009	Olaroz	2,984	In process
Rioros II	Orocobre S.A.	Title	1215-P-2009	Olaroz	793	In process
Riotin II	Orocobre S.A.	Title	1207-P-2009	Olaroz	2,994	In process
Total additional Olaroz					**62,936**	

6.2.3 Option to purchase agreement – the Olaroz Agreement

Rights to the properties over the main part of the Salar de Olaroz are held via a purchase agreement of October 27th, 2006 and addendum of October 14th, 2009. The agreements are in good standing.

The original option to purchase agreement covered four exploration permits (*Cateos*) as shown in Table 6.2. These properties and the subsequent *Minas* that were applied for over the same area are part of the original contract. The current Olaroz tenement package also includes seven *Minas* that were not included in the original contract, as they were applied for after the signing of the contract. This has been addressed by means of an addendum to the contract.

Table 6.2 Tenements covered by the Olaroz option to purchase agreement.

Agreement	Tenements covered
Original signed October 27th, 2006	Cateos: 257-R-2004; 258-R-2004; 390-R-2005; 391-R-2005
Addendum signed October 14th, 2009	MDs: 943-R-2008; 944-R-2008; 945-R-2008; 946-R-2008; 963-R-2008; 964-R-2008; 1134-R-2009; 1135-R-2009; 1136-R-2009; 1137-R-2009. Cateo: 947-R-2008 .
MD tenements covered by Cateo tenements	257-R-2004 (covered by 963-R-08 and 964-R-08); 258-R-2004 (covered by 943-R-2008 and 944-R-2008); 390-R-2005 (covered by 1136-R-2009 and 1137-R-2009); 391-R-2005 (covered by 1134-R-2009 and 1135-R-2009)

Under the agreements, the Company has the right to explore within the properties covered by the contracts, with the option to purchase the properties by paying the purchase price. Orocobre has to exercise the option in order to commercially develop a mine on the properties.

The payment remaining to maintain the purchase contract in good standing under the contracts is:

- US$ 120,000 on or before 10th August 2011

The Company may purchase the properties at any time prior to 10th February 2012 by paying US$ 1,000,000 to the vendors. In addition, following the commencement of commercial production, there are the following payments to the vendors:

- US$250,000 at the commencement of commercial production
- US$50,000 per annum for 10 years after the commencement of commercial production
- A royalty of 1.2% which can be purchased at any time for US$500,000.

6.2.4 Purchase agreement - the Los Andes Agreement

Rights to the properties on the west side of the Salar de Olaroz are held through a purchase agreement dated October 30th, 2009. The agreement is in good standing. The Company has the right to purchase the shares in Los Andes Compañía Minera S.A. (an Argentine registered company) from its shareholders by making payments which total U$ 3.5 million over four years. The remaining payments are:

- US$ 300,000 on or before 24 months
- US$ 300,000 on or before 30 months
- US$ 300,000 on or before 36 months
- US$ 500,000 on or before 42 months
- US$ 1,400,000 on or before 48 months

6.2.5 Standing of licenses

According to advice from lawyers, Santiago Saravia Frias of Salta, the third party agreements are valid and enforceable and the Company's properties are in good standing. Properties "in process" are expected to proceed over time to grant.

6.3 Environmental Liabilities

The Olaroz properties are not subject to any known environmental liabilities. There has been localized ulexite (Borax) mining within the boundaries of some of the smaller tenements in the past, but the operations weree limited to within five meters of the surface and are expected to naturally reclaim fairly quickly as mining has halted.

6.4 Permits

Exploration and mining activities on *cateos* and *minas* are subject to regulatory authority approval of an environmental impact report ("EIR"). The company has obtained approvals for its activities both through approvals on the EIRs it has lodged with regulatory authorities and relevant local aboriginal communities, and also through prior approvals on properties it has acquired or on which it has contractual rights. Subsequent EIA updates have been presented to reflect the ongoing activities. The authors are advised by Santiago Saravia Frias.

On 31 December, 2010, the Company received approval from the Jujuy Province Director of Mines and Energy Resources of the Company's Environmental Impact Statement (EIS) for the development and operation of the Salar de Olaroz lithium-potash project.

The approval followed the recommendation by the Unit of Mining Environmental Management (UGAMP) on 12 November, 2010. UGAMP is a body comprised of twelve members representing various government departments, stakeholder groups and local communities. The development recommendation was fully supported by the local community of Olaroz Chico and other regional community leaders. As part of the approval, the Company had to comply with various monitoring obligations, provide additional information on its planned construction works as the project design is finalized, and keep the local communities informed about its activities. An addenda, including the additional information requested, was recently lodged with government. Subsequent to the recommendation of UGAMP, the Company also signed an access and compensation agreement with the local community of Olaroz Chico.

Under a new decree released on March 4, 2011, the provincial government of Jujuy declared lithium a strategic mineral resource and introduced a secondary approvals process which will apply to the exploitation and exploration stages of all lithium projects in Jujuy province.

According to the new decree, in addition to an EIS approval, exploration and exploitation level projects will now require assessment by a Committee of Experts, and following a positive recommendation from this Committee, approval by the joint resolution of the Minister of Production and the Secretary General of the Provincial Government. The Committee of Experts will be comprised of six people: the Minister for Production, a representative from each of the National Council of Sciences and Technology, National University of Jujuy and Secretariat of Environmental Management, and two representatives from the Jujuy Legislative Assembly. According to the decree, additional approval will be required for both the Salar de Olaroz lithium-potash project for which the Company has already received approval of its development and production EIS, and the Cauchari lithium-potash project, for which an exploration EIS has been submitted. The Committee of Experts is being formed

No additional permits are required for surface access. The National Mining Code provides for primacy of Exploration and Mining Permit holders rights over surface owners rights and activities are permitted subject to the payment of compensation for damage caused or the lodgement of a surety with the government. In the event of a development at the Project, the Company has already negotiated a compensation package with the affected local communities.

7. ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

7.1 Accessibility, Local Resources and Infrastructure

The Olaroz project is located in the Puna area of northwest Argentina, within the province of Jujuy (Figure 7.1). The project covers an area of approximately 705 km^2, over the Olaroz Salar, which is approximately 25 km long (north-south) and 20 km across (east-west) at its widest.

The project site is adjacent to the paved highway Route 52 which passes south of the salar through the international border with Chile, 45 km to the northwest (Jama Pass), continuing on to the major mining center of Calama and the port of Mejillones, near Antofagasta in northern Chile. Approximately 70kms to the south of the project site a railway crosses from northern Argentina to Chile, providing potential access to a number of ports in northern Chile. Access to good road systems and potentially rail are important for project development.

Approximately 15 kms to the north of the salar, there is a gas pipeline running from northern Argentina to Chile. There is a dehumidifying and compression station where the pipeline crosses the N-S road along the west side of Salar de Olaroz. This has the potential to provide a gas supply for onsite electricity generation.

There is a local village close to the project site (Olaroz Chico, population ~150), and the regional administrative centre of Susques (population 2000) is within half an hour's drive and offers basic services. There are a number of other local villages within 50 kilometers radius of the salar. The company employees many people for these local communities.

Access to the area from the City of San Salvador de Jujuy, where the Company has an office, is via Route 9, which heads north-northwest for approximately 60 km, meeting the international highway Route 52 near the town of Purmamarca. Following Route 52 leads to the town of Susques. Access to the project area is from Route 52, which heads south along the eastern side of the Olaroz Salar. Route 70, leading north from Route 52, provides access to the western side of the salar. The total drive distance between the City of San Salvador de Jujuy and the Olaroz project is approximately 220 km, and takes approximately 3 hours. A potential project development could draw on local labor from Olaroz Chico, other villages and Susques and more skilled and other contract services from San Salvador de Jujuy.

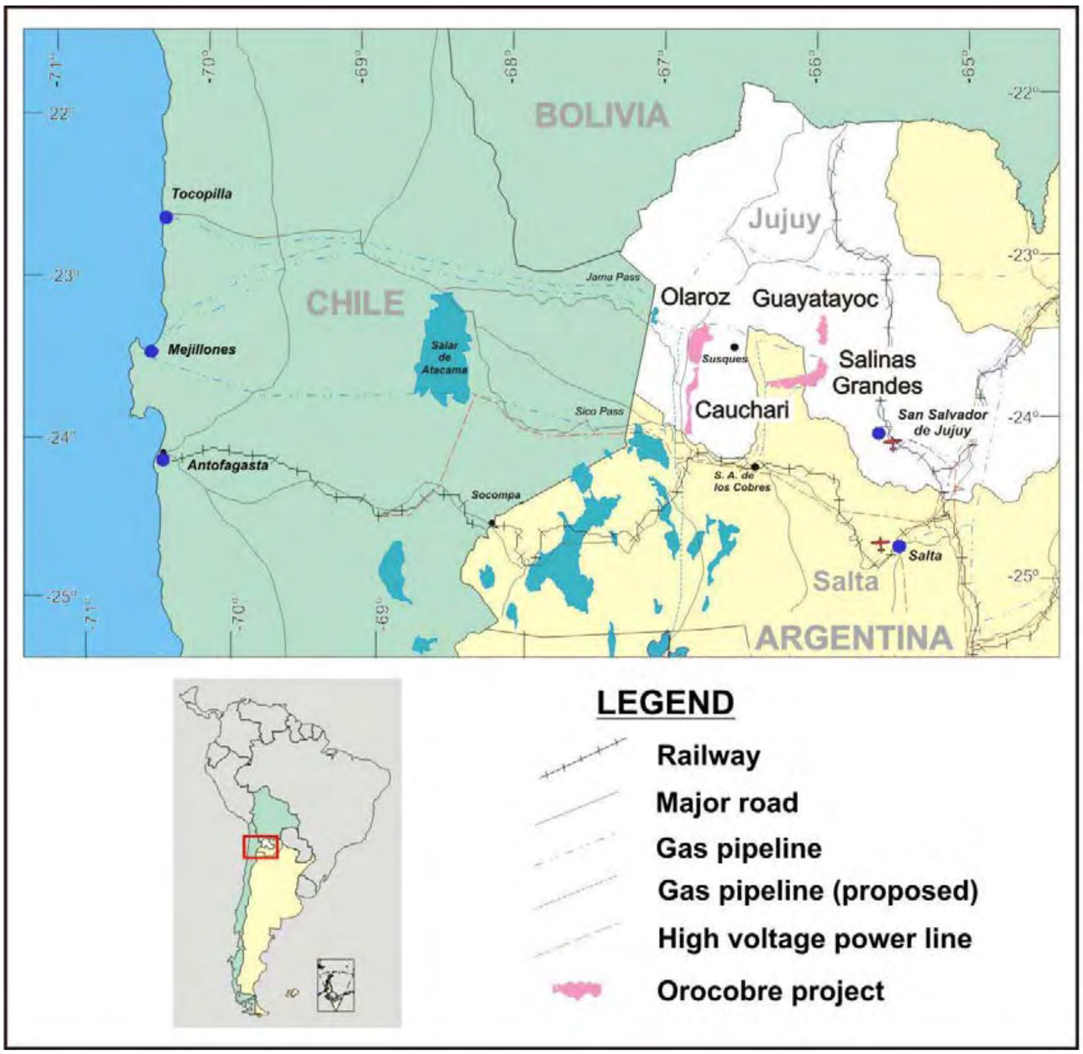
Local accommodation is provided by a basic hotel - Hostal de Pastos Chicos – located approximately 5 km west of Susques and half an hour's drive east of the project, on Route 52 leading to the Jama Pass and Chile. The hotel provides services to travelers crossing the international border. A company camp has also been established on the east side of the salar on one of the company's properties.

7.2 Physiography

The Altiplano-Puna is a high elevated plateau within the central Andes (Figures 7.2, 7.3). Part of the central Andes the Puna covers part the Argentinean provinces of Jujuy, Salta, Catamarca, La Rioja and Tucuman with an average elevation of 3,700 m above sea level.

The Altiplano-Puna Volcanic Complex (APVC) is located between the Altiplano and Puna, and is associated with numerous stratovolcanoes and calderas. Recent studies have shown that the APVC is underlain by an extensive magma chamber at 4-8 km depth (de Silva et al., 2006). It seems likely that this could be the ultimate source of the anomalously high values of lithium in the area.

Figure 7.1 Project location, access and infrastructure.



The physiography of the region is characterized by basins separated by ranges, with marginal canyons cutting through the Western and Eastern Cordilleras and numerous volcanic centers, particularly in the Western Cordillera. Abundant dry salt lakes (salars) fill many basins (see Figure 7.3 below).

The Olaroz-Cauchari salars are located in a closed basin, with internal (endorheic) drainage. The combined Olaroz-Cauchari basin is split in two by the delta of the Archibarca River, which enters the basin from the west. The Olaroz salar project is located in the northern portion of the basin (Figure 7.3). The elevation at the surface of the salar is approximately 3900 m asl. The salar is a flat area, probably hydraulically connected with the Cauchari salar to the south. The water inflow into the salar is produced by precipitation, superficial and groundwater inflows. The largest surface water drainage is that of the Rosario River, draining from the north into the Olaroz salar. Deltaic fans are formed in the northern area where the river enters into the salar. The approximately area of the basin is 6,000 km^2. Drainage within the salar is towards the interior, where discharge occurs by evaporation. The drainage basins of the salars in the Orocobre tenement package are shown in Figure 7.4.

Figure 7.2 Physiographic and morphotectonic features of the Central Andes, showing the Altiplano-Puna Volcanic Complex (APVC) and associated stratovolcanoes (triangles) and calderas (circles). The locations of the salar projects are shown in yellow. 1) Olaroz, 2) Cauchari, 3) Salinas Grandes, 4) Guayatayoc.

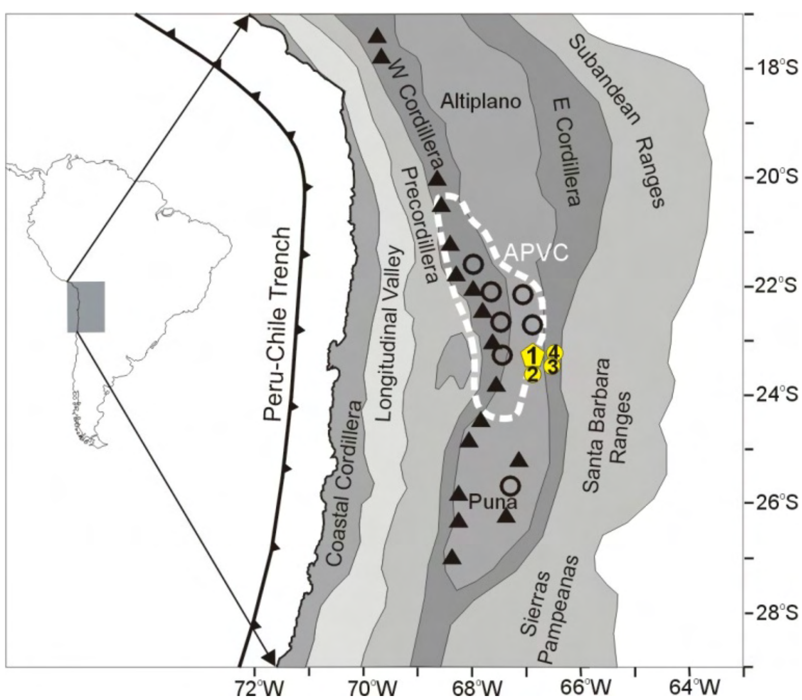


Figure 7.3 Digital elevation model of the Puna showing the location of salars and the salar project areas Olaroz, Cauchari, Salinas Grandes and Guayatayoc

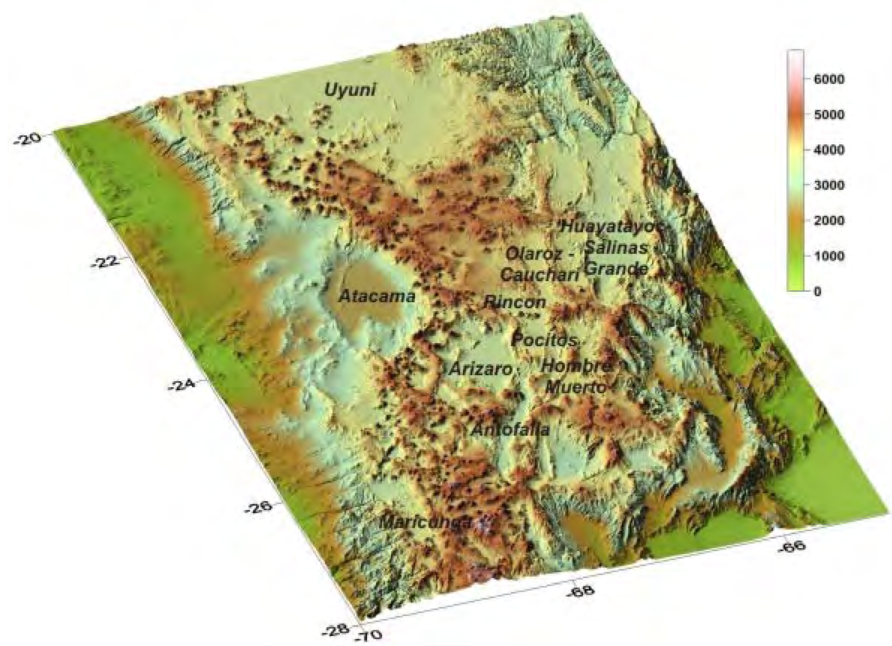
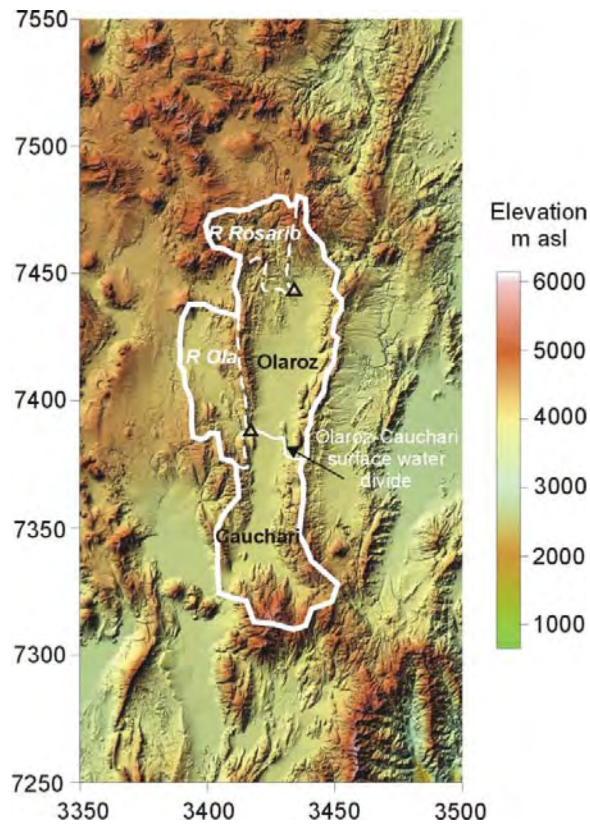


Figure 7.4 Catchment area draining to the Olaroz-Cauchari salars. Surface water flow monitoring points shown as triangles.



7.3 Climate

The climate in the project area is severe, although not so severe as to restrict working activities at any time during the year. Daily temperature variations up to 25°C. The climate can be described as a continental cold high altitude desert, with resultant scarce vegetation. Solar radiation is intense, especially during the summer months of October through March, leading to high evaporation rates.

The climatic conditions are considered attractive for solar evaporation processes. Although not quite as high as the evaporation rate at Salar de Atacama, the conditions are expected to be very similar to the Salar Hombre Muerto, which has been producing lithium for over 10 years and is located 230 km south of Olaroz.

Due to the remote location there is limited historical climate data available for the project. Because of the inadequate local climate data for the project the company has established local automated weather stations, although data collected is still limited to date.

At the Salar de Olaroz three weather stations have been installed. In the center of the salar a Davis Weather with a solar radiation sensor is installed, and on the eastern border of the salar, an Easy Weather Station has been installed, whilst in the northern part of the salar, another Easy Weather Station has been installed.

Partial data collection between September 2008 and July 2009 showed the average temperature was 8.24ºC; the average wind speed 21.90 km hr^{-1}; the average relative humidity 30.6%, and the accumulated rainfall 84.9 mm total.

Figure 7.5 A weather station installed at the Salar by the Company.

7.3.1 Rainfall

The main rainy season is between the months of November to March, when most of the annual rainfall occurs, often in brief convective storms that originate from Amazonia to the northeast. The period between April and October is typically dry. Annual rainfall tends to increase towards the northeast, especially at lower elevations. Significant control on annual rainfall variability is exerted by ENSO (El Niño-Southern Oscillation), as recently observed during summer 2010-11 due to the development of a strong La Niña (cold phase) episode.

Only limited precipitation data are available for the Olaroz project. Orocobre has been collecting precipitation data on the Salar at three portable weather stations since 2008, but unfortunately due to instrumentation malfunctions no complete annual data are available. The following table provides data from Olaroz and five nearby weather stations.

Table 7.1 Average monthly rainfall in mm, standardized over the rainfall period 1982-1990.

Olaroz project weather station, 60 km west of project August 2008-September 2009 (3900 m)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
19	15.5	9.4*	0	0	0	0	0	0	0*	0*	5*	48.9*
Hombre Muerto salar, 180 km south of project 2008-2009 (4000 m)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
8.7	17.1	25.2	0	0	0	0	0	0	2.4	4.2	17	74.6
Susques, 50 km west of project 1982-1990 (3675 m)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
53.3	58.3	30.4	0.6	0	0	0	0	0	0.3	16	29.1	188.1
La Quaica, 185 km northeast of project 1982-1990 (3442 m)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
80.3	72.6	52.4	11.8	0	0	0	0	0	12.8	35.2	73.9	339
Mina Pan de Azucar, 120 km northeast of project 1982-1990 (3690 m)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
100.6	100	66.4	19.7	0	0	0	0	0	6.7	76.3	87.9	457.6
Olacapato, 65 kms South of project 1950-1990 (3820 m)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
34	23	4	0	0	0	0	0	0	0	0	10	71
*data incomplete												

Based on this data, and both the location and elevation of the Salar in relation to regional precipitation patterns (Houston, 2006a), it is calculated that a mean annual rainfall of 130 mm is probable for the Salar, with monthly distribution as shown in Figure 7.6.

7.3.2 Temperature

Records from the weather station at Susques (35 km east of Olaroz) and the Olaroz weather station include temperature (Table 7.2) in addition to rainfall.

The average annual temperature at the project site is approximately 7° C, with extremes of 30º C and -15º C. The coldest months with temperatures below zero correspond to May through August. November till March are months with almost no frost. Details are collated in the Table 7.2, below. An annual mean temperature of 8 °C was registered in the locality of Catua, with 6 ºC measured in the Hombre Muerto salar during the 1979 - 1995 period.

Table 7.2 Average monthly temperature °C at the Olaroz weather station and other weather stations in northwestern Argentina

Olaroz project weather station, August 2008-September 2009 (3900 m)													Average
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean	12.8	14.1	11.6	10.8	6.9	5.1	4.3	5.3	5.5	9.3	11.5	13.0	9.2
Maximum	22.9	24.1	21.9	21.6	19.1	15.5	13.4	16.8	17.9	21.2	22.6	24.1	20.1
Minium	2.7	4.1	1.4	-0.8	-5.2	-5.3	-4.9	-6.3	-7.0	-2.7	0.4	1.9	-1.8
Susques, 35 km east of project 1972-1996 (3675 m)													
Mean	11.3	11.2	10.5	8.1	4.9	3.0	2.5	4.6	6.6	8.9	10.4	11.1	7.8
Other Puna area data													
La Quiaca	12.3	12.0	12.2	10.0	6.4	3.9	4.1	5.8	8.6	10.4	12.0	12.2	9.2
Abra Laite	11.3	11.2	10.5	8.2	5.1	3.2	2.7	4.7	6.6	8.9	10.4	11.0	7.8
Barrios	11.9	11.7	11.2	9.0	6.1	4.2	3.7	5.7	7.5	9.8	11.1	11.6	8.6
Cangrejillos	11.6	11.5	10.2	7.5	4.0	1.6	1.1	3.3	5.4	7.8	10.1	11.4	7.1
Castro Tolay Abdon	12.4	12.2	11.5	9.1	6.0	4.0	3.4	5.6	7.6	10.0	11.5	12.2	8.8
Abra Pampa	11.8	11.8	11.5	10.6	6.5	4.0	3.9	6.1	8.5	10.5	11.8	12.2	8.0
Susques	10.8	10.6	10.2	8.3	5.0	2.3	2.0	3.8	6.1	9.8	10.3	11.1	7.5
Tres Cruces	10.3	10.2	9.7	8.5	5.4	3.3	3.1	5.1	7.4	9.0	10.5	10.7	7.8
Cieneguillas	10.7	10.7	10.3	8.2	5.3	3.5	2.9	4.8	6.5	8.8	10.0	10.5	7.7
Cochinoca	11.2	11.0	10.5	8.3	5.2	3.4	2.8	4.8	6.7	9.0	10.3	10.9	7.8
Condor	10.0	10.0	9.6	7.5	4.5	2.8	2.1	4.1	5.8	8.0	9.3	9.8	7.0
Coranzuli	9.1	9.1	8.6	6.4	3.3	1.6	0.9	3.0	4.8	6.9	8.3	8.9	5.9

7.3.3 Wind

Strong winds are frequent in the Puna, reaching speeds of up to 80 km hr^{-1} during warm periods of the dry season. During summer, the wind is generally pronounced after midday, usually calming during the night. During this season, the winds are warm to cool. During winter wind velocities are generally higher and more frequent.

Table 7.3 Mean wind speeds (km hr^{-1}) for stations in northwest Argentina.

Localidad	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Purmamarca	3.56	3.79	4.28	4.3	5.58	5.04	4.7	3.61	3.99	5.03	4.44	3.86	4.35
Susques	2.37	3.38	4.73	4.62	6.6	4.38	1.68	3.61	4.09	4.44	2.32	2.62	3.74
Olaroz	6.4	7.4	8.7	8.6	10.6	8.4	5.7	7.6	8.1	8.4	6.3	6.6	7.7

7.3.4 Evaporation

Class A evaporation pans with both fresh water and brine have been in operation at the Salar since 2008 (Figure 7.6). Monthly pan evaporation is given in Table 7.4 and shown in Figure 7.6.

Figure 7.6 Class A Evaporation Pan and Pan A bis installed at Olaroz.

Table 7.4 Average monthly open "water" evaporation in mm recorded at the Salar de Olaroz.

	density (gm/cm^3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Freshwater	1.000	383	331	356	307	201	213	221	242	332	461	421	433	3,900
Brine	1.198	248	173	234	208	133	162	173	180	236	327	276	265	2,614

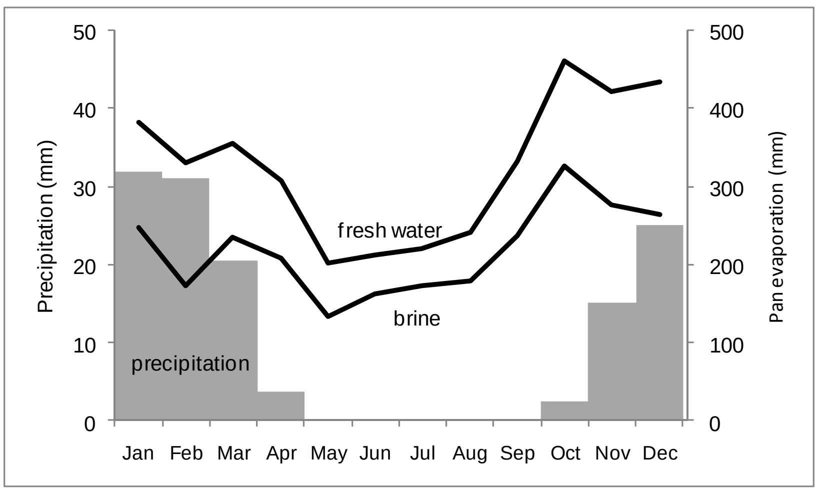
Evaporation reaches a maximum in October at the start of summer and prior to the wet season, which as a result of increased cloud, causes the observed reduction in evaporation. Minimum evaporation rates occur between May to August. The total annual evaporation recorded at Olaroz is significantly higher than expected when compared with other salars in the region (Table 7.5), and should thus be considered provisional until further data is obtained.

Table 7.5 Comparison of mean annual evaporation in mm from Class A pans in different salars

	fresh water	brine
density (gm/cm^3)	1.0	±1.2
Olaroz	3,900	2,614
Atacama	2,920	2,081
Hombre Muerto	2,515	1,916

Figure 7.6 shows that mean open "water" evaporation is approximately ten times higher than precipitation, indicating that such evaporation rates can only be maintained when there is available water at or above the ground surface and decreases when the water bale is below the ground surface.

Figure 7.6 Monthly precipitation for the Salar de Olaroz compared with Pan evaporation. The synthetic precipitation is taken as 13 mm/a factored by the mean monthly rates in Table 7.1.

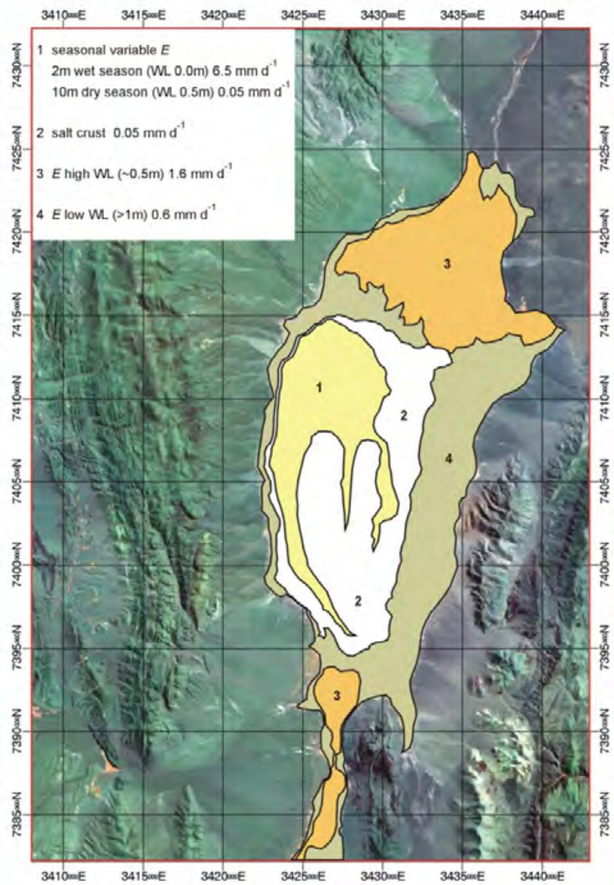


Note also that evaporation from brine at density of 1.198 gm/cm^3 is reduced to 67% of that from fresh water. The pan evaporation data should be representative for open "water" conditions, but not for wet soils. Since large areas of the Salar, and its surroundings have high water tables, these areas also evaporate inflowing waters. It has been shown that both salinity (density) and depth to water or brine influence evaporation rates in a predictable manner (Houston, 2006b), so that it is possible to derive reliable estimates for the Salar de Olaroz.

No direct measurements of evaporation have been made from nucleus or marginal zones at Olaroz, but significant data is available from studies undertaken during 1992 at the Salar de Hombre Muerto where conditions are considered to be comparable. The studies at Hombre Muerto consisted of the installation and monitoring of six lysimeters in different soil types, as well as a Bowen ratio station on the halite crust (WMC, 1992). Different soil types and depths to the water table can be identified on satellite imagery. Based on this interpretation, coupled with ground surveys, a map of differing soil types and evaporating zones has been prepared for the Salar and its margins (Figure 7.7). Using the methodology outlined in Houston (2006b) mean evaporation rates for each of these zones have been estimated, independently of the pan evaporation results.

- Zone 1: salar nucleus (salt crust) with mean annual flooding during a two month wet season, and with a 10-month dry season. The annual average evaporation rate is calculated at 1.1 mm/d. Zone 1 covers an area of 50 km^2 in Salar de Olaroz.
- Zone 2: salar nucleus (salt crust) without annual flooding. The annual average evaporation rate is set at 0.05 mm/d. Zone 2 covers an area of 105 km^2 in Salar de Olaroz.
- Zone 3: marginal zone with depth to groundwater approximately 0.5 m. The annual average evaporation rate is calculated at 1.6 mm/d. Zone 3 covers an area of 80 km^2 in Salar de Olaroz.
- Zone 4: marginal zone with depth to groundwater greater than 1.0 m. The annual average evaporation rate is calculated at 0.6 mm/d. Zone 4 covers an area of 115 km^2 in Salar de Olaroz.

Figure 7.7 Evaporation zones of the Salar de Olaroz and its margins, with estimates of mean daily evaporation for each zone based on depth to the water table and fluid density, factored from measured data in the Salar de Hombre Muerto.



7.4 Vegetation

Due to the extreme weather conditions in the region, the predominant vegetation is of the high-altitude xerophytic type adapted to high levels of solar radiation, winds and severe cold. The vegetation is dominated by woody herbs of low height from 0.40 - 1.5m, grasses, and cushion plants. With high salinity on its surface, the nucleus of the salar is devoid of vegetation.

To date no specific vegetation survey had been carried out in the tenement area. However, it is possible to define a number of vegetation areas, based on their physiography.

7.4.1 Low lying areas in the vicinity of water

These environments are characterized by having vegetation cover of 70-85, occupying small areas (1 km maximum) associated with water logged soils and more or less permanent bodies of water.

7.4.2 Mixed Steppes

Different types are recognized, depending on the grass species, which may consist of *Stipa sp.*, *Festuca sp.* and *Panicum chloroleucum*.

7.4.3 Bushy Steppes

Three different types are recognized, depending on the dominant bush species, such as rica-rica (*Acantholippia sp*.), tall tolillar (*Fabiana densa*) and short tolillar (*Fabiana sp*.).

7.5 Fresh and process water supply

7.5.1 Demand

Water supply requirements for the Olaroz Project are projected to total 20 l/s and consist of the following components:

- high quality fresh water: 4 l/s
- brackish process water: 10 l/s
- contingency: 6 l/s

7.5.2 Work carried out

A review of hydrogeology, satellite images, borehole logs, water chemistry data, and the legal status of mining claims was carried out to finalize potential groundwater exploration targets. This review led to the selection of the Rio Rosario basin as the primary groundwater exploration target, with the Archibarca alluvial fan as an alternate.

Water supply exploration hole WSE-1 is located in the Rio Rosario basin at 7.427.500 m N, 3.433.750 m E and at an elevation of 3,965 m asl. WSE-1 was initially drilled by Valle using conventional rotary method at 5-inch diameter to a depth of 65 m. After review of the favorable drill cuttings the exploration hole was reamed to 17-inch diameter from surface to total depth. The well was completed with 10-inch diameter Schedule 80 PVC blank casing from ground-surface to 35 m and with 10-inch diameter Schedule 80 PVC slotted (1 mm) casing from 35 m to 65 m. The annulus was completed with gravel pack to TD. The well was developed and completed with a surface cement seal, and a 20 HP submersible pump (BMS 669/20) was installed in the well to carry pumping test work. The well is completed in medium- to coarse-grained clean gravel units that are inter-bedded with medium grained sandy gravel layers. These gravel sequences are part of the Rio Rosario flood plain sediments and form a permeable aquifer unit. The static water level in the well is 5.9 m.

A variable rate pumping test was carried out at 11,5 l/s (120 min), 16 l/s (120 min) and 21 l/s (180 min). The results of the step test analysis indicate that the well has a high efficiency of 98%. A constant rate pumping test was carried out in production well WSE-1 at a pumping rate of 20 l/s over a period of 6 days. The maximum observed drawdown at the end of the pumping test was 3.2 m. The transmissivity (T) is calculated at 2,519 m^2/d and the hydraulic conductivity (K) at 42 m/d.

A water sample was collected during the pumping test for laboratory analysis by ASA. A second sample was collected on completion of the pumping test for analysis by Induser. The results of the laboratory analyses indicate total dissolved solids (TDS) concentrations up to 2,473mg/L, with lithium of 9 mg/L and boron of 36 mg/L.

Exploration hole DWS was drilled to investigate the hydrogeological conditions on the south side of the Olaroz Salar. Valle installed an initial shallow hole to 15 m depth immediately adjacent to DWS (completed with 4-inch diameter PVC slotted casing) to provide water for the DWS drilling operation (this shallow hole was called "Analia"). DWS was drilled using conventional rotary method at 5-inch diameter to a depth of 200 m.

A constant rate pumping test was carried out in well "Analia" at a pumping rate of 1.6 l/s over a period of 2,520 minutes. The maximum observed drawdown at the end of the pumping test was 0.81 m. The transmissivity (T) is calculated at 1,000 m^2/d and the hydraulic conductivity (K) at 67 m/d.

Concentrations of total dissolved solids (TDS) in the adjacent well DWS are around 2,000 mg/l in the upper 50 m interval of the well. Below 50 m the TDS concentrations increase to 48,000 mg/l at a depth of 200 m.

7.5.3 Discussion

The gravity profile (see Figure 12.7) indicates that the gravels of the Rosario fan-delta have a thickness of up to 400 m. The hydraulic gradient is estimated at 0.0025 and the results of the WSE-1 pumping test indicate that the hydraulic conductivity is up to 40 m/d. Assuming an average hydraulic conductivity across the full width of the section of 20 m/d, the groundwater through-flow in the Rio Rosario flood plain sediments is estimated at 38.3 million m^3/a. The project water supply requirements are approximately 631,000 m^3/a, or less than two percent of the annual groundwater through-flow.

The drainable porosity of the Rio Rosario basin sediments is assumed to be 10 percent, so that the groundwater storage in the Rio Rosario basin is on the order of 4,800 million m^3. The total project water consumption over a 40 year mine-life is approximately 24 million m^3 or less than 0.5 percent of all groundwater in storage.

An alternate water supply is available in the Archibarca alluvial fan. Groundwater inflow to the Salar takes place through the alluvial sediments in the canyon at Archibarca. The gravity profile (Figure 12.8) shows that the alluvial sediments across the Archibarca canyon have an average thickness of approximately 50 m. The hydraulic gradient across this area is estimated at 0.0075. Hydraulic conductivity (K) across this section is estimated at 20 m/d. Groundwater through flow is estimated to be on the order of 2,500,000 m^3/a. The project water supply requirements are approximately 631,000 m^3/a, or 25 percent of the annual groundwater through flow.

The drainable porosity of the Archibarca fan sediments is assumed to be 10 percent so that the groundwater storage in the alluvial fan below the Archibarca "gap" is estimated on the order of 400 million m^3. The ATM section (Figure 12.14) suggests that the thickness of the "fresher" water unit within the Archibarca fan approximately 50 m. The lateral extent of this fresher water unit can be interpreted to pinch out somewhere between "Analia" and C19 to the north, by the 3,425,000 m E easting to the east and by the 7,383,000 m N northing to the south. Due to the relatively limited volumetric extent of the "fresher" water unit within the Archibarca fan, the water quality of a production well in the Archibarca fan may deteriorate over the life of the Project, although it is difficult to predict the extent of this water quality deterioration at this stage.

8. HISTORY

8.1 Pre-Orocobre

Fabricaciones Militares (Argentine government agency) carried out sampling of brines from Puna salars, in 1970. The presence of anomalous Li values was detected at this time, when only salt and borates were exploited from the Puna salars.

Initial evaluation of the mineral potential of the salars in Northern Argentina is documented by Igarzábal (1984) as part of the Institute of Mineral Benification (IN-BE-MI) investigation carried out by the University of Salta. This investigation involved a geological and geomorphic evaluation and limited sampling of salars in the Puna for Li, K and other elements. The Olaroz and Cauchari salars showed amongst the highest lithium values in this investigation with values of 0.09 % Li and 0.56% K at Olaroz, and 0.092% Li and 0.52% K at Cauchari.

8.2 Orocobre pitting program 2008

Orocobre undertook pit sampling of the Olaroz salar on a variable grid between March and May 2008, to evaluate lithium concentrations and the superficial salar geology. The initial sampling included a total of 62 brine samples from 60 pits. Summary statistics for these pits are given in Table 8.1 below.

Table 8.1 Pit sample statistics.

	Li	K	Mg	Mg/Li
N	62	62	62	62
Mean	641	8,918	1,964	3.1
Standard deviation	225	2,837	724	0.7
Max	1,207	16,219	3,926	8.0
Min	168	3,249	839	2.6

The results of the pitting program confirmed similar values to the earlier Institute of Mineral Benification program and lead to the decision to drill a series of holes at regular intervals across the salar, to evaluate the distribution of porous brine host lithologies and to obtain additional brine samples for analysis.

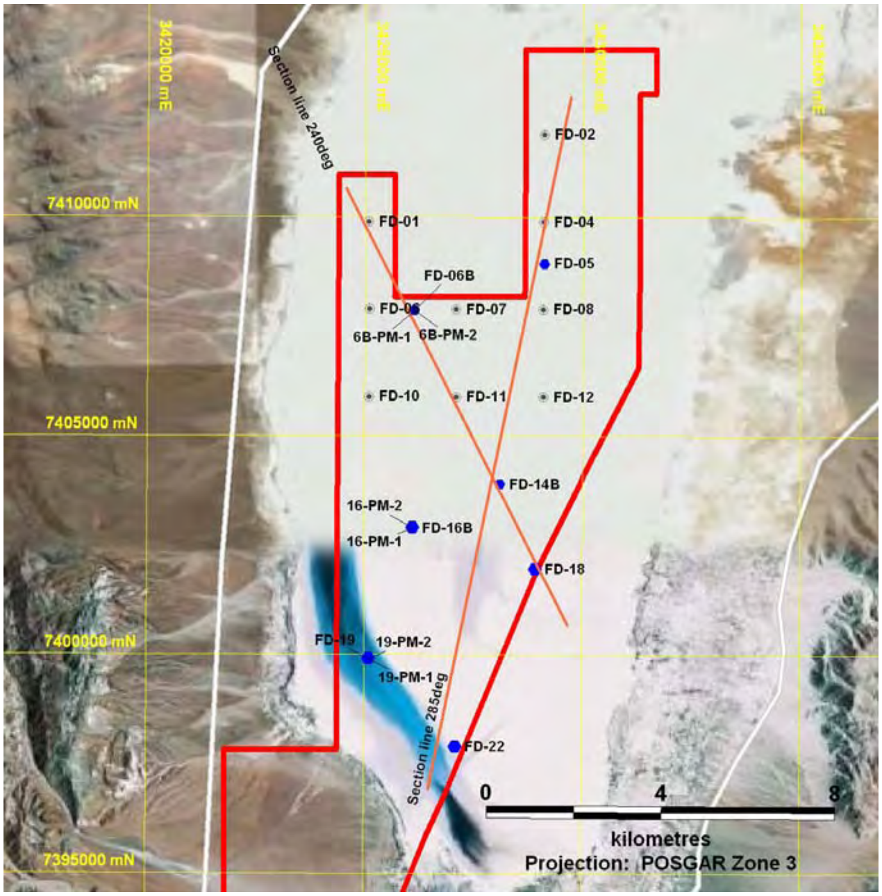
8.3 Orocobre drilling program 2008

8.3.1 Drilling

Orocobre undertook a drilling program between 4 September and 2 December 2008 using Falcon Drilling. Twenty-two HQ3 diamond core holes were drilled, totaling 1496.3 m. Drillhole locations were based on handheld GPS readings and their location is shown in Figure 8.1.

The initial 16 HQ3 diamond drill holes (core diameter 61 mm) in the program were drilled on a variable grid, to an average depth of 60 m. Two holes in this program were drilled to greater depths of 125.4 and 199 m. Six further HQ3 holes were drilled as monitoring wells for the hydrogeological test work.

Figure 8.1 Locations of boreholes, showing pumping and observation wells and the position of the section shown in Figure 8.7 (from Geos Mining, 2009).



8.3.2 Interpretation of drilling results

Diamond drilling was carried out with the triple tube drilling system. However, core recoveries were very poor with an average recovery of only 44%. The poor core recovery was attributed to the unconsolidated nature of the salar deposits and loss of the sand and other unconsolidated layers during drilling. Orocobre geologists conducted detailed geological logging of the drill core. Lithological units encountered include sand, silt, clay, halite and ulexite (borate).

Geophysical logs, self-potential, short and long resistivity, and natural gamma were run in the 7 holes which had been cased to significant depths. The logging was limited to the upper sections of these holes as a result of fine sediment filling the basal sections through the slotted casing. This was to a depth of between 27 m to 45 m with an average of 34m. These, together with geological logs of the recovered material provide the basis of the later geological interpretation of the subsurface by Geos Mining. Since the geophysical logs did not extend to the full depth of most bores, the interpretation of the deeper lithologies relied solely upon the core logging.

8.3.3 Geological interpretation

The surface of the salar was considered by Geos Mining (2009) to show typical zoning, with deposition of carbonates on the margins of the salar. Gypsum is deposited further towards the center, with halite forming a central zone.

At depth, the Olaroz salar consists of bedded fluvial and lacustrine sediments that comprise gravels, sands, silts and clays interbedded with evaporites (primarily halite, with minor sulfates and ulexite).

The drill logs were interpreted to show a near-surface halite layer, termed Zone 1 by Geos Mining (2009). Beneath the halite unit is a zone of mixed clays, sands and silts down to around 45-60 m below the salar surface. This unit was termed Zone 2. For those holes greater than 60 m deep, the underlying units showed a significant change being more consolidated, with higher clay content. This unit was defined as Zone 3 in the Geos Mining (2009) resource model of the salar. Zone 3 was not included in the subsequent resource estimate.

8.3.4 Porosity measurements

Porosity measurements undertaken by Orocobre were made by measuring moisture content of the recovered drill core. The technique proved difficult in practice because of the unconsolidated nature of the material, bias toward more consolidated core, and the errors associated with weight conversions to volume. Measuring moisture content approximates to total porosity. Values ranged from 32%-44% for a wide range of material, from muddy sand to sand.

8.3.5 Brine depth sampling

Excluding hydrogeological monitoring holes, cased bores were established to significant depths at 7 of the core drillhole sites across the salar. The core drill holes were reamed out with a tri-cone bit to a diameter of 165 mm (6 ½ inches) and a well screen of 100 mm (4”) diameter PVC was installed from 0.5 m below surface to the total depth of the hole, with 2-3 cm long slots.

Subsequent to completion of the bores, they were developed by airlifting to establish data on potential yields, to ensure that all drilling fluid and cuttings were removed, and the brine bearing zones were in good hydraulic connection with the test bore.

During airlift development and subsequent testing, airlift flow rates were monitored with a V-notch weir, or more normally by filling a known volume. The airlift flow data established bores with high yields and several with low yields. This information was used to plan the subsequent pumping tests.

Brine sampling was undertaken by Company staff in December 2008, with re-sampling of some bores during the February 2009. The results of the sampling program being presented below in Table 8.5.

Because of the construction of the bores with screened sections throughout the test bore, pumped samples with the pump set at specific depths do not represent discrete depth samples, but are integrated samples, with brine volumes in proportion to the transmissivity of different layers within the aquifer(s).

Table 8.2 Results for brine analyses from wells (ASA Analyses).

Well	Depth (m)	Sample #	Sample Date	Li	K	Mg	Na	Ca	B	Mg/Li	B/Li	K/Li
W01	13	416	17-Dec-08	560	3983	1259	107836	466	652	2.25	1.16	7.11
W01	13	432	07-Feb-09	602	4651	1321	110058	521	713	2.19	1.18	7.73
W02	0.7	425	07-Feb-09	1016	9174	2835	112421	739	973	2.79	0.96	9.03
W04	0.7	426	07-Feb-09	1159	9964	3332	111498	529	898	2.87	0.77	8.60
W 05	25	417	17-Dec-08	1018	8372	2996	112936	493	899	2.94	0.88	8.22
W 05	25	427	07-Feb-09	717	6596	2013	114384	721	637	2.81	0.89	9.20
W 05	19	428	07-Feb-09	871	6902	2383	111284	557	831	2.74	0.95	7.92
W 05	13	430	07-Feb-09	795	7101	2239	116913	660	708	2.82	0.89	8.93
W06	4	431	07-Feb-09	673	6076	1400	115375	817	633	2.08	0.94	9.03
W06 Bis	36	415	16-Dec-08	748	NR	2154	NR	279	457	2.88	0.61	NR
W06 Bis	0	419	06-Feb-09	740	6386	2123	114125	710	741	2.87	1.00	8.63
W06 Bis	25	420	07-Feb-09	712	6443	2067	112624	745	731	2.90	1.03	9.05
W06 Bis	13	421	07-Feb-09	739	6551	2081	113080	743	746	2.82	1.01	8.86
W07	4	422	07-Feb-09	1108	9228	3461	111906	554	940	3.12	0.85	8.33
W08	4	424	07-Feb-09	800	7418	2255	114236	687	713	2.82	0.89	9.27
W10	4	433	07-Feb-09	285	2839	805	117246	1172	316	2.82	1.11	9.96
W11	25	418	18-Dec-08	1267	10037	4293	113526	310	1085	3.39	0.86	7.92
W11	4	434	07-Feb-09	1192	9611	3634	117008	282	1043	3.05	0.88	8.06
W12	13	435	08-Feb-09	566	5130	1365	110872	796	568	2.41	1.00	9.06
W 14 Bis	24	401	04-Dec-08	939	7167	2592	119167	395	1062	2.76	1.13	7.63
W 14 Bis	13	436	08-Feb-09	498	4598	1341	114655	740	497	2.69	1.00	9.23
W 14 Bis	31	438	08-Feb-09	508	4763	1360	114090	727	520	2.68	1.02	9.38
W 16 bis	30	408	14-Dec-08	749	6200	2230	112399	463	860	2.98	1.15	8.28
W 16 bis	13	441	09-Feb-09	497	4664	1342	111772	795	536	2.70	1.08	9.38
W 16 bis	19	442	09-Feb-09	495	4764	1360	111667	806	551	2.75	1.11	9.62
W 16 bis	30	443	09-Feb-09	502	4605	1323	111200	798	538	2.64	1.07	9.17
W18	30	402	05-Dec-08	946	7508	2429	115074	369	1033	2.57	1.09	7.94
W18	13	439	08-Feb-09	610	5353	1667	110185	612	660	2.73	1.08	8.78
W18	19	440	08-Feb-09	644	5557	1649	109055	624	670	2.56	1.04	8.63
W19	36	404	08-Dec-08	555	4168	1656	114439	544	844	2.98	1.52	7.51
W19	13	445	09-Feb-09	467	3822	1124	111652	712	624	2.41	1.34	8.18
W19	22	446	11-Feb-09	454	3833	1164	112002	763	579	2.56	1.28	8.44
W19	31	447	11-Feb-09	463	3911	1185	110290	758	588	2.56	1.27	8.45
W22	30	403	07-Dec-08	607	5063	1419	118824	425	867	2.34	1.43	8.34
W22	11	448	11-Feb-09	273	2773	725	111994	983	415	2.66	1.52	10.16
W22	25	449	11-Feb-09	334	3301	871	109134	947	466	2.61	1.40	9.88

8.4 Pump test program

At three of the test bores, two additional holes drilled were constructed as observation bores for pumping tests. Pump testing was carried out by Company staff. Pump testing consisted of three constant rate drawdown tests of between 5.5-24 hours duration, and five pumped well recovery tests. Airlift yields of up to 420 $m^3\ d^{-1}$ (4.9 $l\ s^{-1}$) were achieved. Australian Groundwater Consultants (2009) analyzed the results which indicated permeability ranging from 0.5-5 m/d, and specific yield from 0.02-0.26. Such values are typical for fine sands.

8.5 Geos Mining Report

Geos Mining of Sydney, Australia, were contracted to undertake an initial resource assessment of the Olaroz salar. Their report (Geos Mining, 2009) concluded with an Inferred Resource estimate.

The estimate was based on an interpreted two Zones: 1 with an average thickness of 11 m and 2 with an average thickness of 54 m. Values of specific yield were assigned to these zones based in part on observed field characteristics and in part on literature values. Average values of 0.22 were used for sand lithologies, 0.05 for halite and 0.01 for clays. These specific yields were applied to the lithologies recorded in each hole, and for each zone a lithology-thickness weighted specific yield was calculated.

As there were two sampling rounds conducted from the bores, with some repeat sampling in the February round, assays accepted from each hole for use in the resource estimate were determined by Geos Mining (2009) as follows:

- If the February, 2009 assays were comparable to the December, 2008 assays, the average of all assays was used,
- If the February, 2009 results were significantly different, the average of the December, 2008 assays only was used,
- For those holes that were not sampled in the December program the average of the February assays was used.

This procedure results in a conservative estimate of the brine concentration.

Based on the drillhole data, and using the claim boundaries within the area of the Salar, the volumes of the host aquifer for Zones 1 and 2 was calculated as $545x10^6$ and $3,455x10^6\ m^3$ respectively.

For each Zone and each hole Geos Mining estimated an equivalent brine thickness based on the total thickness for each lithology multiplied by it s specific yield, and then summed for each borehole. The product of equivalent brine thickness and the average concentration in each borehole provided an estimate of tonnage for each borehole site. These values were then contoured using the minimum curvature method and the total volume calculated. Average concentration values for Li and K across the resource volume were calculated as 787 and 6,567 mg/L, respectively.

Table 8.3 Accepted grades for Li, Mg and K (in mg/L) for each drillhole (Geos Mining, 2009).

Hole	Li	Mg	K
FD-01	580	1290	4317
FD-02	1016	2835	9174
FD-04	1150	3332	9964
FD-05	900	2604	7619
FD-06	670	1400	6076
FD-06B	748	2122	6460
FD-07	1108	3461	9228
FD-08	800	2255	7418
FD-10	310	805	2839
FD-11	1200	3964	9824
FD-12	550	1365	5130
FD-14B	800	2592	5924
FD-16B	700	2230	5439
FD-18	850	2429	6482
FD-19	555	1656	4012
FD-22	600	1419	4050
Average	**796**	**2289**	**6660**

Table 8.4 Inferred Resource estimate, as prepared by Geos Mining (2009).

Classification	Area (km^2)	Zone	Zone Volume (10^6 m^3)	Average Specific Yield	Brine Volume (10^6 m^3)	Li (gm m^3)	K (gm m^3)	B (gm m^3)
		1	545	11.5%	63			
Inferred Resource	75.0	2	3,455	8.3%	287	800	6600	800
		TOTAL	4,000		350			

The brine resources are equivalent to 1.5 million tonnes of lithium carbonate and 4.4 million tonnes of potash (potassium chloride). The sensitivity of the estimated resources to variability in the specific yield was investigated and the range of estimates are provided in Table 8.5, below.

Table 8.5 Estimated range of resource based on different values of Specific Yield.

	Brine vol. (million kL)	Lithium (g/kL)	Potassium (g/kL)	Lithium Carbonate equivalent (million tonnes)	Potash equivalent (million tonnes)	Zone 1 Average Specific Yield	Zone 2 Average Specific Yield
Preferred Estimate	**350**	**800**	**6,600**	**1.49**	**4.40**	**11.5%**	**8.3%**
Higher Estimate	415	800	6,600	1.76	5.22	13.3%	9.9%
Lower Estimate	255	800	6,600	1.09	3.23	9.0%	6.0%

8.6 Preliminary Economic Assessment

An initial scoping study, equivalent to a Preliminary Economic Assessment study under NI43-101, was carried out by the Company in May 2009, following completion of the drilling, testing and the initial resource estimate. This was undertaken when the Company was only listed on the Australian Securities Exchange and subject to different reporting regulations and terminology.

The study was an internal Orocobre exercise, summarizing the work undertaken, the potential process route, the financial assumptions and costs for capital items. Inputs into the study were provided by staff and consultants with experience on similar salar projects. The objective of the study was to ascertain if the project has economic potential and set the scope for further investigations. The positive outcome of the scoping study led to planning of additional drilling and test work for the project as part of a definitive feasibility study to be undertaken in 2010.

The Preliminary Economic Assessment was preliminary in nature, included Inferred Mineral Resources that by definition are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the preliminary assessment would be realized. Mineral resources that are not mineral reserves do not have demonstrated economic viability.

9. GEOLOGICAL SETTING

9.1. Regional

The following publications have been used as background information in preparing this Technical Report, in addition to those specifically referenced in the text:

Allmendinger, R.W., Jordan, T.E., Kay, S.M., and Isacks, B.L., 1997. The Evolution of the Altiplano-Puna Plateau of the Central Andes: Annual Review of Earth and Planetry Science, v. 25, p. 139-174.

Alonso, R. N., 1999. Los salares de la Puna y sus recursos evaporíticos, Jujuy, Salta y Catamarca. En Recursos Minerales de la República Argentina (Ed. E. O. Zappettini), Instituto de Geología y Recursos Minerales. SEGEMAR, Anales 35: 1907-1921, Buenos Aires

Alonso, R.N., Jordan, T.E., Tabbutt, K.T. and Vandevoort, D.S. 1991. Giant evaporite belts of the Neogene central Andes. Geology, 19: 401-404.

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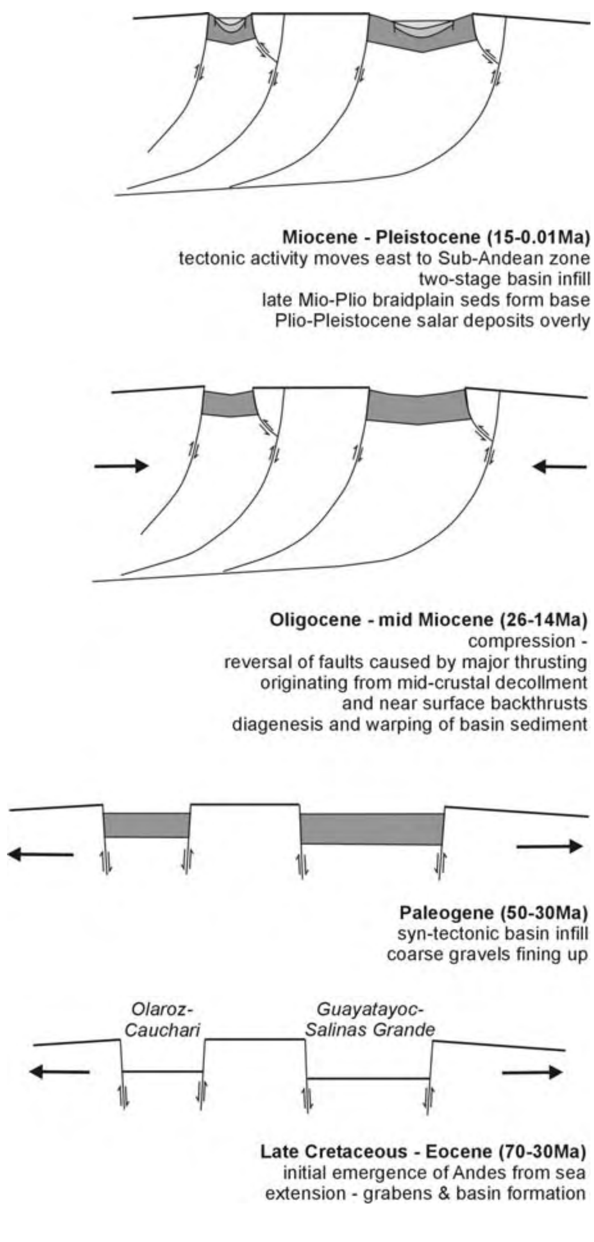
9.1.1 Jurassic-Cretaceous

The Andes have been part of a convergent plate margin since the Jurassic, and both the volcanic arc and the associated sedimentary basins developed as a result of subduction processes. An initial island arc formed along the west coast of South America during the Jurassic (195-130 Ma), moving eastward during the mid Cretaceous (125-90 Ma) (Coira et al., 1982). An extensional regime persisted through the late Cretaceous (Fig. 9.1) generating back-arc rifting and grabens (Salfity and Marquillas, 1994). Marine sediments covering most of the Central Andean region indicate an extensive back-arc seaway with little land above sea level (Lamb et al., 1997; Scotese, 2001).

9.1.2 Paleogene

During the late Cretaceous to Eocene (78-37 Ma), the arc shifted farther east to the location of the current Precordillera (Allmendinger et al, 1997; Lamb et al., 1997). Significant shortening commenced during the Incaic Phase (44-37 Ma) largely in the west, with associated uplift to perhaps 1000 m (Gregory-Wodzicki, 2000) creating a major north-south watershed. Coarse clastic continental sediments eroded from this ridge indicate eastward transport in Chile and Argentina (Jordan & Alonso, 1987). The subsequent initiation of shortening and uplift in the Eastern Cordillera of Argentina (~38 Ma), led to the development of a second north-south watershed with coarse continental sediment accumulating throughout the Puna (Allmendinger et al., 1997; Coutand et al., 2001).

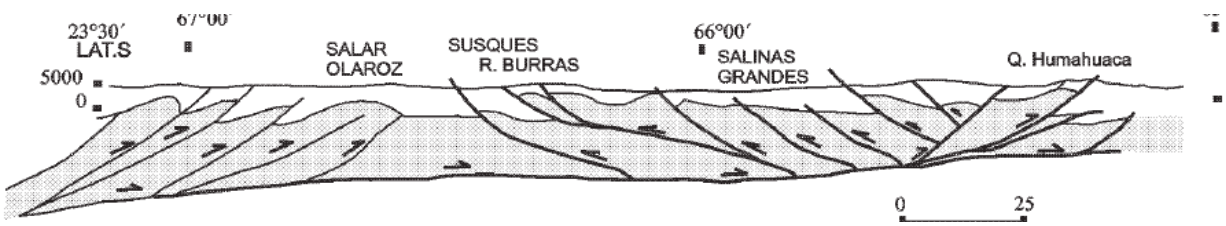
Figure 9.1 Generalized structural evolution of the Puna basins



9.1.3 Neogene

By the late Oligocene to early Miocene (20-25 Ma), the volcanic arc switched to its current location in the Western Cordillera. At the same time, significant shortening across the Puna on reverse faults led to the initiation of separated depocenters (Fig. 9.2). Major uplift of the Altiplano-Puna plateau began during the middle to late Miocene (10-15 Ma), perhaps reaching 2500 m by 10 Ma, and 3500 m by 6 Ma (Garzione et al., 2006). Coutand et. al. (2001) interpret the reverse faults as being responsible for increasing the accommodation space in the basins by uplift of mountain ranges marginal to the Puna salar basins.

Figure 9.2 Structural cross section from the Chilean border through the Olaroz and Salinas Grandes salars. Note the development of a mid-crustal decollement with an east vergent, thrust fault and associated back thrusts creating the ranges bordering the salars, with Paleogene to Neogene deposits in the salar basins bordered by uplifted Ordovician to Cretaceous bedrock (from Mon, 2005)



West of Salar de Olaroz and the Salar de Cauchari, Marreti et. al. (1994) note that the north-south striking reverse faults are covered by continental clastic and pyroclastic strata dated at 9.5 Ma, with the faults cutting lower-middle Miocene strata (Schwab and Lippolt, 1976; Schwab, 1980). The approximate kinematics of late Tertiary deformation in this area involve subhorizontal east-west shortening. Kay et. al., (2008) also note that Ordovician sedimentary rocks overthrust late Miocene Pastos Chicos Formation sediments on the west the flank of the Salars de Olaroz-Cauchari (Fig. 9.3).

Fig 9.3. View of the west side of the Salar de Olaroz, south of Pastos Chicos, showing Middle Miocene continental sediments (light color) overlain by Ordovician metasediments dipping west on the basin boundary thrust.

The late Miocene volcanic flare-up (5-10 Ma) centered on the Altiplano-Puna Volcanic Complex (APVC) between 21°-24° S (de Silva, 1989), produced a high density of both caldera subsidence and associated extensive ignimbrite sheets, as well as andesitic-dacitic stratovolcanoes. In the Puna volcanic activity was frequently constrained by major NW-SE crustal megafractures (Chernicoff et al., 2002), that are especially well displayed along the Calama-Olocapato-El Toro lineament to the south of Cauchari (Salfity, 1985).

During the early to middle Miocene, red bed sedimentation is found throughout the Puna, Altiplano and Chilean Pre-Andean Depression (Jordan & Alonso, 1987). As thrust faulting, uplift and volcanism intensified during the middle to late Miocene, the sedimentary basins became isolated by the mountain ranges, developing internal drainages, with major watersheds (the Cordilleras) bounding the Puna to the west and east. Sedimentation in these basins initiated with alluvial fans being shed from the uplifted ranges and continued with playa sandflat and mudflat facies.

Northern Argentina has experienced a semi-arid to arid climate since at least 150 Ma as a result of its stable location relative to the Hadley circulation (Hartley et al., 2005), but as a result of Andean uplift almost all flow of moisture from Amazonia to the northeast has been blocked, leading to increased aridity since at least 10-15 Ma. Consequently, given the zonally high radiation and evaporation levels, the reduction in precipitation has led to the development of increased aridity in the Puna. The combination of internal drainage and arid climate led to the deposition of evaporite precipitates in many of the Puna basins.

9.1.4 Late Neogene-Quaternary

During the Pliocene-Pleistocene deformation as a result of shortening moved out of the Puna into the Santa Barbara system. At the same time orbital influences led to a fluctuating climate regime with short periods of wetter conditions alternating with drier. As a result of both reduced tectonic activity and frequent aridity, a reduction in erosion and accommodation space means that sediment accumulation in the isolated basins has been limited. Nevertheless, ongoing runoff, both surface and underground continues solute dissolution from the basins and concentration in their centers where evaporation is the only outlet.

Evaporite minerals occur both disseminated within clastic sequence and as discrete beds. The earliest record of evaporite formation is for the middle Miocene, but their frequency and magnitude tends to increase during the Late Neogene-Quaternary (Alonso et al., 1991; Vandervoort et al., 1995; Kraemer et al., 1999). Dating of the thick halite sequences in the Salars de Hombre Muerto and Atacama suggest that they have mostly formed since 100 Ka (Lowenstein, 2000; Lowenstein et al., 2001).

A geological map of the area is provided in Fig. 9.4, and details of the stratigraphy of the basin in Table 9.1.

Figure 9.4 Geological map of the Olaroz area, based in part on SEGEMAR, 2008.

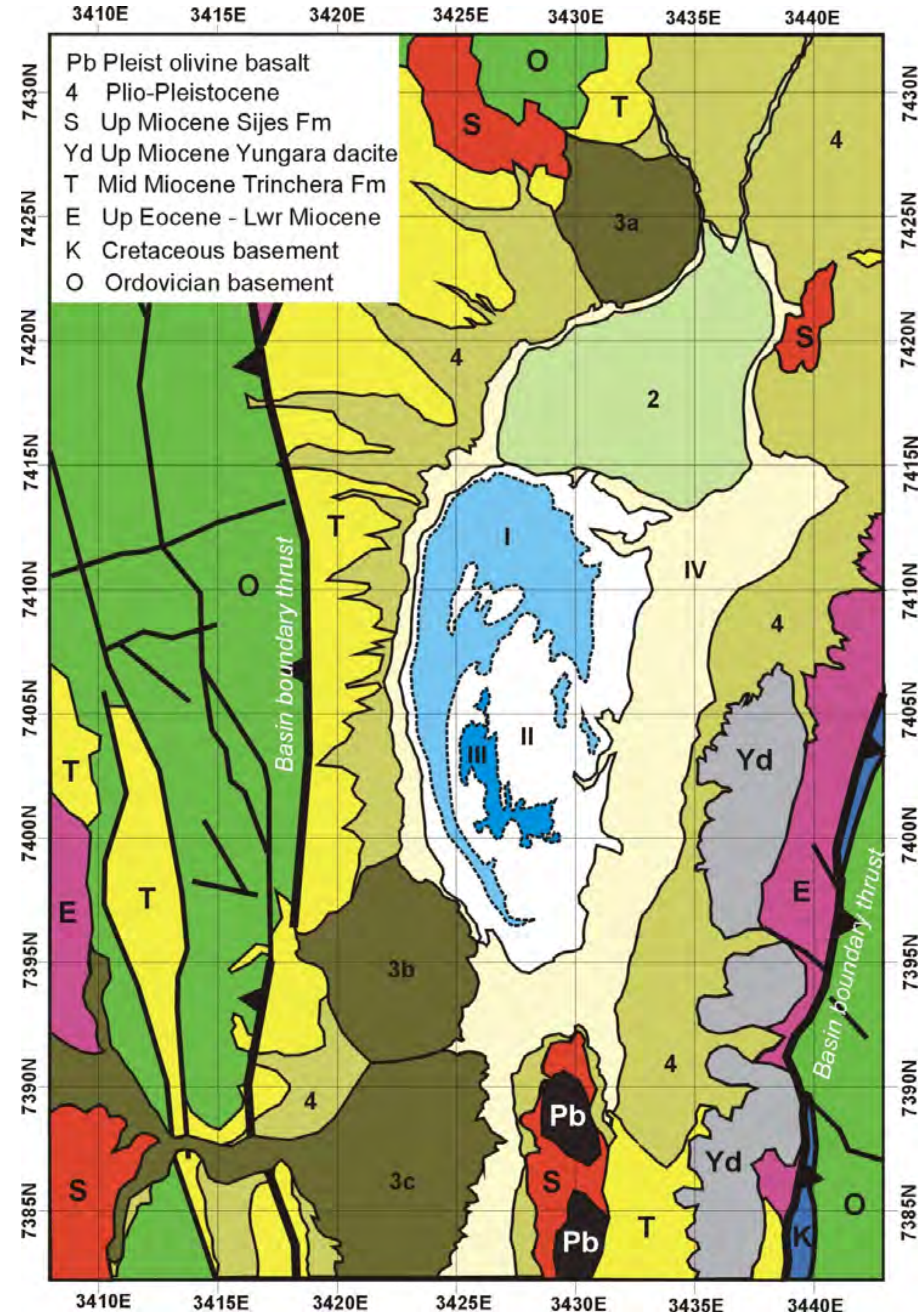


Table 9.1 Stratigraphic table for the Olaroz basin (numbers refer to SEGEMAR, 2008 map units).

	Age period	Ma	Rock types	Geological environment	Tectonic events	1:250,000 Map Sheet	
						Susques (2366-III)	San Martin (23664)
Quaternary	Holocene	0.01	Alluvial deposits, salars	Closed basins, salars	Post Quechua deformation	Salar deposits, lacustrine, colluvial and alluvial sediments (40-44)	Salar deposits, lacustrine, colluvial and alluvial sediments (25c-30)
	Pleistocene	2.6	Alluvial, colluvial, lacustrine , ignimbrites	Closed basins, fan deposits, volcanic centres	NE-SW shortening (from 0.2 Ma) due to strike-slip faulting continuing to present	Tuzgle ignimbrite (38-39)	Alluvial and glacial deposits (5a, 25b, 26)
Neogene	Pliocene	5.3	Continental sediments +/- ignimbrites	Some volcanic complexes developed in continental sediments	Major volcanic centres and calderas 8-6 Ma	Jama volcanic rocks (36-37). Andesite, dacite lavas, ignimbrites; Atana ignimbrite	Malmar, Uquia and Jujuy Formations. Continental sediments - sandstone, conglomerate +/- mudstone (19, 22-24)
	Miocene		Andesitic to dacitic volcanics	Volcanic complexes in continental sediments		Volcanic complexes (35)	Formations Oran (16 Ma - 0.25 Ma), Callegua, Formation Agua Negra. Continental sandstones, with clay interbeds (19, 20-21)
			Ignimbrites			Coyaguayma & Casabindo dacite Ignimbrites (33 & 34)	
			Continental sediments & tuffs		Start of thrusting, with WNW-ESE directed thrusting from 13-4 Ma	Sijes Formation (32) ~7-6.5 Ma sandstones, mudstones and tuffs	
			Continental sediments, tuffs, volcanic breccias		End of Quechua phase event finished by 9-15 Ma, with associated folding	Chimpa volcanic complex (31) andesites, dacites, lavas, ignimbrites. Pastos Chicos Fm ~10-7 Ma with unnamed tuff 9.5.	
			Dacite domes, pyroclastics, intrusives			Yungara dacite domes (30) & subvolcanics (SE side Olaroz)	
			Rhyolitic, dacitic volcanic complexes, continental sediments			Volcanic complexes (23-29), Cerro Morado, San Pedro, Pairique, Cerro Bayo and Aguiliri, Pucara Formation. Andesite to dacite lavas, domes and ignimbrites. Susques Ignimbrite ~10 Ma	
			Continental sediments			Vichacera Superior (22b). Sandstones and conglomerates, with tuffs & ignimbrites	
		23.8				Vichacera Inferior (22a). Sandstones and interbedded claystones	
Paleogene	Oligocene	33.9	Continental sediments	Red bed sequences	Incaic Phase II - Compression, resulting in folding	Rio Grande Fm Superior (21b). Red aeolian sandstones	Casa Grande and Rio Grande Formations (18). Continental sandstones, conglomerates, siltstones and claystones
	Eocene					Rio Grande Fm Inferior (21a). Alternating coarse conglom. & red sandstones	
		55.8	Continental sediments, locally marine and limey	Local limestone development, local marine sequences		Santa Barbara subgroup (20). Fluvial and aeolian alternating conglomerates and red sandstones	Santa Barbara subgroup. (17)continental limy sandstones, siltstones, claystones
	Paleocene						Balbuena subgroup (16). - see below
BASEMENT - PRE TERTIARY UNITS (MARINE)							
Mesozoic	Cretaceous		Continental sediments, locally marine and limey		Peruvian phase - extension and deposition of marine sediments	Balbuena Subgroup (19). Sandstones, calcareous sandstones, limestones, mudstones (Marine).	Balbuena subgroup (16). Continental/marine calcareous sandstones
			Continental sediments			Piruga Subgroup (16). Alluvial and fluvial sandstone & conglomerate	Piruga subgroup (15). Red sandstones, silty claystones and conglomerates
						Granites, syenites, granodiorite (15,17,18)	Granites, monzogranite (11-14)
Paleozoic	Carboniferous -Silurian		Marine sediments	Marine platform and turbidite deposits	Isoclinal folding on NW/SE trending axes, extending to early Cretaceous	Upper Paleozoic marine sediments (14)	Machareti and Mandiyuti Groups (10). Sandstones, conglomeratic sandstones, siltsones and diamictites. Silurian Lipeon & Barite Formations (9). Claystones and diamicties
						Multiple Paleozoic intrusive suites (6-13)	El Moreno Formation (8). Porphyritic dacite
	Ordovician		Marine sediments	Marine delta and volcanic deposits/domes		Ordovician sandstones (3-5) , volcaniclastic sediments & Ordovician turbidites	Guayoc Chico Group (7) & Santa Victoria Groups (6). Marine sandtones, mudstones and limey units

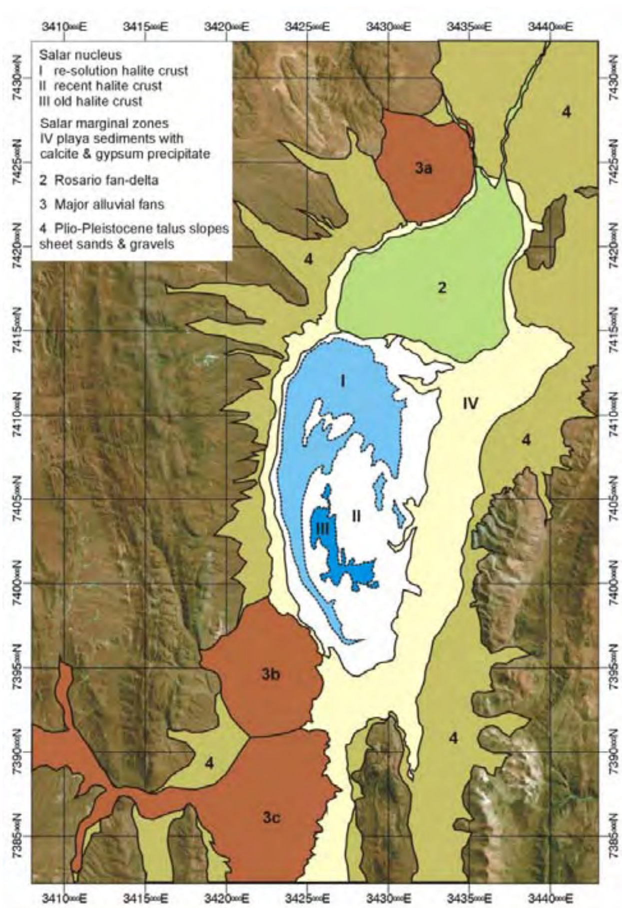
10. DEPOSIT TYPE

10.1 The Olaroz Basin and Hosting Aquifer

10.1.1 Post Miocene Basin

The Olaroz-Cauchari basin is bounded by a pair of inwardly vergant N-S thrust faults (Fig. 9.4). These faults can be seen to thrust Ordovician and Cretaceous basement rocks over the Cenozoic basin fill (Kay et al., 2008). The gravity profile (Fig. 12.6) suggests that the Cenozoic basin infill is of the order of 800-1,200 m deep. The ATM sections (Figs. 12.11-12.15) suggest that within the basin boundary faults, a series of N-S normal faults downthrow towards the centre of the basin along both the east and west sides. Outcrop along the east and west sides of the basin are composed of Paleogene (outer) and Neogene (inner) sediments, which the gravity profile indicates also underlie the central post-Miocene sediments. Along the SE side of the Olaroz basin the Yungara dacite and a Pleistocene olivine basalt outcrop in a N-S alignment, suggestive of intrusion up now hidden normal faults. Satellite image interpretation and walk-over surveys have been used to map the post Miocene geology within the centre of the basin (Fig. 10.1).

Figure 10.1. Post Miocene geological map of the Olaroz basin.



Outside the margins of the salar the oldest unit is comprised of Plio-Pleistocene sheet sands and coarse gravels, representing talus slopes eroded from the bounding ranges. The salar margins are comprised of finer grained sands and silts with abundant disseminated and interbedded calcite and gypsum, considered to represent playa facies.

10.1.2 Marginal alluvial fans and fan delta

To the north and southwest a fan-delta and three alluvial fans enter the salar, and interdigitate with the salar sediments at depth as shown in the cross section (Figure 10.3).

To the north of the salar, the Rosario fan-delta (labeled 2 in Fig 10.1) has a lower gradient and is more extensive than the alluvial fans, covering an area of 60 km^2 at the surface, although gravity surveys conducted for fresh water resource evaluation suggest it may be more extensive at depth. The fan-delta is sourced from a 2,000 km^2 catchment to the north. Well C00 penetrates 54 m of the fan-delta, interdigitated with 3-4 m of Unit B (see nucleus geology below) in the upper 10 m, and 2 m of Unit C at 20 m depth. The upper 18 m at this location is assigned to Unit Fd1, consisting largely of beds of coarse sand to gravel (1-7 cm), alternating with some beds of fine sand and occasional beds up to 1 m thick of silty clay and clay. Thin beds (<1 m) of carbonates occur at three levels, as calcretes, representing paleosol horizons. From 20-54 m in well C00 fine-medium grained sands up to 3 m thick alternate with silty sand and clay horizons up to 1 m thick. This sequence is assigned to Unit Fd2. The sands and gravels are composed of subangular quartz (<95%), metamorphic and volcanic lithic fragments (2<50%), magnetite (<10%), biotite (<4%), calcite (<4%), gypsum (<3%), and clay (<10%), reflecting source material in the catchment. Bedding appears to be massive or layered with laminations of finer grained material. Interbed erosional surfaces are present and rare grading and cross lamination occur. The architecture of these beds suggest that they represent a distributory fluvial system or braid delta (Stanstreet & McCarthy, 1993; Miall, 1996), in which deposition has been largely subaerial (eg. interbed erosion surfaces and paleosols), but also at times subaqueous (eg. cross bedding and ?ripples). Sequences of similar lithology and architecture are encountered in wells C01 and C02, and have been assigned to Units Fd0, Fd1 and Fd2 depending on their stratigraphic position and lithology. Unit Fd0 is lithologically similar to Fd2, but occurs stratigraphically in the highest part of the well, overlying Fd1 and Fd2. These units together make up 29 m thickness in C01 and 51 m in C02.

The three alluvial fans that enter the salar are labeled 3a-3c in fig. 10.1. The largest and most active is the Archibarca alluvial fan (3c in Fig. 10.1) which has its origin in a 1,200 km^2 catchment outside the basin boundary fault to the west. Well C18 penetrates 52 m of this fan, subdivided into an upper Unit F1 dominated by gravel and fine sand, and a lower Unit F2 dominated by sandy gravel. The remaining two fans have relatively small catchment areas within the western basin boundary fault. All three alluvial fans are Type II of Blair and McPherson (1994), being dominated by debris flow and planar sheetflood couplets of gravel/sand or gravel/clay. Couplets range from cm to m scales. The gravel beds consist of subrounded clasts with a typical maximum diameter of ~10 cms at fan apex, decreasing down fan. The gravel beds are clast or matrix supported with some crude, thick cross-stratification and occasional grading. These sheetflood deposits have wide, belt-like geometries which can be traced over many hundreds of meters and are cut by occasional shallow, erosive based, gravel filled, avulsion channels.

10.1.3 Structure

Based on the interpretation of the core drilling (Appendix A) the structure of the Olaroz basin has been mapped out as shown in the plans and sections below. Units A though F are defined on their lithostratigraphy as detailed in section 10.2.

Figure 10.2 Structure contours on the base of Units A through F in the Salar de Olaroz. Note: contour interval is not equal on each map.

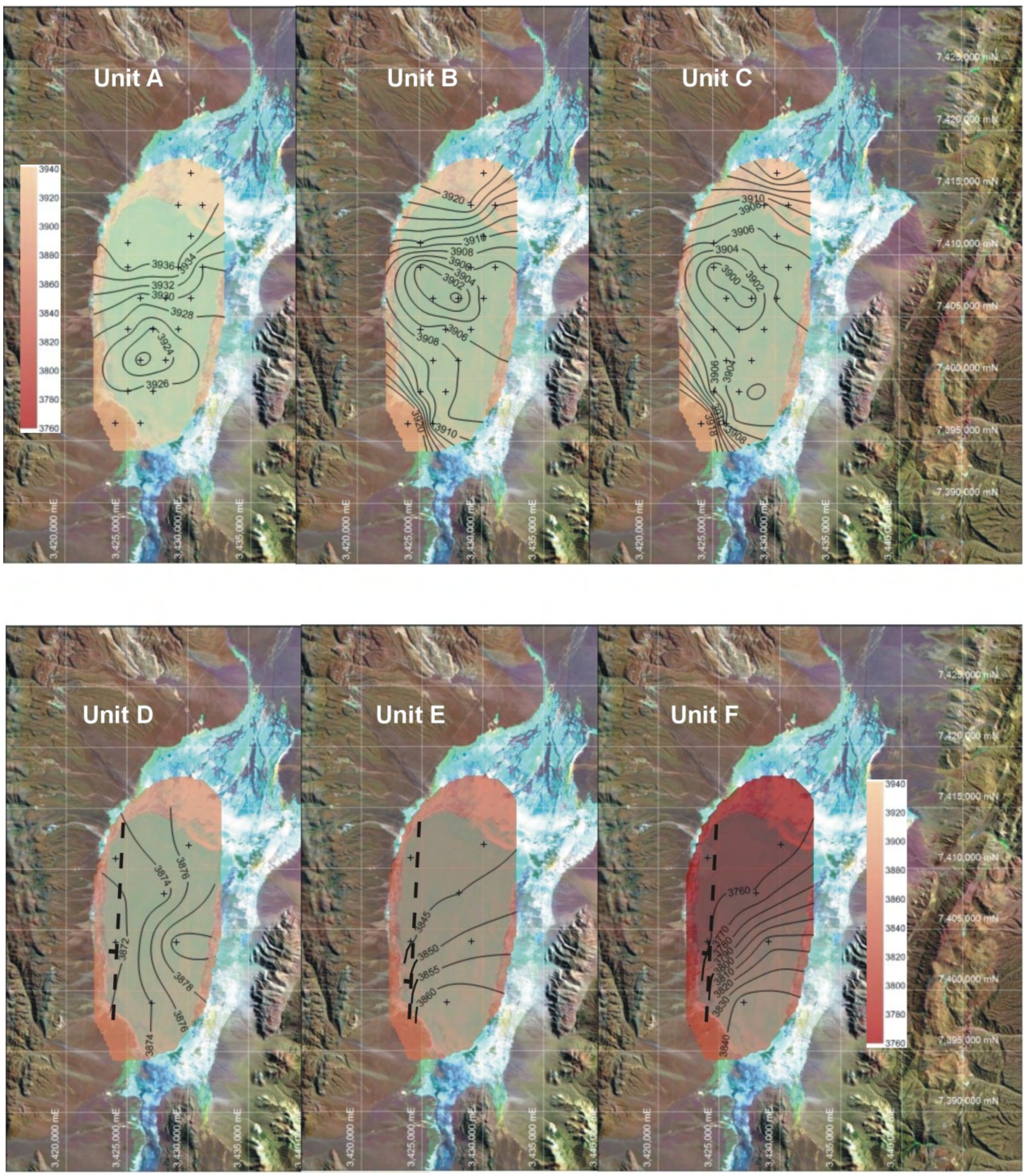


Figure 10.3 S-N section through the Salar de Olaroz.
Graphic and natural gamma logs are shown in more detail in Appendix A.

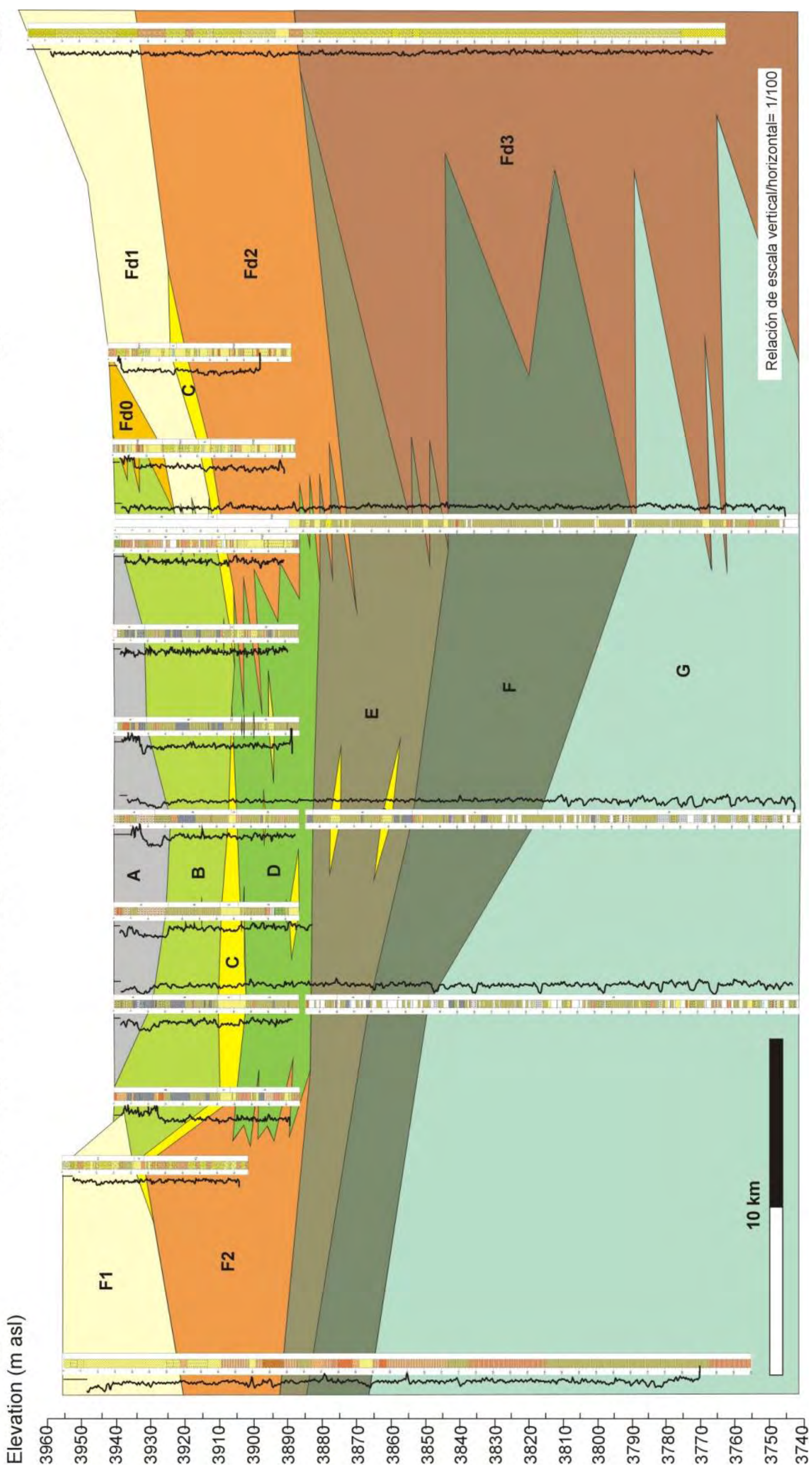
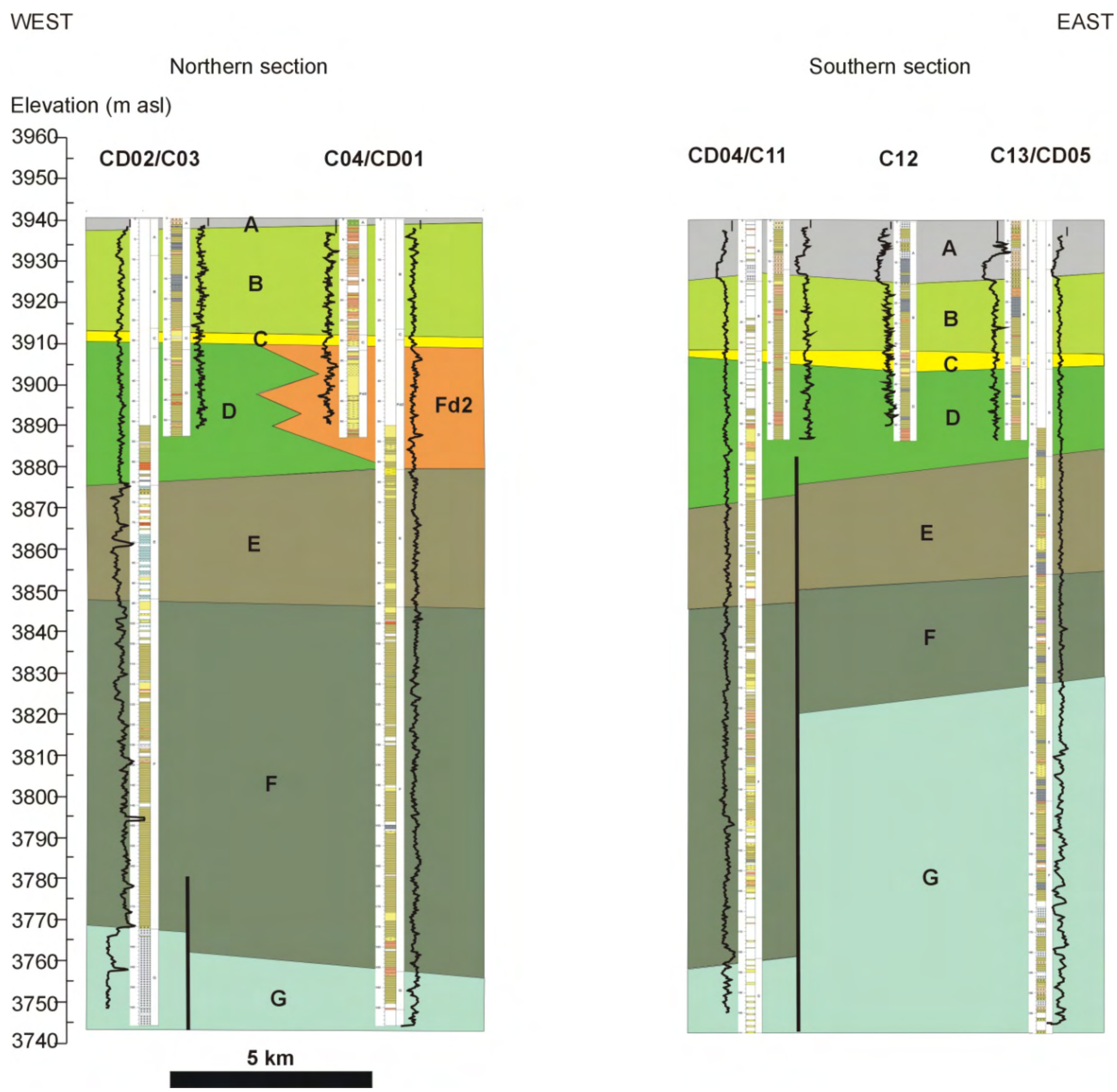


Figure 10.4 W-E sections through the Salar de Olaroz.
Graphic and natural gamma logs are shown in more detail in Appendix A.
The gravity and ATM sections are described in greater detail in section 12.



Figures 10.2 through 10.4 show that Units A-C constitute a shallow basin in the nucleus of the Salar, with a maximum thickness of 39 m. The Archibarca fan-delta interdigitates with the salar Units in the north, whilst the Archibarca fan has a similar relationship in the south and southwest.

The structure of the basin changes somewhat below Unit C. A marginal, north-south growth fault identified on the western side of the basin probably occurs between wells CD02, CD04 and wells CD01, CD03, CD05, CD06 in the center. This normal fault shows a significant downthrow to the west in the south, but rotates to downthrow slightly to the east in the north. An estimate of the maximum throw on this fault indicates that it increases with depth from ca. 3 m for Unit D, through ca. 15 m for Unit E to >40 m for Unit F. Similar faults have been identified on the ATM section (Figure 12.14) further south beneath the Archibarca fan.

Units E and particularly F show an increasing thickness towards the north, suggesting that the basin deepens towards the north as it expands northwards from the relatively narrow Salar de Cauchari in the south to the northern part of the Salar de Olaroz. Unit D, overlying units E and F has a tilt towards the west, probably consequent on movement on the previously identified fault. It is interesting to note that sediments associated with the Archibarca fan do not appear below Unit C.

Unit G has not been fully penetrated and thus it is not possible to determine the bottom of the basin, but the gravity and ATM data suggest that it may be as much as 600 m deep.

10.2 Salar nucleus (host aquifer) geology

The Units described in this section of the report are universally thin (mm-dm) bedded, that can be followed over a few meters (such as between a test production well and an observation well at 7 m) but no further. These beds alternate in color, appearance or grain size rather rapidly. Furthermore the grain size of any bed is generally not uniform and may be composed of silt to clay size particles with some sand mixed in. Thus, in referring to a sand dominant or clay dominant bed, it is taken to refer to the bulk property. The lithofacies maps indicate fractions of the endpoints of the lithology, for example: sand, clay, halite. Silt, which often occurs with either clay or sand or both, is not separately identified..

10.2.1 Salar Crust

The salar nucleus is superficially covered in halite crust that can be subdivided into three types (Fig. 10.1). Old crust appears as low (<0.5 m) rugose pinnacles of halite that are greater than 10 years old (as determined at salars Atacama and Hombre Muerto). Recent halite crust (2-5 years old) is represented by halite with well-developed contraction polygons. Re-solution crust is smooth, with high reflectance, and represents areas that have recently (less than 2 years) undergone inundation by precipitation or flooding, usually along the side of the nucleus, and subsequent re-precipitation of halite (Fig. 10.5).

Fig. 10.5 Polyphase development of contractional halite polygons approx. 2 years old (left), and the western edge of the crust undergoing re-solution during flooding (right) in 2010.

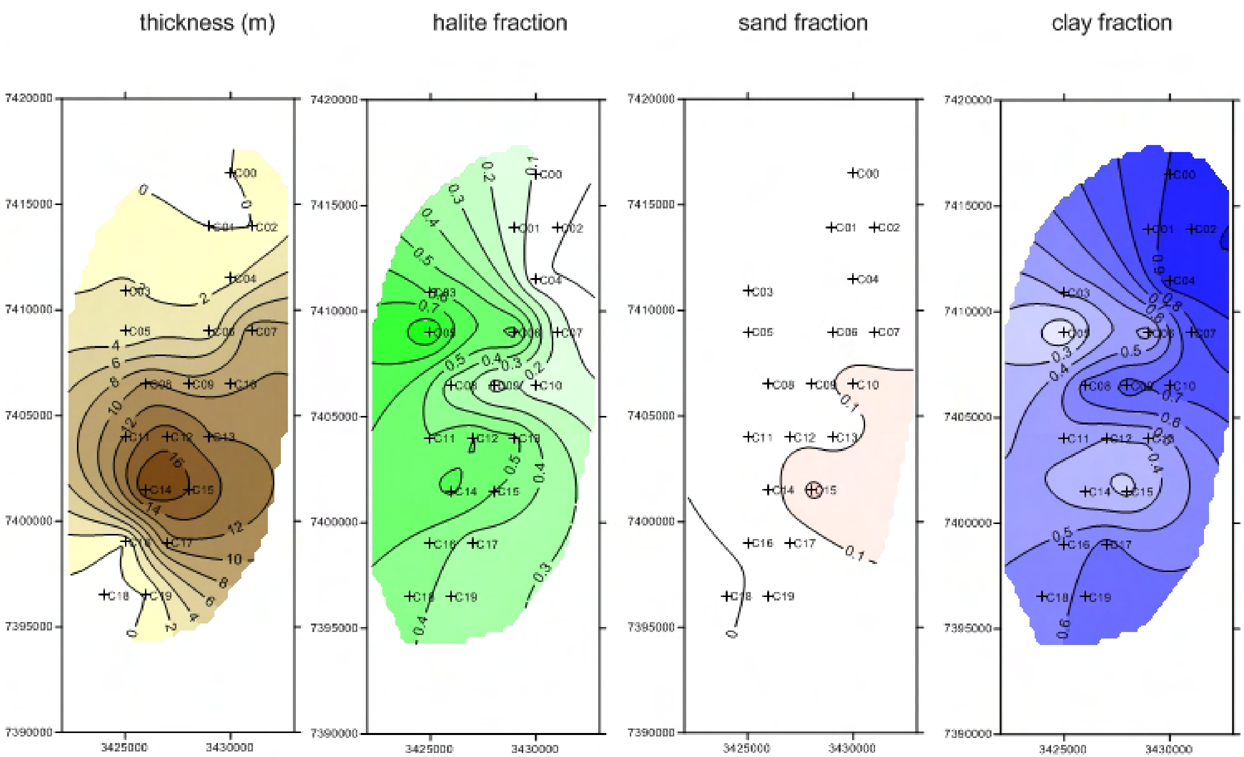
Based on the lithological and geophysical logs from the C series wells (Appendix A) the top 54 m of the salar nucleus has been assigned to four lithostratigraphic units.

10.2.2 Unit A

Unit A is found in all wells except C00, C01 and C02, in the north where it is replaced by Fd0 and Fd1 (as described above), and C16, C18 and C19 in the south where it is replaced by F1 in C18 and is does not occur in the other two wells.

Unit A reaches a maximum thickness of 18 m in C14, decreasing to zero at the eastern and western salar margins and to the north and south (Fig. 10.6). It forms a shallow basin with the main depocenter in the central southern part of the salar. It is dominated by halite with over 80% halite in the northwest and 50% in the southwest, and and increasing sand fraction to the southeast (to 15%), and clay fraction to the northeast (to 98%). Rare, thin beds (<20 cm) of ulexite and gypsum occur towards the northeast associated with the clays.

Figure 10.6   Isopachs and lithofacies of Unit A.



The halite may be coarsely or finely crystalline and relatively pure, or mixed with clay, frequently black and organic. Sand is generally fine grained with considerable silt and some clay. Clays are red-brown, green or dark organic rich. Sonic cores show considerable lamination and thin bedding. The lithology and structures suggest alternating subaqueous (coarse halite crystals forming on lagoon floors and organic rich shallow lagoon to marsh) to subariel (fine halite crystals indicate surficial evaporation-precipitation) deposition, with periodic flooding (sand) from the south (Fig. 10.7)

Figure 10.7 Sedimentary structures identifiable in sonic cores indicate that little disturbance took place during drilling. Left: water escape structures in organic clays overlying ball and pillow structures. Right: sand filled worm burrows in silty sediment.

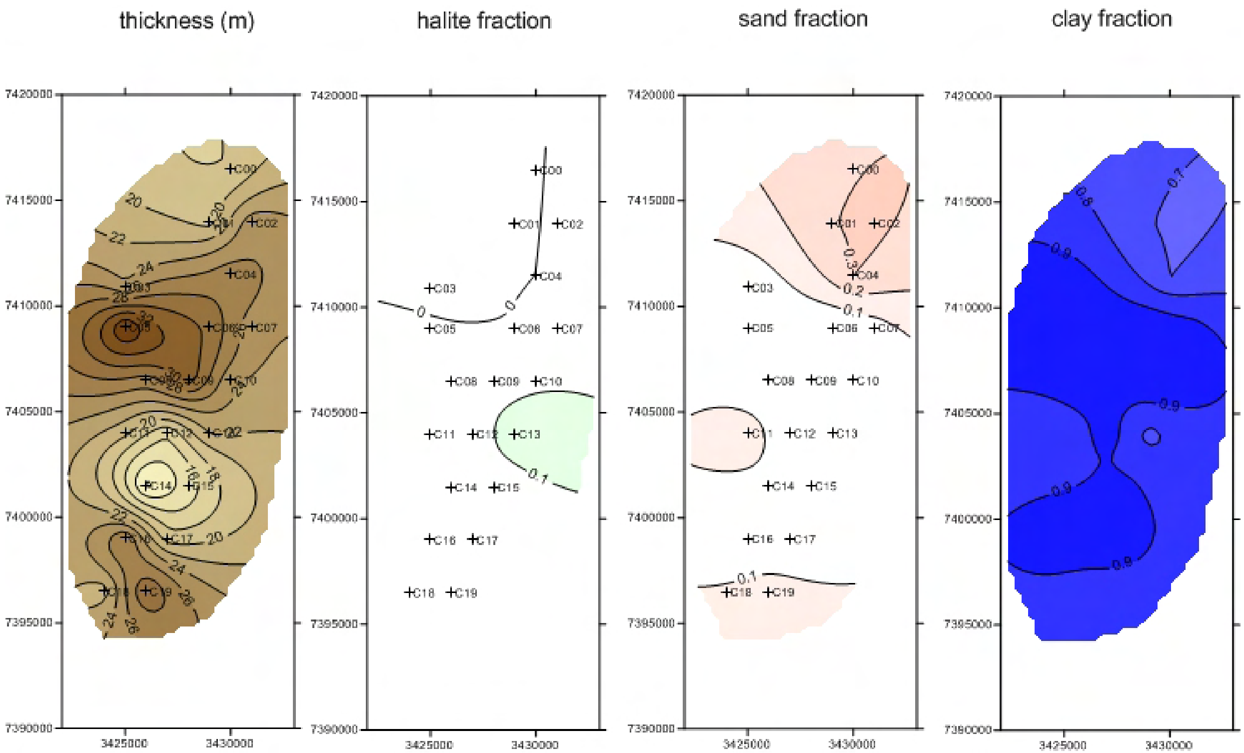
10.2.3 Unit B

Unit B is found in all wells except C00 and C02 in the north, where it is replaced by Fd1, and in C18 in the south, where it is replaced by F1.

Unit B reaches maximum thicknesses in C05 (36.2 m) and C16 (28 m) (Fig. 10.8). For the most part the Unit maintains a thickness over 20 m, except between these two wells Unit B forms a saddle (11.5 m in C14), and rapidly thins to zero, or possibly finely interdigitates, where the Rosario fan delta and the Archibarca fan sediments dominate.

It is a unit of interbedded sediments dominated by clay (>75%) over the whole area, with a sand fraction reaching 30% in the northeast, and halite reaching 18% in the central east. The clays are plastic, red-brown, green or black and organic rich. Sonic cores show convolute lamination and load structures with discontinuities. They are frequently laminated, silty, with thin sand lenses, and contain widely disseminated crystals of selenite. Rare nodules of ulexite occur, and there are one or two occurrences of either Cinnabar (HgS) or Realgar (AsS). The sand in the northeast is generally fine grained and silty. Halite is fine grained and mixed with silt and clay.

Figure 10.8   Isopachs and lithofacies of Unit B.



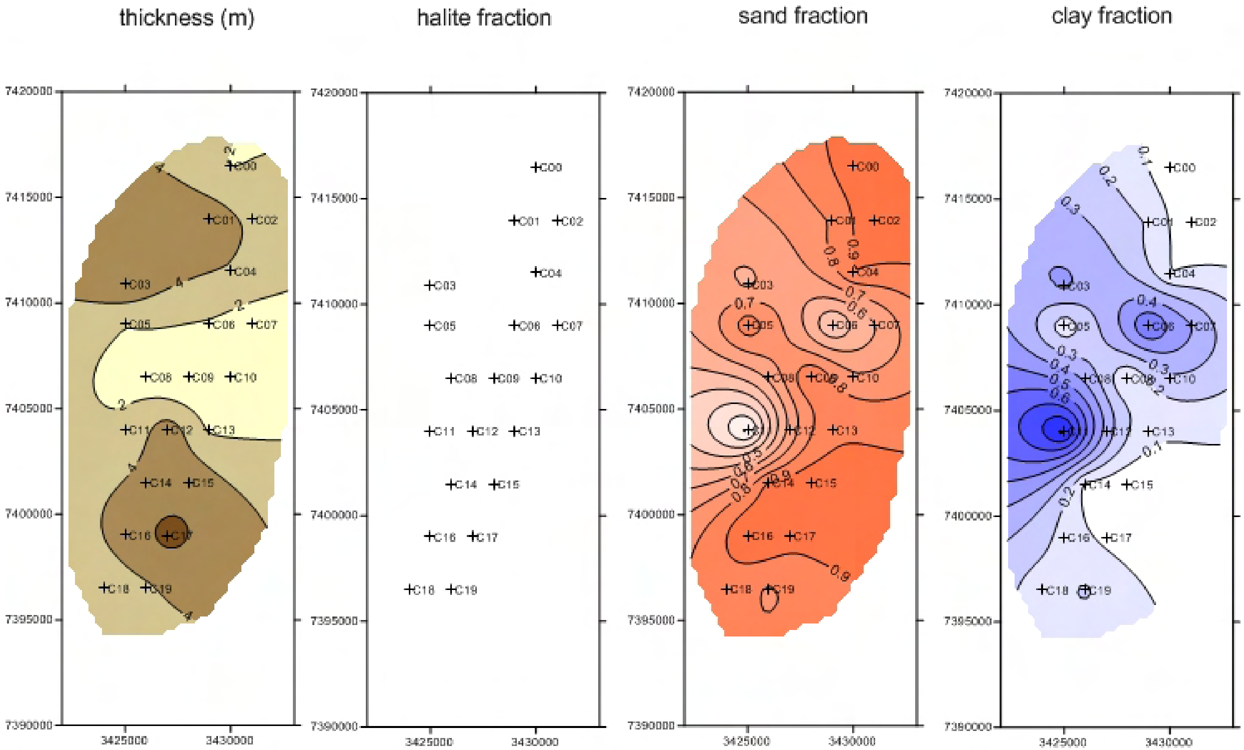
This unit indicates deposition in an eutrophic, strongly reducing lake, with some periodic flooding from the northeast (associated with the Rosario delta), where halite precipitated in its distal limits. The soft sediment structures indicate that Unit B was originally deposited with loose packing-high porosity, and is undergoing internal deformation as a result of sediment gravitational reorganisation (Raleigh-Taylor instability). Consequently the sediments may currently be considered underconsolidated. The selenite and ulexite show displacement of surrounding clays, consistent with post-depositional, diagenetic growth in-situ. This is to be expected as connate water is ejected during compaction. The sulphide minerals may indicate a nearby geothermal source.

10.2.4 Unit C

Unit C is a well defined sand bed, occurring in all wells throughout the salar and interdigitating with the Rosario fan delta in the north and Archibarca delta in the southwest.

Unit C ranges in thickness from 6.6 m in well C17 to 0.1 m in well C07, tending to be thicker in the north and south and thinner in the center of the salar (Fig. 10.9). No halite is encountered in Unit C. Apart from well C11, the sand fraction averages 80% and reaches 100%. At C11 the sand fraction is anomalously low at 6%. It is universally underlain by clays or silty clays of Unit D.

Figure 10.9   Isopachs and lithofacies of Unit C.



The sand is well sorted, fine to medium grained and dominated by quartz, but with some biotite. In wells C00, C01, C02 C03, and C04 in the north, a thin horizon (<50 cm) is well cemented with calcite.

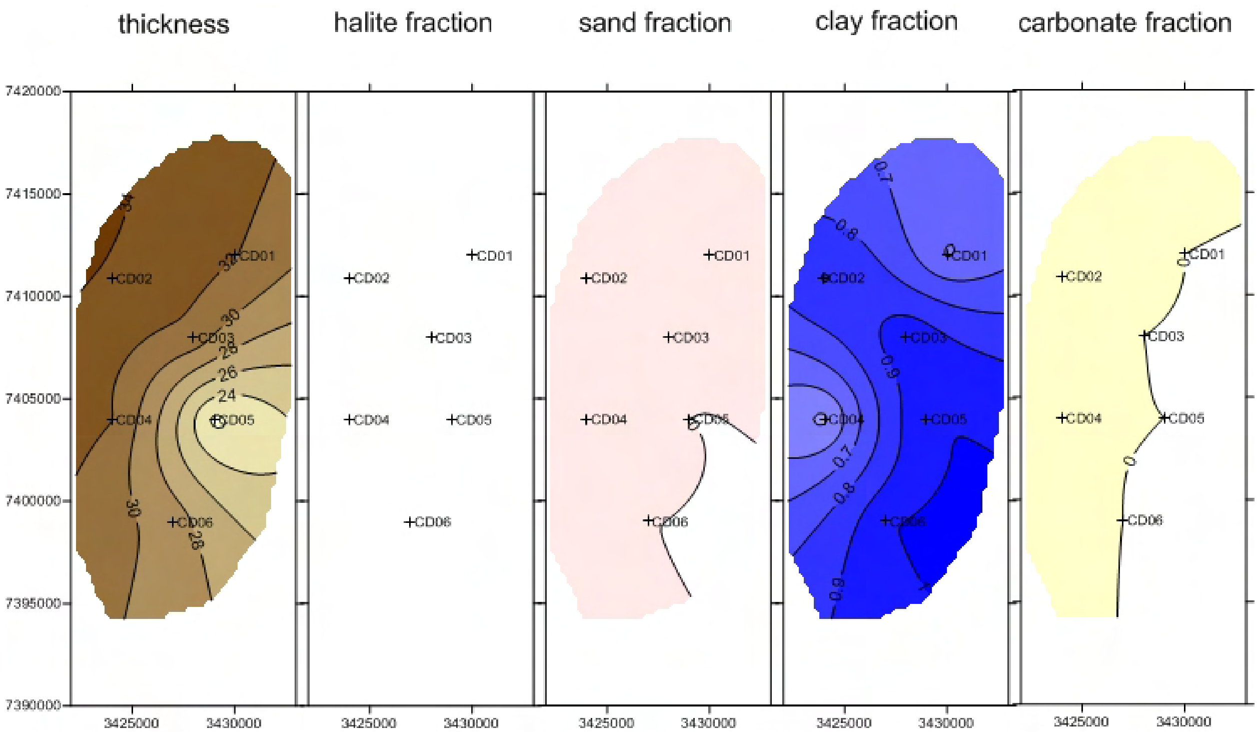
At the time of writing the origin of this unit is not clear. Options include an extensive fluvial event (although the uniformity of grain size militates against this), or possibly an air-fall mafic-poor tuff deposited subaqueously (ie. between over and underlying lacustrine clays). A petrological investigation will resolve this shortly.

10.2.5 Unit D

Unit D occurs in all wells except C00, C01, C02, C04 in the northeast, and C18 in the southwest. Since the base of this unit was not encountered in these wells, it may still be present at greater depths especially since it is encountered in all the deeper CD wells. It is likely that Unit D is replaced by Fd2 in the northeast and F2 in the southwest, associated with the Rosario fan delta and Archibarca fan respectively.

The thickness of Unit D (Fig. 10.10) increases from 20 m in the central east to over 32 m in the west and northwest. Unit D comprises interbedded sediments dominated by clay and silty clay (>60%), with lesser fractions of sand and thin beds of carbonate (calcrete or travertine). There are rare lenses of halite and ulexite (less than 0.5 m thick) towards the south (wells C14, C15 and C17).

Figure 10.10 Isopachs and lithofacies of Unit D.



The clays are generally red-brown or green, only rarely black and organic rich. They are frequently silty, and the sand fraction tends to occur as thin beds between 10 cm to 3 m thick. It is not possible to correlate these between wells so their continuity is unknown. The sand ranges from fine grained to coarse grained. Material described as sandy clay is recorded as containing significant quantities of pore fluid. Calcite cements sometimes occur in the sands or silty sands, and thin beds of calcrete or travertine occur.

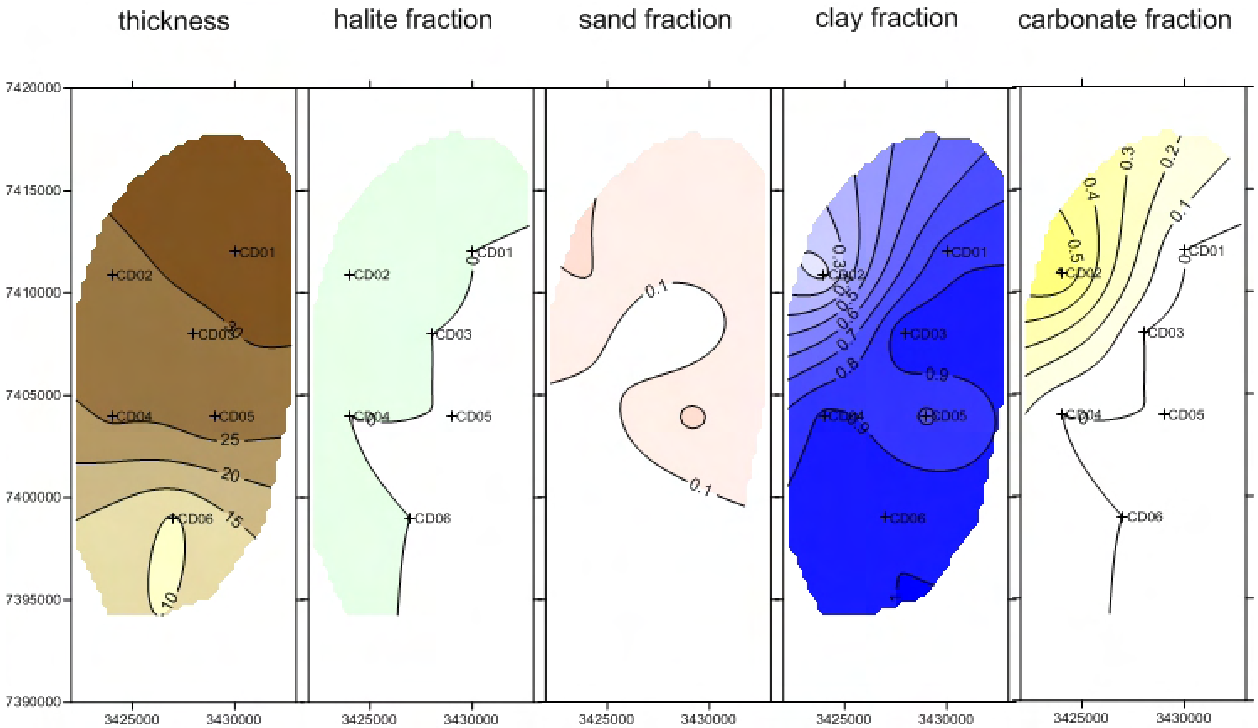
Although the clays and possibly the carbonates indicate prevailing lacustrine conditions, there appears to be less eutrophication compared with Unit B, and the frequent intercalation of sand of a range of grain size suggests the area received periodic fluvial action (especially from the southeast and northeast), which would have lead to better aeration of the lake at this time.

10.2.6 Unit E

Unit E is present in all the CD series wells, and shows a general increase in thickness from less than 10 m in the south to over 30 m in the north.

Unit E is dominated by clay rich sediments, frequently with silty laminae, in the south, center and east. A small proportion of sand is encountered in the northern half of the salar, originating or associated with the Rosario fan-delta. Carbonate facies (calcretes or travertine), reaching 50% of the thickness are located in the northwest quadrant of the salar, and thin beds of halite are found throughout the west, into the center of the salar.

Figure 10.11 Isopachs and lithofacies of Unit E.



The clays are red, brown or green, sometimes black with entrained organic matter. They are frequently interbedded with silts, sands and even gravel in the northwest (CD02). The carbonates as discrete beds up to 10 m thick (CD02) and are composed of crystalline calcite with an overgrowth of calcite cement. Druses are occasionally present with microcrystalline calcite interiors. They contain some clastic material as lithics and thin silts beds.

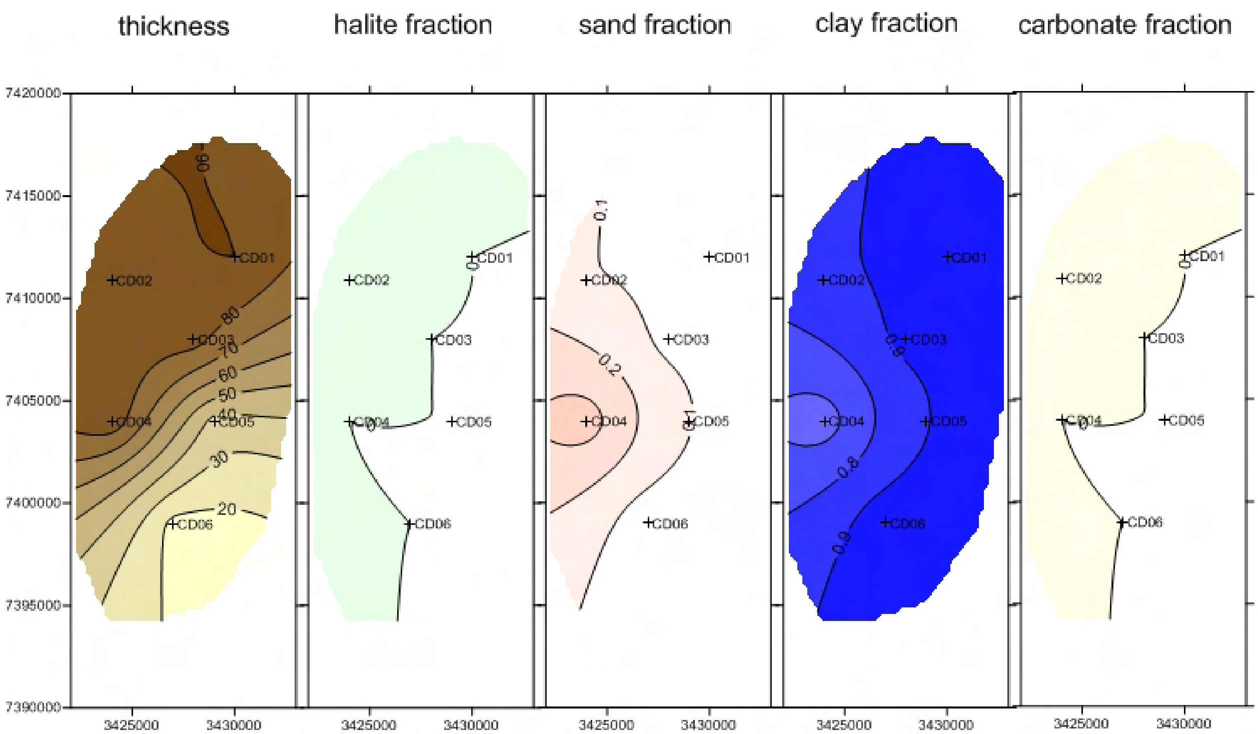
The lithofacies of Unit E suggest mixed fluvio-palustrine and lacustrine conditions; the former prevailing to the north and west, the latter towards the south and east. This distribution suggests a northward provenance for the sediments, with a probable connection through to the Salar de Cauchari in the south. There is little or no evidence that the Rio Ola and the Archibarca fan were active at this stage.

10.2.7 Unit F

Unit F is relatively thick increasing from less than 20 m in the south to 90 m in the north. The isopach map (Figure 10.12) suggests that the contours align SW-NE, but this is probably an artifact of the contouring algorithm, since the structure contour plots (Fig. 10.4) strongly suggest that the Unit is affected by a normal fault in the west, downthrowing to the east.

The unit is clay dominated, although with frequent thin sand beds, throughout much of the eastern part of the salar, with sand becoming more prevalent in the west. Throughout the western part of the salar, thin beds of ulexite, halite and carbonate occur.

Figure 10.12 Isopachs and lithofacies of Unit F.



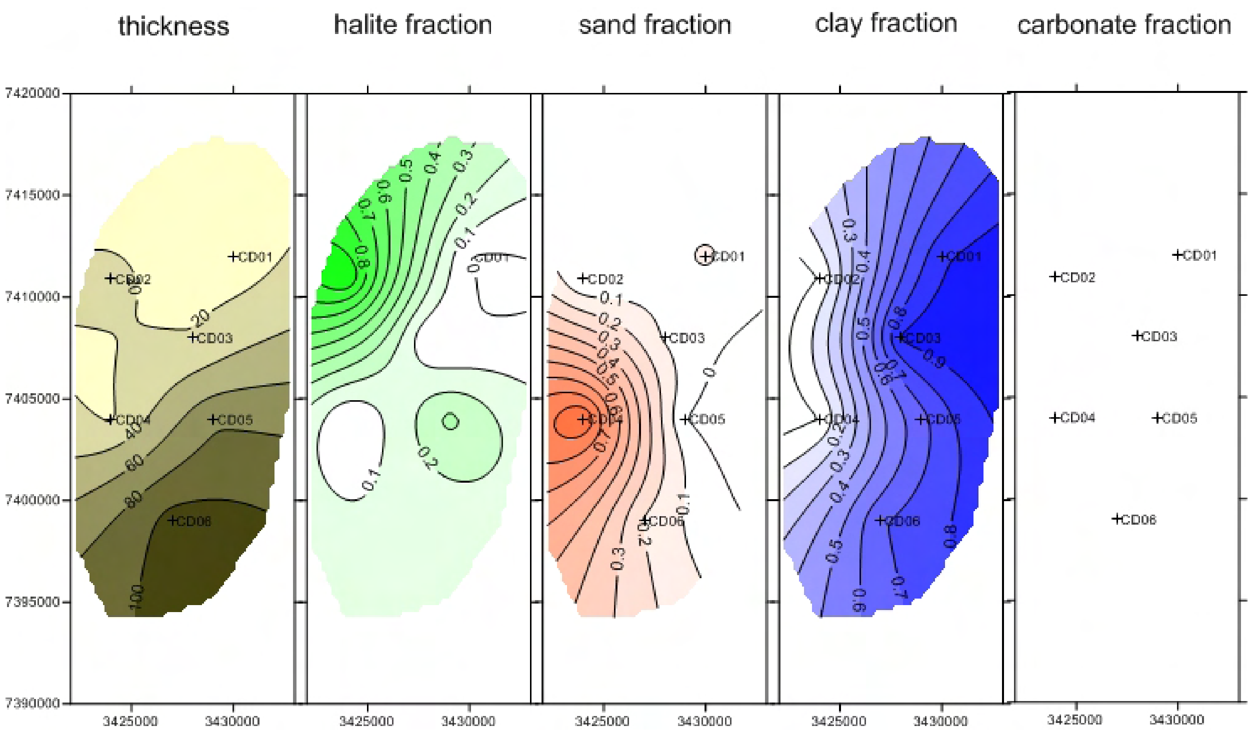
The structure and distribution of the Unit F lithofacies suggest that during its formation, active subsidence was taking place on the western margin, where deeper water lacustrine conditions prevailed. It is likely that tilting of the whole basin towards the north was also occurring at the same time to provide additional accommodation space in the north.

10.2.8 Unit G

The isopach map for Unit G is biased by the fact that nowhere was the Unit penetrated by drilling and all drilling ceased at an average 197 m depth. Thus within the depth of investigation it appears that the thickness decreases from north to south. Since this is contrary to all other Units, it is speculated that this Unit probably deepens towards the north.

Clays again dominate the far eastern side of the basin, with considerable sand in the west. The clays are red, brown, grey and green with widespread but uncommon nodules of Ulexite. The sand is generally fine-medium grained with some silt. Halite occurs throughout the salar. In the northwest (CD02) it occurs as a single, 25 m thick bed, but elsewhere separates into a number of discrete beds (11 in CD05) that can be clearly identified in the geophysical and geological logs.

Figure 10.13 Isopachs and lithofacies of Unit G.
Note that no well penetrates this Unit and their average base is 197 m.



The west to east asymmetry in the lithofacies again suggests active subsidence in the west during the formation of the Unit, probably on the previously identified normal fault. The fact that halite occurs as a single thick bed in the northwest but separates into discrete beds across the rest of the salar also suggests active subsidence in the west and north, and that the discrete halite beds are a function of tectonics rather than changing climatic conditions. The near 100% halite fraction in the northwest does however suggest more stable arid climate conditions than at any other time in the sequence.

10.3 Basin analysis

10.3.1 Development over time

The Salar de Olaroz originated as a structurally bounded, closed basin during the late Paleogene-Early Neogene. During much of the Miocene it appears to have slowly filled with medium to coarse grained alluvial fans and talus slopes eroded from the surrounding mountain ranges. As accommodation space was filled the sediments became progressively finer grained, braidplain, sandflat, playa and fluvial architectures are noted in the Upper Miocene and Pliocene. As the climate became more arid during the Pliocene evaporitic deposits first appeared. Normal faulting created additional accommodation space probably initiated at this time too. The lowest drilled sediments indicate an arid climate with abundant halite. These Units are probably Pleistocene in age and are likely contiguous with the lowest drilled and reported sediments in the

Salar de Cauchari to the south, suggesting the two basins operated as a continuous hydrologic entity at that stage. Succeeding Units suggest continued subsidence in the center of the basin, with a climate that was variable, but never as arid as during Unit G time. Subsidence decreased through Units E and F and effectively appears to have ceased during Unit D. Until Unit D the major source of sediment supply appears to have been from the Rosario catchment to the north. At an early stage during Unit D deposition the mountain range on the west was breached and sediment began to be supplied to the southwestern part of the salar from the Archibarca catchment. Three major depositional cycles occurred during what is presumed to be largely the Pleistocene-Holcocene. The first cycle, Unit D represents shallow, largely freshwater conditions in the salar with associated alluvial fan and fan-delta Units F2 and Fd2 to the south and north of the salar respectively. This cycle is separated from the succeeding by a widespread and rather thin, uniform Unit C which is taken to represent a short but significant excursion into rather wetter conditions. The second cycle, Units B, F1, Fd0, and Fd1, suggest eutrophic, lacustrine conditions in the salar possibly with some volcanic or hydrothermal supply. The final cycle, comprised only of Unit A suggests a return to relatively arid conditions with infill largely confined to the basin center.

10.3.2 Salar type

The Salar de Olaroz is clastic dominant, and operates under a relatively high moisture regime. It may therefore be characterized as an immature salar (Houston et al., *in press*).

10.4 Host aquifer physical properties

10.4.1 Aquifers and aquitards

The geological sequence of the salar deposits described in section 10.2 represent a multi-aquifer system, with Units A, C and G being the most permeable based on their lithology. Units B, D, E and F are less permeable based on their lithology. However, the rapid alternation of beds and laminae within each of the lithostratigraphic units suggests that at the large scale (100’s of m to kms) the sequence is relatively homogeneous and isotropic. This is supported by the results of the pumping tests (Appendix C) that show no evidence of semi-confined conditions nor of significant anisotropy. Furthermore, head data taken during drilling suggests that the units are in hydraulic contact with each other. On the smaller scale (meter) some inhomogeneity and anisotropy may be identified, with thin discontinuous confining beds apparent, but it is unlikely that this will have any significant bearing on the flow of fluid throughout the system.

10.4.2 Porosity

Porosity is highly dependent on lithology as demonstrated in section 15.2. P_t is much higher in finer grained sediments, whereas the reverse is true for S_y, due to the high S_r in these sediments. Lithology is highly variable, with sand-silt-clay mixes spanning the full spectrum of possibilities. Thus, it is only possible to discriminate the dominant lithology, for example, sand dominant or clay dominant. With this in mind, it is not surprising that the porosity of sand dominant, or clay dominant (for example) lithologies have a wide range (Figures 15.7, 15.8) with considerable overlap (Table 10.1).

Table 10.1 Mean values and standard deviations of total porosity (P_t) and specific yield (S_y) for different lithologies

	P_t	S_y
Sand dominant	0.31 ±0.06	0.13 ±0.07
Silt & sand-clay mixes	0.37 ±0.08	0.06 ±0.04
Clay dominant	0.42 ±0.07	0.02 ±0.02
Halite dominant	0.27 ±0.14	0.04 ±0.02

Within the 200 m depth range that has been investigated by drilling and testing, there is no significant depth-porosity relationship (see Appendix B), because of the overwhelming control by lithology.

The control by lithology can be seen in the distribution maps of Sy (Figures 10.14, 10.15). In Unit A values of Sy above 0.1 are located in the centre of the salar, roughly coincident with the occurrence of halite. In Units B, C and D higher values of Sy tend to be associated with sandy facies in the north of the salar. In the lower layer, higher values of Sy tend to be associated with sand, halite or carbonate facies in the west and north of the salar.

Figure 10.14 Distribution of S_y in the upper 54 m, for each Unit.

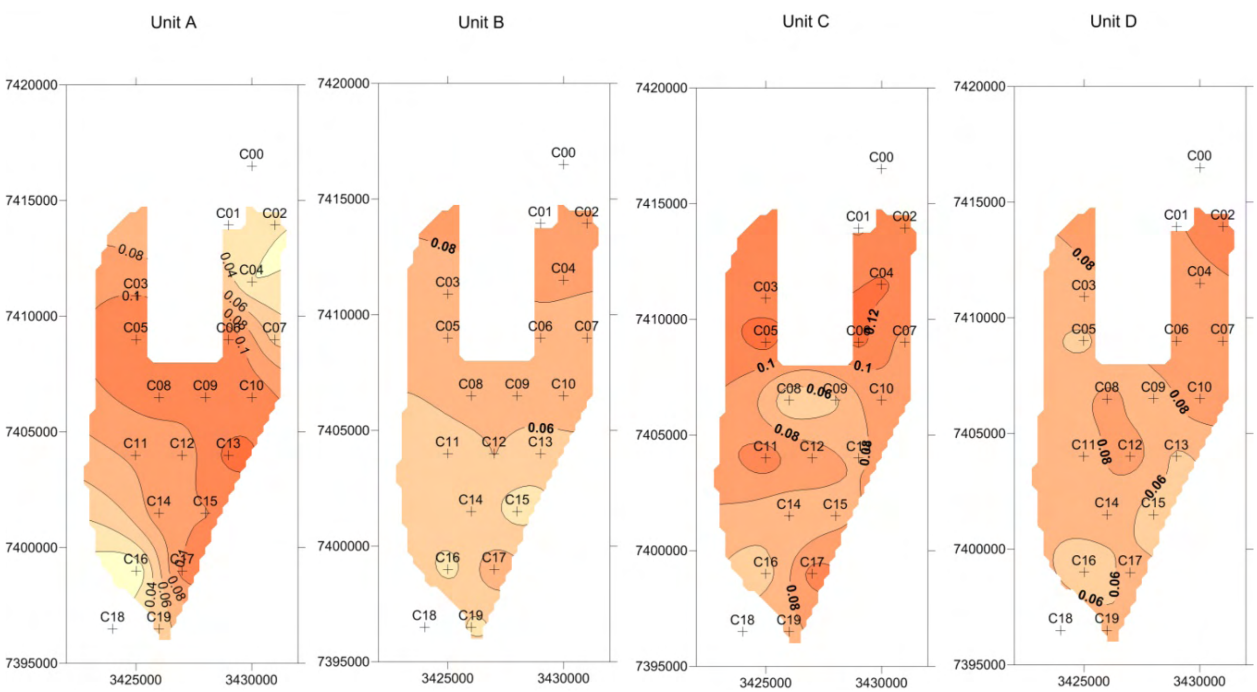


Figure 10.15 Distribution of S_y in the lower 54-197 m, for each Unit.

10.4.3 *Permeability*

Permeability has been determined from pumping tests carried out on three test production wells drilled to 50 m and two test production wells drilled to 200 m. The latter are still in progress and will be reported in due course.

The analysis of the pumping tests from P1, P2 and P3 are presented in Appendix C, using standard analytical techniques (Kruseman and de Ridder, 1990; Dawson and Istok, 2000), and the results summarized in Table 10.2.

Table 10.2 Summary of aquifer characteristics determined from pumping tests (Appendix C).

Test production well	Efficiency	Flow conditions	Permeability K (m/d)	Storativity
P1	93%	Confined (2-50 m)	1.2-1.3	$0.4\text{-}3 \times 10^{-3}$
		Unconfined (0-6 m)	1-2	0.2
P2	92%	Aquitard (6-26 m)	0.15	6×10^{-6}
		Confined (26-50 m)	1-2	
		Unconfined (0-11 m)	1.5-2.5	0.02-0.16
P3	87%	Aquitard (11-16 m)	nd	nd
		Confined (16-50 m)	1.5-2.5	$0.6\text{-}4 \times 10^{-4}$

The results show consistent values of permeability for the sediments: 1-2 m/d for aquifers and ~0.15 for aquitards. Both values are typical for fine grained sands and silts respectively. The ratio of aquifer:aquitard permeability could be used as a measure of minimum horizontal:vertical permeability (K_H:K_V) and approximates 10. Unconfined storage is equivalent to specific yield, with pumping test values in the range 0.02-0.2, which compare closely with values of specific yield determined from core analysis. Confined storage coefficient was only determined on P3 and varied between 0.6-4x10-4, values typical for confined aquifers. Aquitard storage coefficient was determined in P2 (6x01-6), indicative of low flow in this unit.

11. MINERALIZATION

11.1 Brine chemistry

11.1.1 General characteristics

The general characteristics of the brine with respect to the elements of interest are given in Table 1. High values of Li, K and B are present throughout the salar. The lower layer (54-197 m) tends to have 13-36% higher concentrations, with less variation (smaller SD) than the upper layer (0-54 m). Nevertheless the Mg:Li and SO_4:Li ratios remain similar for both layers.

Table 11.1 Basic statistics for the brine samples used in the resource estimate.

	Li (mg/L)		K (mg/L)		B (mg/L)		Mg/Li (mg/L)		SO_4/Li (mg/L)	
	0-54 m	54-197 m	0-54 m	54-197 m	0-54 m	54-197 m	0-54 m	54-197 m	0-54 m	54-197 m
N	429	162	429	162	429	162	429	162	429	162
mean	611	693	4,874	5,994	742	1,008	2.37	2.37	24.9	26.7
standard deviation	339	148	2,603	1,347	369	337	0.62	0.50	8.8	8.5
max	1,432	1,000	10,248	8,926	1,604	2,235	5.56	3.60	54.6	78.2
min	10	354	20	2,770	13	450	1.17	0.37	8.2	9.0

Histograms of the species of interest (Figures 11.1, 11.2) confirm the wider spread of values in the upper layer with much more uniform brine in the lower layer. Li and K in the upper layer may indicate a bimodal distribution.

Figure 11.1 Frequency histograms for Li, K and B for the layer 0-54 m, with best fit normal curve.

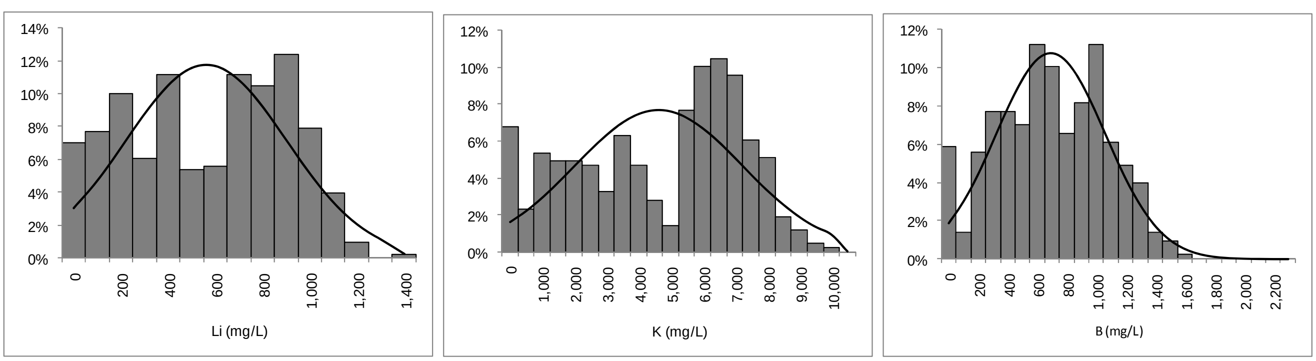
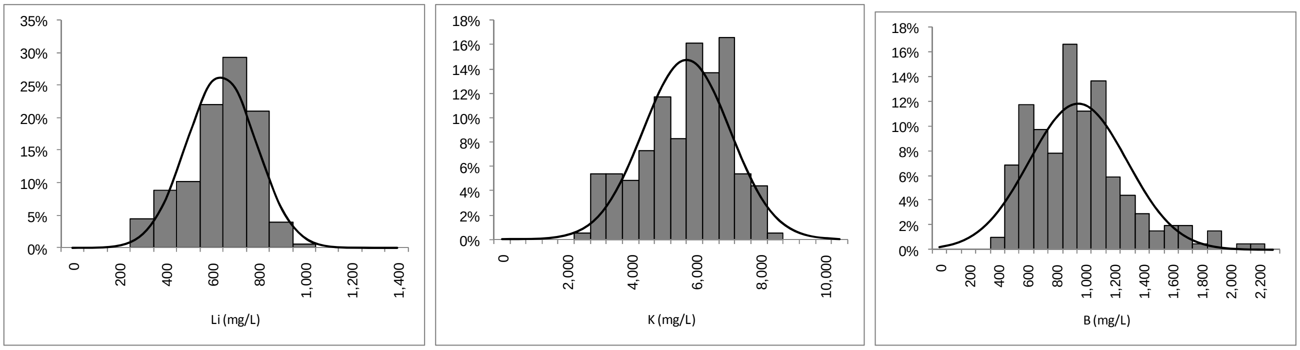
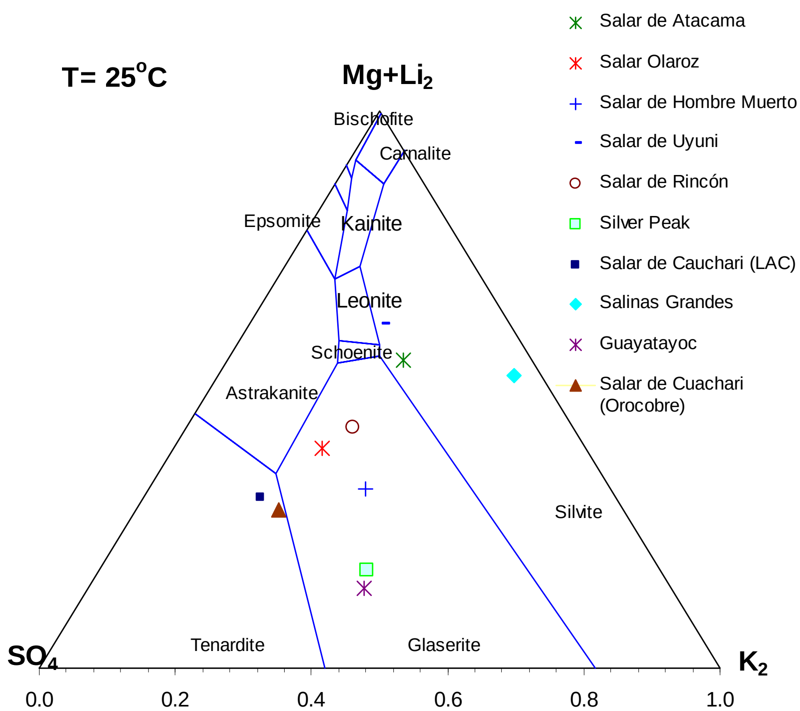


Figure 11.2 Frequency histograms for Li, K and B for the layer 54-197 m, with best fit normal curve.



The phase diagram (Figure 11.3) does not indicate concentrations, but it does allow an indication of the types of salt that can be expected to crystallize during the solar evaporation process. The Salar de Olaroz brine is located in almost the center of glaserite ($Na_2SO_4*3K_2SO_4$) field. Low ambient temperatures at the Salar will cause the crystallization of sulfate as glaubersalt ($Na_2SO_4*10H_20$) in the evaporation ponds, which is stable at low temperatures. The low Mg:Li ratio of the brine opens the feasibility of magnesium removal with slaked lime. The Olaroz brine has high sulfate content (high SO_4:Mg); hence sodium and potassium sulfate salts are likely to crystallize. As the SO4:Mg ratio is higher than four, there is enough sulfate available in the brine to precipitate the calcium liberated during magnesium removal process.

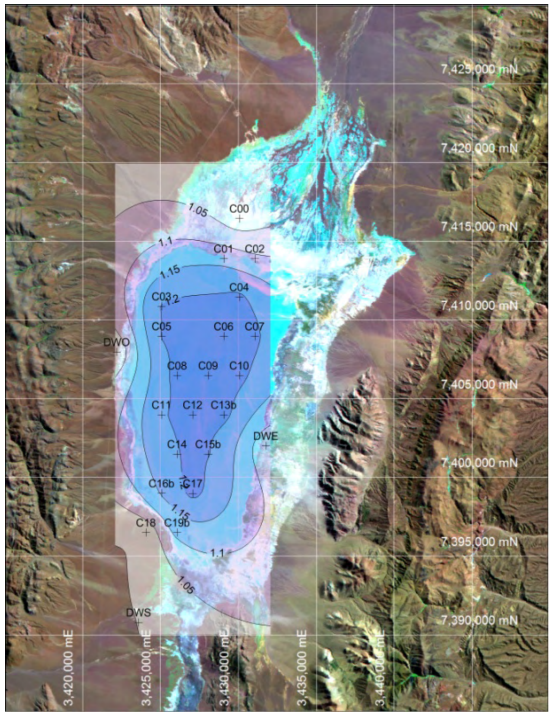
Figure 11.3 Salar de Olaroz average brine composition plotted on a Janecke Phase Diagram and compared with other known brine compositions.



11.1.2 Upper layer 0-54 m

The distribution of density through the salar generally follows the salar outline as seen in the satellite image, with the 1.1 gm/cm^3 contour tracking almost exactly the current nucleus of the salar. Much of the salar indicates brines with a density of 1.20<1.24 gm/cm^3.

Figure 11.4 Mean density (gm/cm^3) distribution in upper layer (0-54 m), Units A-D.



Figures 11.5 through 11.9 show the distribution of Li, K, B, Mg and SO^4 in the upper (0-54 m) layer. The highest concentrations are found in the center of the nucleus with a tendency for the peak to increase somewhat, and shift from the center to the central eastern part of the nucleus with depth.

Figure 11.5 Distribution of Li (mg/L) in upper layer (0-54 m), Units A-D.

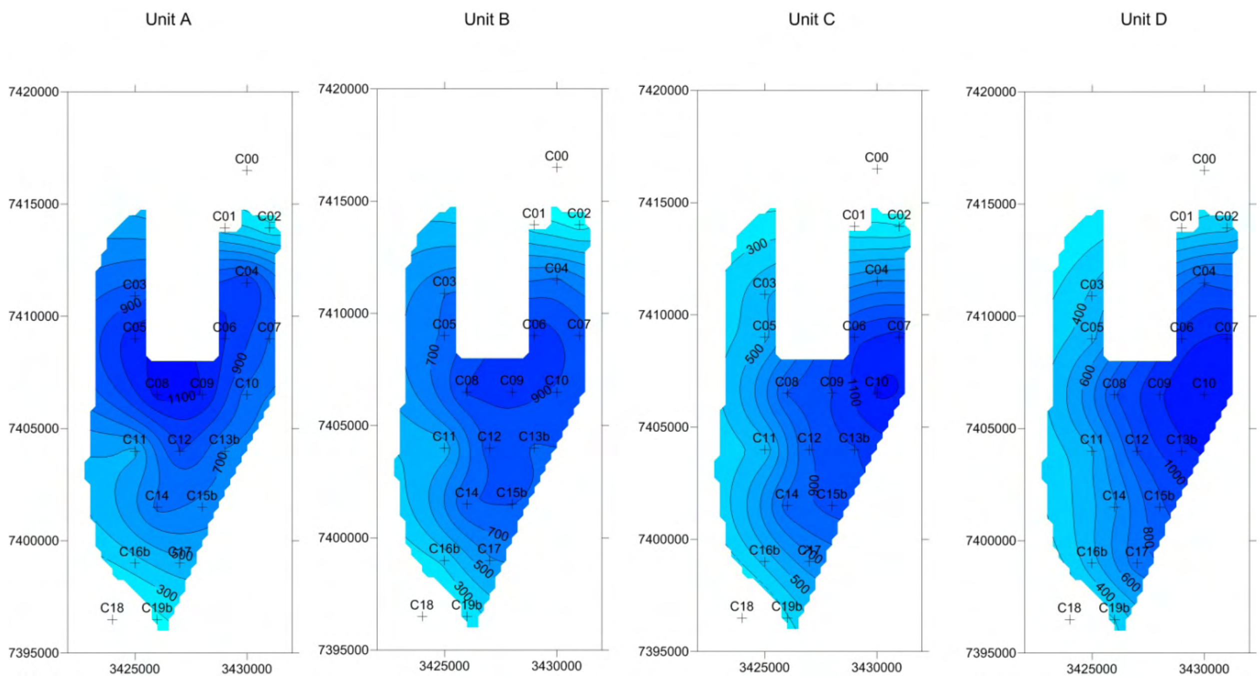


Figure 11.6 Distribution of K (mg/L) in upper layer (0-54 m), Units A-D.

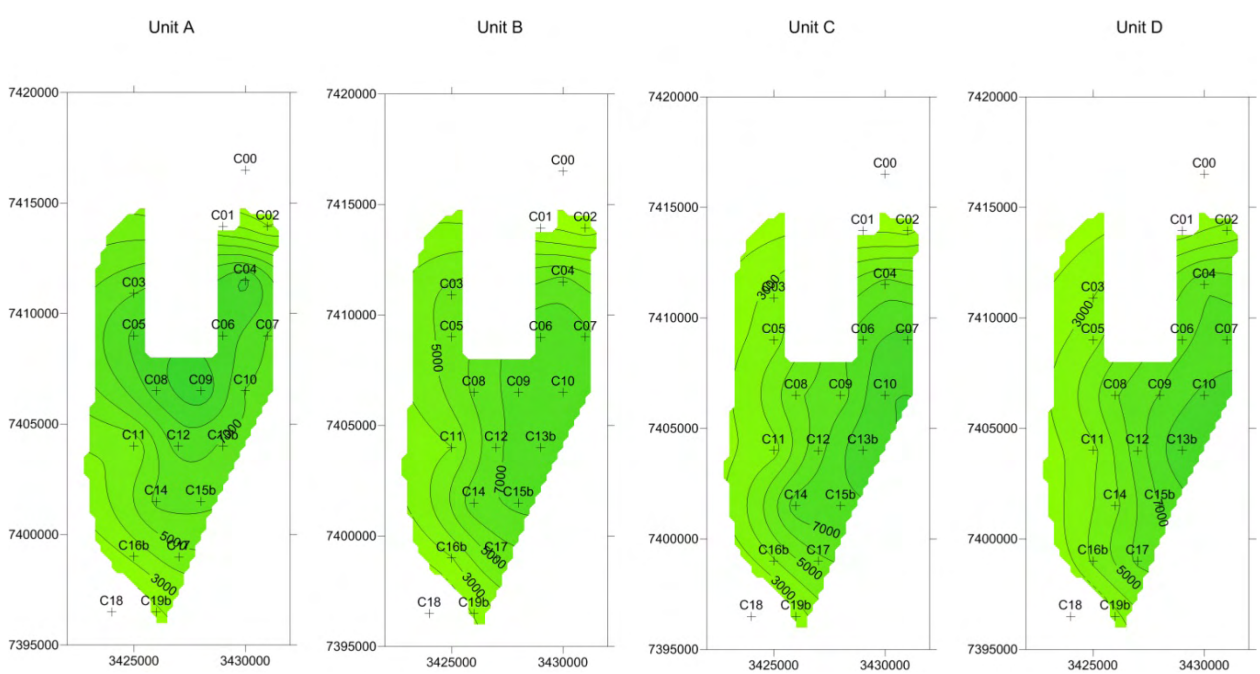


Figure 11.7   Distribution of B (mg/L) in upper layer (0-54 m), Units A-D.

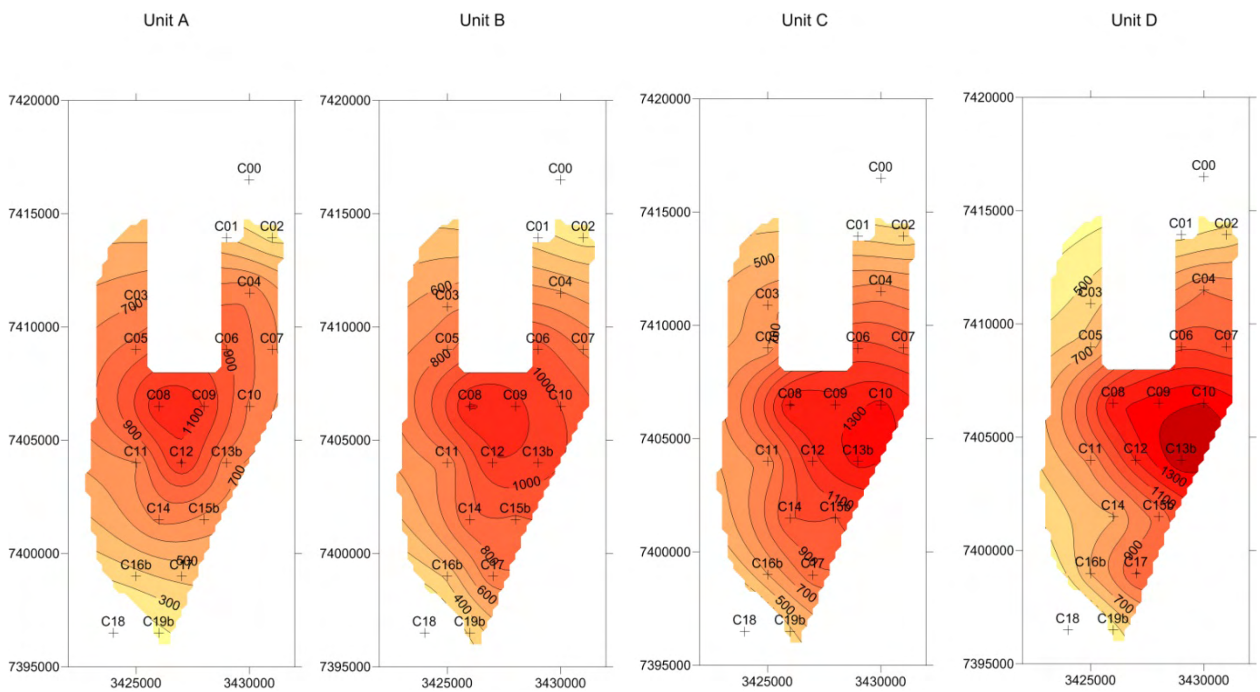


Figure 11.8   Distribution of Mg (mg/L) in upper layer (0-54 m), Units A-D.

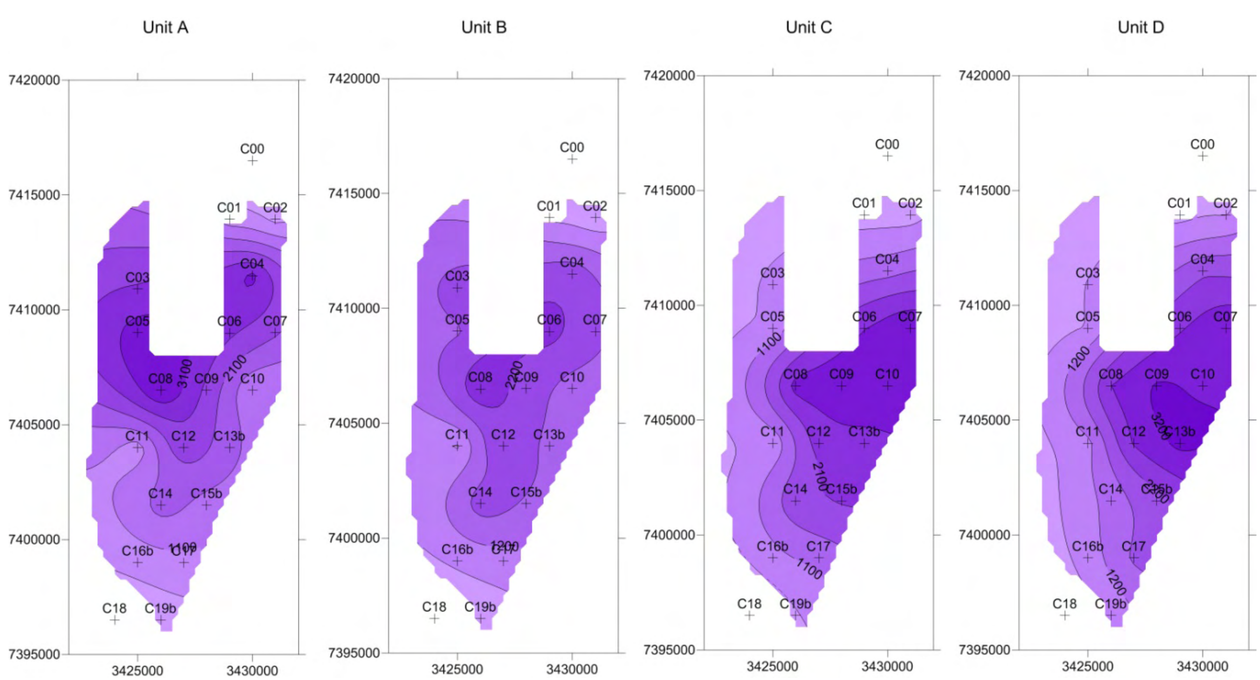
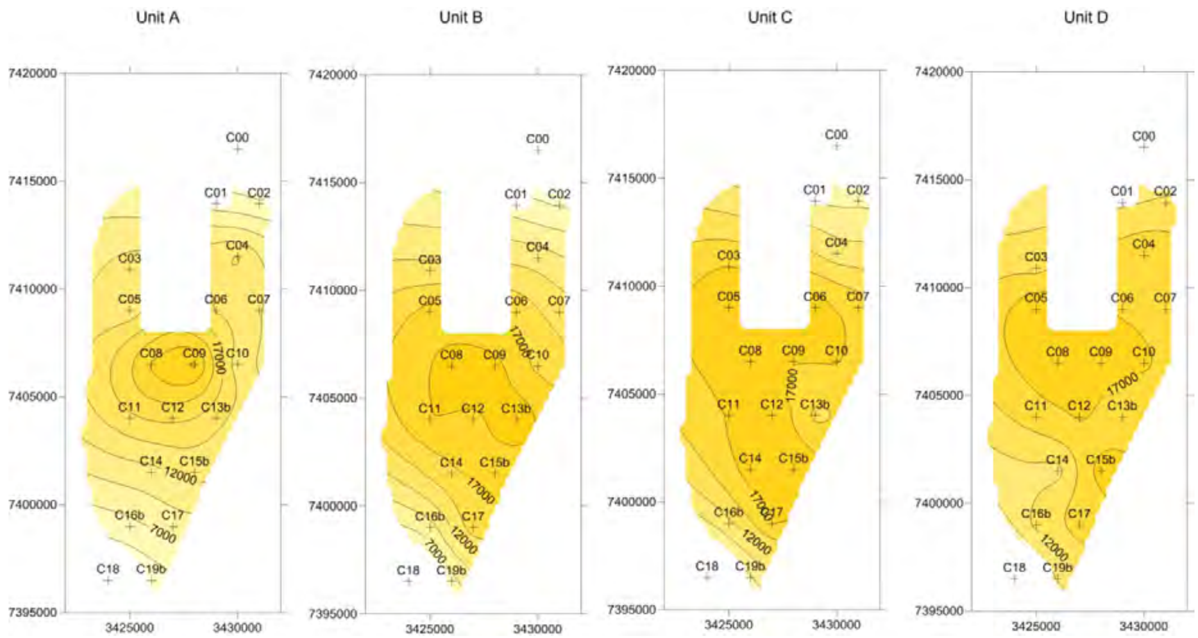


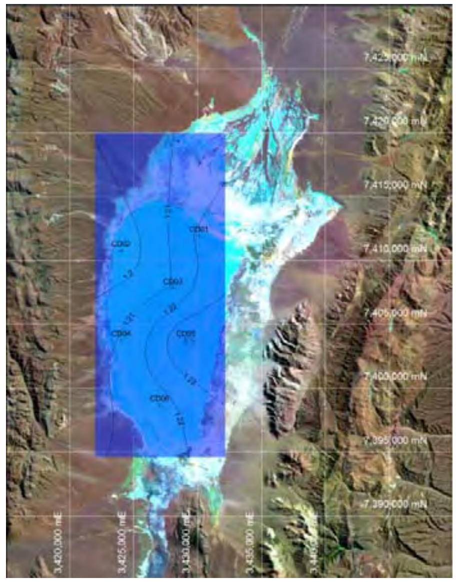
Figure 11.9 Distribution of SO_4 (mg/L) in upper layer (0-54 m), Units A-D.



11.1.3 Lower layer 54-197 m

With depth, density tends to increase slightly, but especially for densities >1.20 gm/cm^3 to extend over a much wider area than the upper layer. A marked asymmetry can also be observed with increasing values from west to east. This asymmetry may be coincident with lower permeability associated with the finer grained sediments to the east, suggesting perhaps that partial flushing of the aquifer in the western more permeable, more sandy, parts may have taken place during a past wetter hydrological regime.

Figure 11.10 Mean density (gm/cm^3) distribution in lower layer (54-197 m), Units D-G.



The asymmetry shows up in the concentration of Li and K (Figure 11.11-11.15) with peak concentrations in the central eastern part of the nucleus. B, Mg and SO4 follow the same pattern in Units D and E, but show a marked change below this depth. Boron tends to higher concentration both in the north and the south of the nucleus, whilst magnesium is higher in the south of Unit F and north of Unit G, and sulfate increase significantly in the south, close to the juncture of Olaroz with Cauchari.

Figure 11.11 Distribution of Li (mg/L) in lower layer (54-197 m), Units D-G

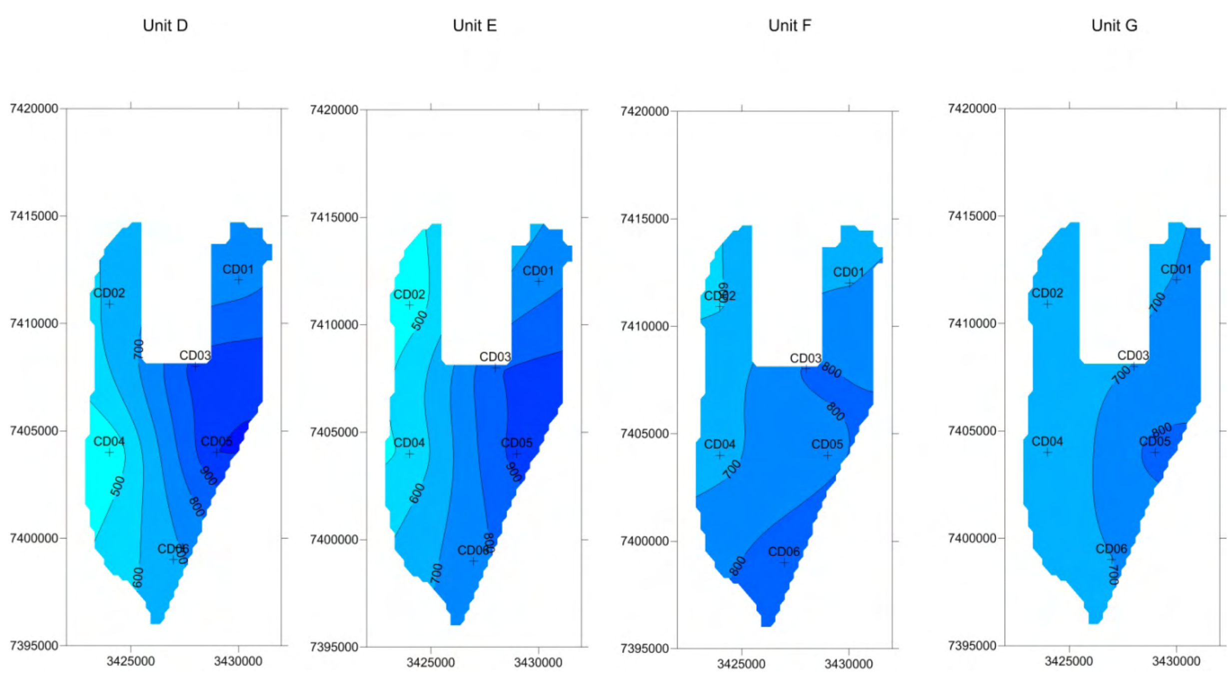


Figure 11.12 Distribution of K (mg/L) in lower layer (54-197 m), Units D-G.

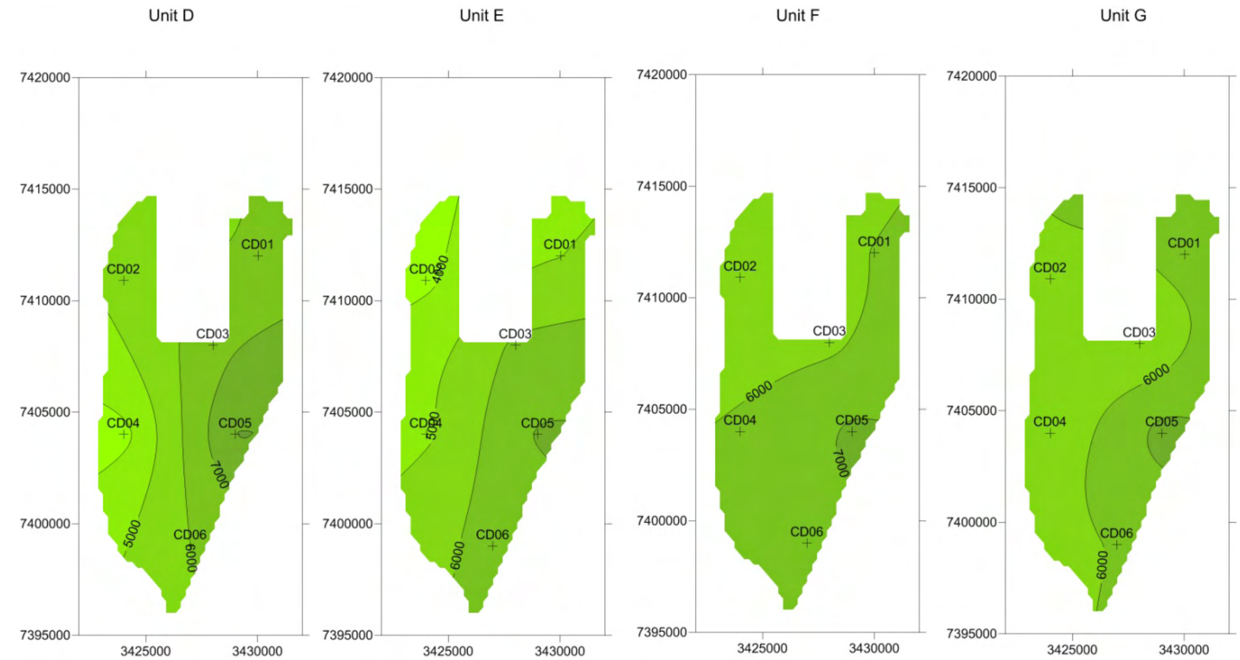


Figure 11.13   Distribution of B (mg/L) in lower layer (54-197 m), Units D-G.

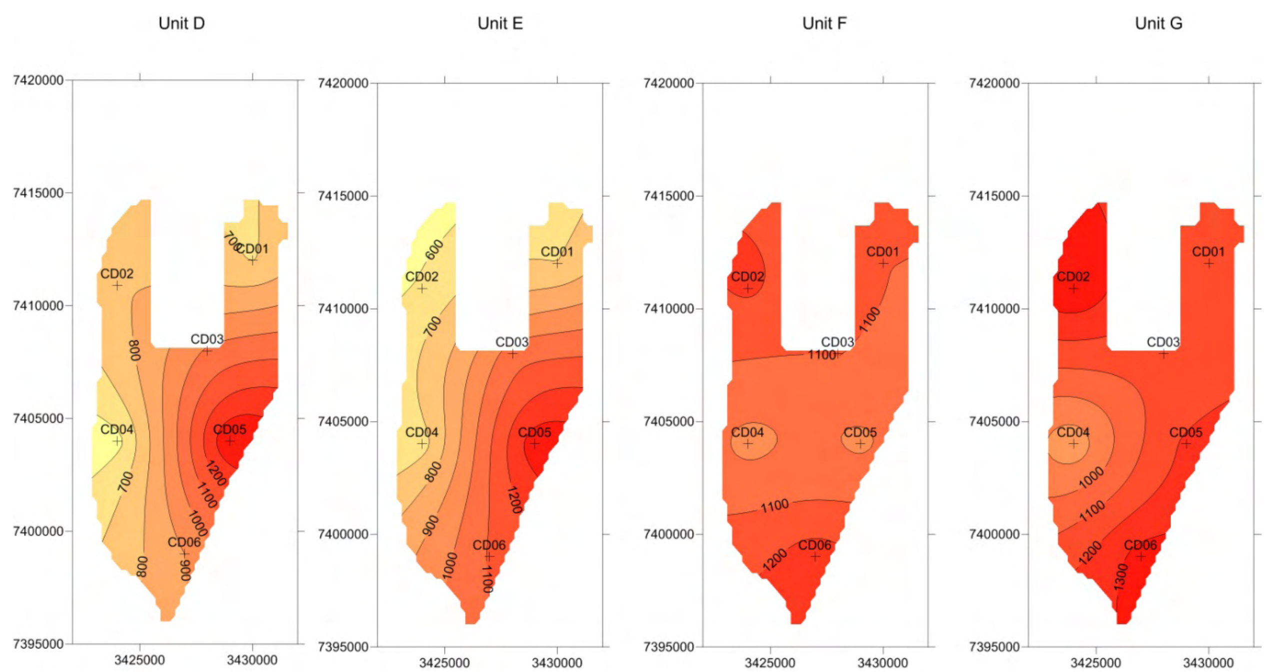


Figure 11.14   Distribution of Mg (mg/L) in lower layer (54-197 m), Units D-G.

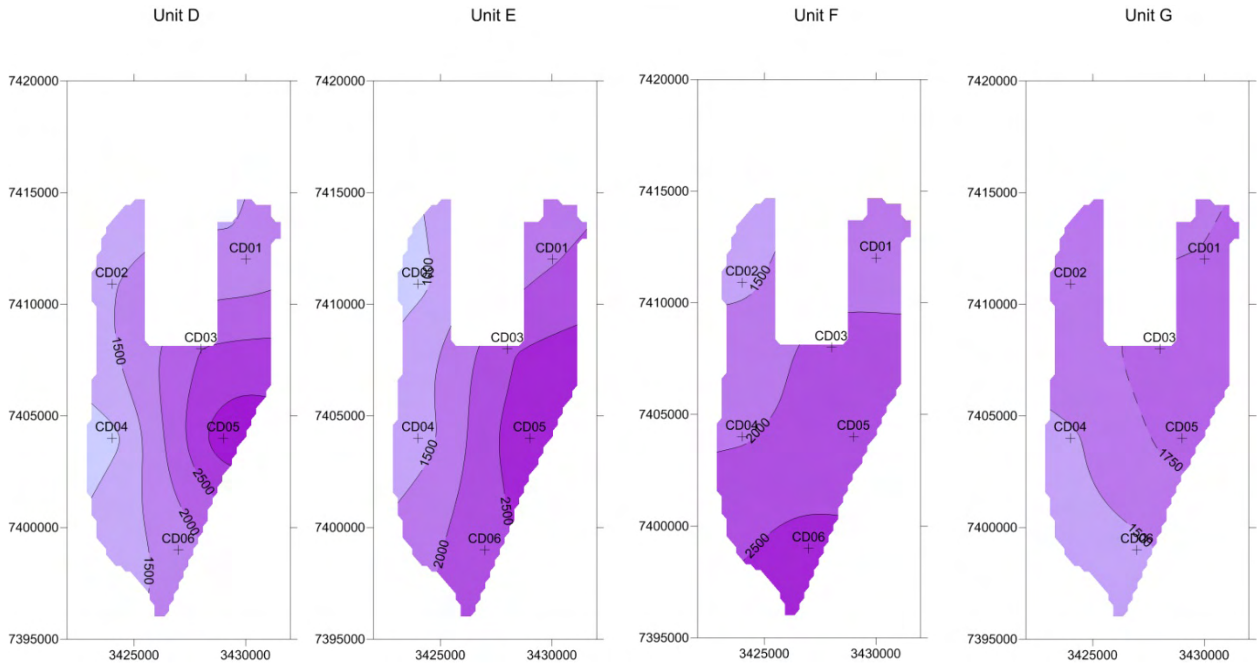
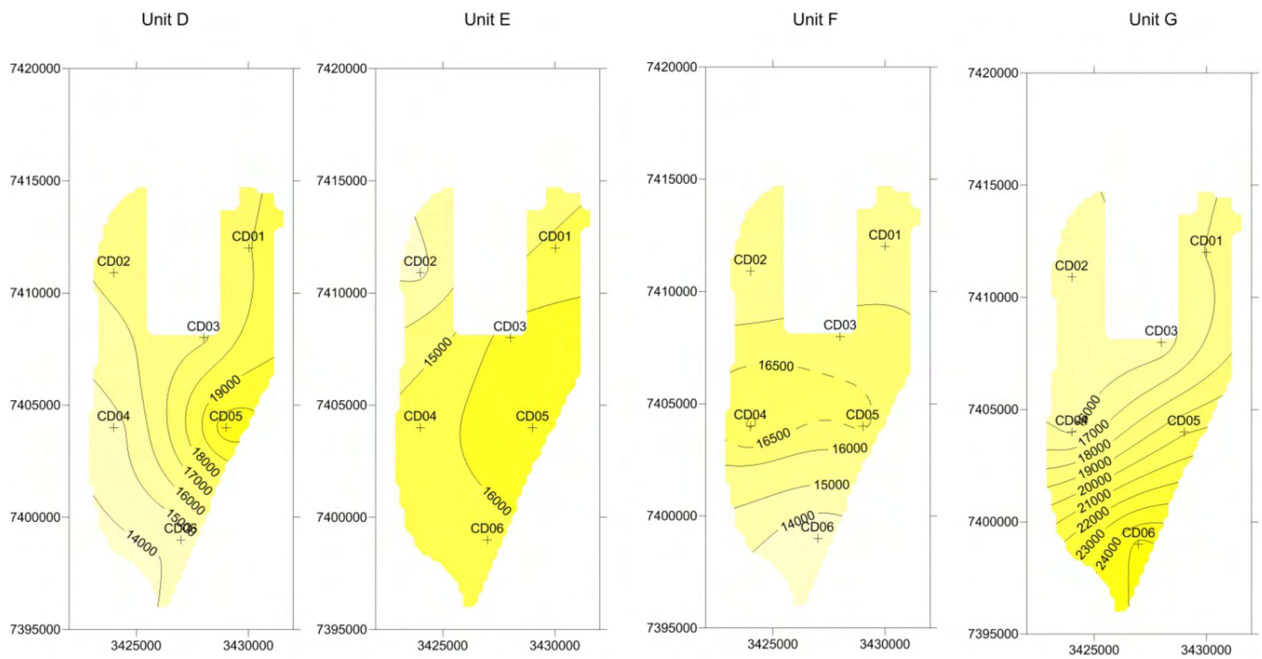

Unit D
Unit E
Unit F
Unit G
7420000
7415000
7410000
7405000
7400000
7395000
3425000
3430000
CD01
CD02
CD03
CD04
CD05
CD06
1500
2000
2500
1750

Figure 11.15 Distribution of SO4 (mg/L) in lower layer (54-197 m), Units D-G.



11.2 Brine evolution

The tendency for brine to increase in density and concentration with depth has already been noted and can be seen in the plot of TDS to depth (Figure 11.16). Dilute inflow water cluster at low TDS concentration in the upper left of the plot. Concentrated brines (>270,000 mg/L TDS) are found at all depths in the center of the nucleus and plot on the right hand side of Figure 11.16. Between these two endpoints, wells C00, C01, C02 in the north and C18 in the south demonstrate their penetration of the marginal brine body in the Rosario fan-delta and Archibarca alluvial fan respectfully. In these zones the increase in concentration with depth is well displayed suggesting that with increasing evaporative concentration at the surface, the brines tend to sink as a result of their increased density. Maximum concentrations are in the region of 320,000 mg/L TDS.

A plot of Na: Cl shows that the brine has undergone simple evaporative concentration from the dilute inflow waters through to highly concentrated brine, with no suggestion of any interaction from other sources, such as hydrothermal fluids or evaporite re-solution.

Figure 11.16 Relation of total dissolved solids (TDS mg/L) to depth. Inflow samples represent those taken from surface water around the periphery of the salar.

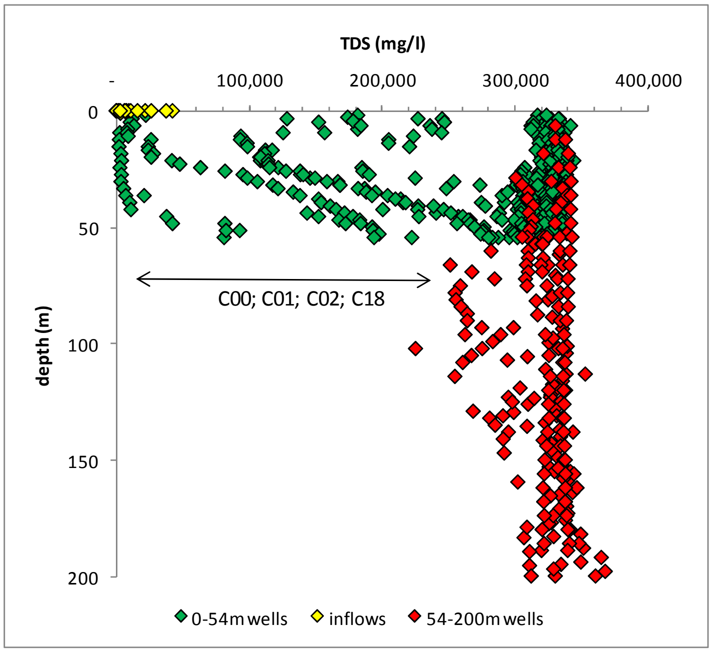
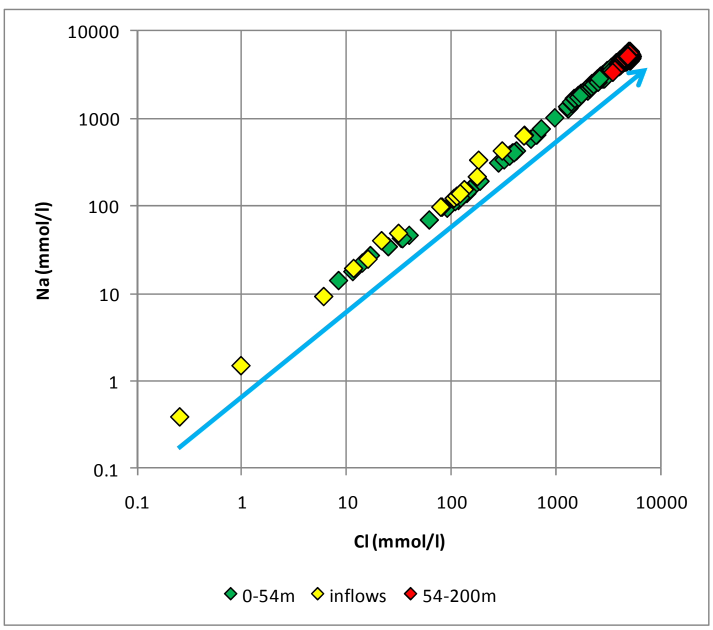


Figure 11.17 Relation of Na to Cl (mmol/L), showing path of evaporative concentration (blue arrow).



As the brine becomes increasingly concentrated as a result of evaporation it passes through several evolutionary divides (Hardie and Eugster, 1970). The first such divide occurs once calcite saturation is reached and starts to precipitate (Figure 11.18 left). From here on carbonate is taken out of solution into the calcite lattice leaving a fluid enriched in calcium (Hardie-Eugster pathway II). A group of samples from well C02 appear to evolve somewhat differently from the remainder of the brine body. The next divide is for gypsum. When fluid concentrations reach this level gypsum precipitates, taking out calcium into its lattice and leaving the fluid enriched in SO_4 (Hardie-Eugster pathway VI) (Figure 11.18 right). Eventually the brine reaches sufficiently high concentrations (>320,000 mg/L TDS) that halite saturation is reached and starts to precipitate. At this point, since Li remains in solution and does not precipitate, the Li concentration increases further (Figure 11.19).

Figure 11.18   Relation of Ca-Mg (mmol/L) to alkalinity (meq/L) (left) and Ca (mmol/L) to SO_4 (mmol/L) (right), showing evolutionary path (blue arrows).

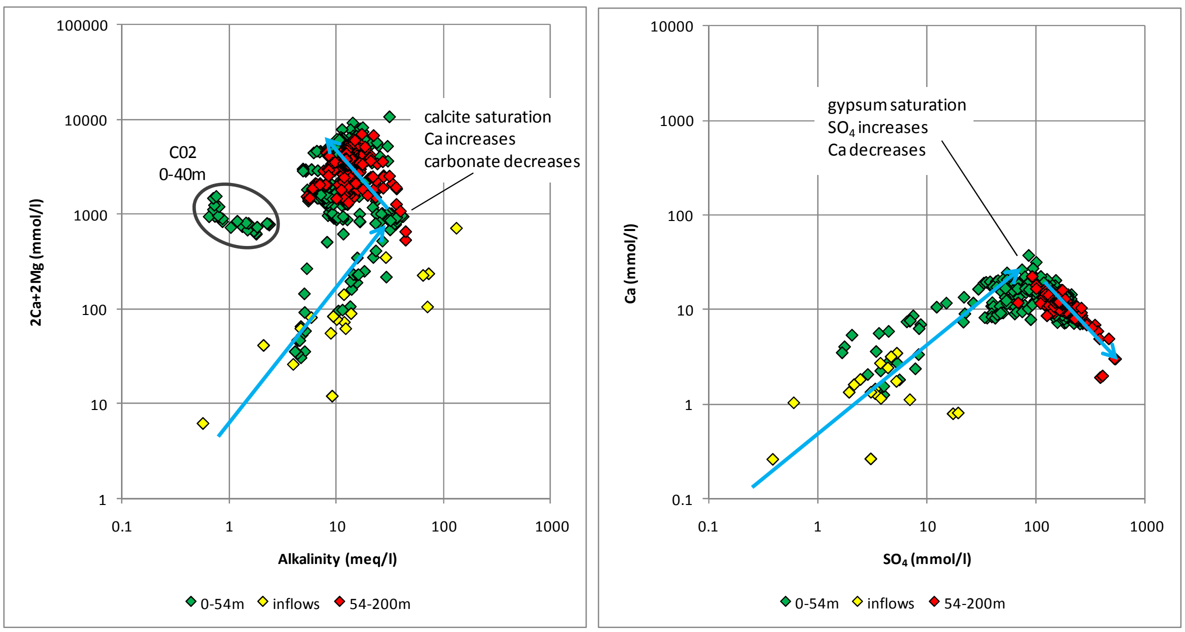
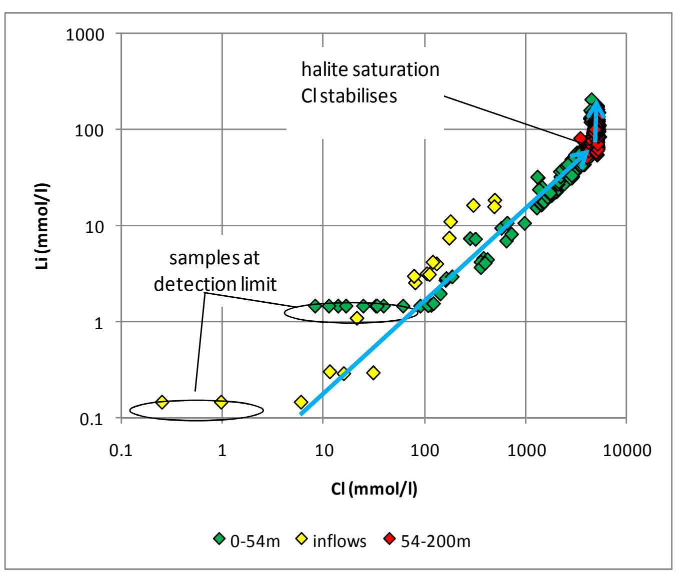


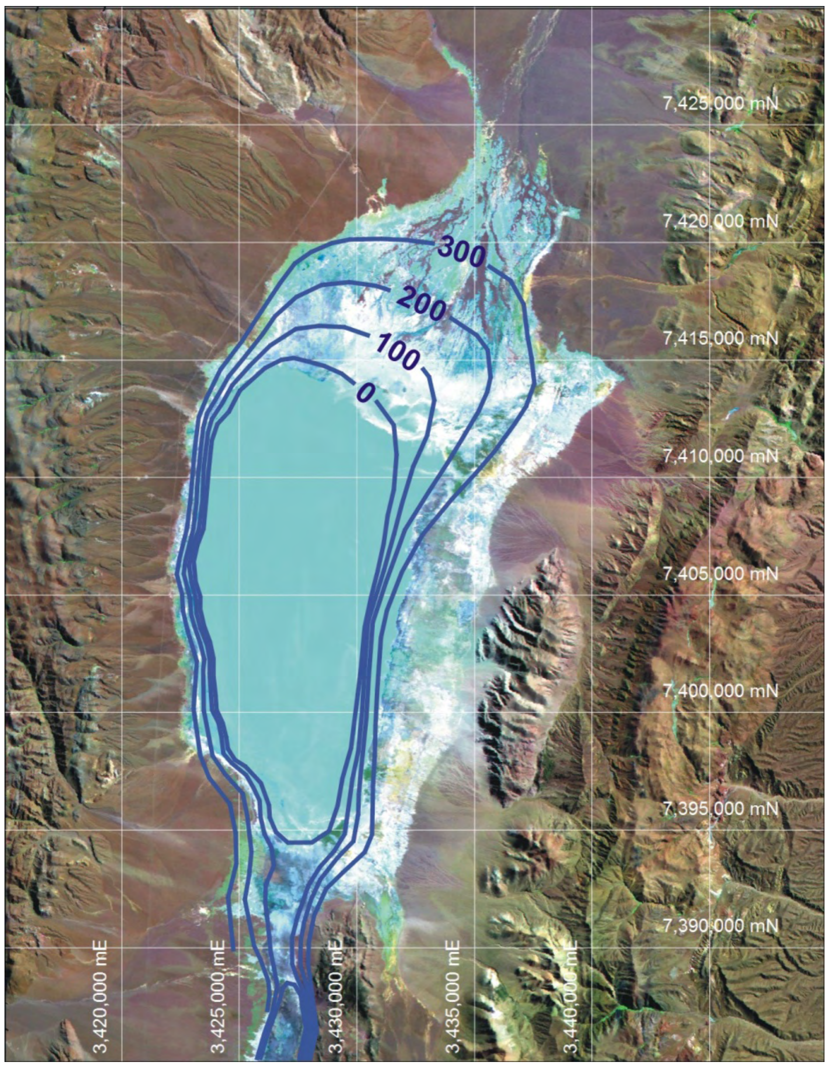
Figure 11.19   Relation of Li (mmol/L) to Cl (mmol/L), showing evolutionary path (blue arrows).



11.3 Brine body

Based on data from wells, coupled with the AMT geophysical sections it is possible to map the form of the brine body (Figure 11.20). The body expands considerably with depth in the north where it is unconstrained in the sediments of the Rosario fan-delta. Elsewhere the margin is much steeper, probably as a result of reduced permeability in the eastern and western margins, inhibiting movement at depth.

Figure 11.20 Brine body geometry: depth to 1.10 gm/cm^3 density in m, based on drill hole data and AMT results.



11.4 Salar water balance

The Salar de Olaroz is a closed (endorheic) basin, meaning that there are no surface or groundwater outlets. Consequently all water that enters the Salar from the surrounding basins must be lost by evaporation under natural conditions. For the purpose of the water balance evaluation, the Salar is considered to include both the nucleus and the surrounding marginal zones as shown in Figure 7.7. Several surface water catchments drain to the Salar, the most important being the Rio Rosario through the northern fan-delta and the Rio Ola which enters via the Archibarca alluvial fan.

The water balance for the Salar de Olaroz is given by the following equation:

$$P + I_{SW} + I_{GW} = E$$

Where P is the precipitation falling within the Salar and its margins, I_{SW} is the surface water input component and I_{GW} is the groundwater input component. E represents evaporation from open water and soils within the Salar and its margins.

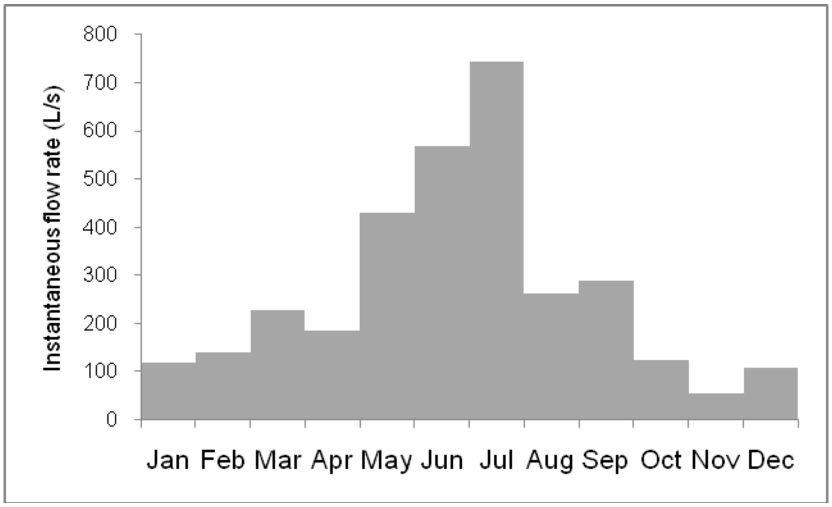
Mean annual precipitation over the salar nucleus and margin has been estimated at 130 mm (section 7.3.1). Evaporation has been estimated for the different zones indicated in Figure 7.7, based on data obtained from Hombre Muerto.

Groundwater inflows have been estimated using Darcy's law (section 7.5.3) with reasonable confidence since cross sectional area was estimated based on gravity profiles, gradients were observed and the permeability determined from pumping tests in the lines of section.

Surface water inflows are being monitored and peak flood flows have been estimated. The Rio Rosario enters the Olaroz basin from the north. It forms a shallow-gradient fan-delta where it emerges from the basement rocks of its catchment that terminates in the Salar. At the point where the Rio Rosario enters the salar nucleus (3437E 7424N) the catchment area is approximately 2,000 km^2. The significant catchment relief which varies from almost 5,000 m where it rises on the flanks of Volcan Toma, to 4,000 m at the Salar, means that it attracts significant precipitation and consequently also produces significant runoff. No permanent flow gauging station is installed on the river but flow monitoring has been undertaken since 2008 at 3432E 7443N (Figure 7.4) where the river disgorges from bedrock at 3,995m and starts to infiltrate the basin sediments. Mean monthly flow rates are shown in Figure 11.21. This data does not contain any of the recent flood flows and therefore represents baseflow from the catchment. Maximum flow rates occur in midwinter, indicating a lag of approximately six months from the peak summer rainfall, due to storage buffering within the catchment. Mean annual baseflow is calculated at $8.5x10^6$ m^3/a, equivalent to 270 L/s.

Flood flows, as a consequence of unbuffered, direct overland flow, have been estimated based on the slope-area method (Benson, 1968). Cross- and longitudinal profiles were surveyed of a uniform reach of the channel, to the topmost level of fresh overbank deposits. The cross-profile was split into sections and resistance coefficients estimated for the bed of each section using Manning's *n* (Chow, 1959). Based on this information, an instantaneous peak flow of ~10 m^3/s, and a total annual flood flow of ~$1.3x10^6$ m^3 is estimated.

Figure 11.21. Mean monthly flow of the R Rosario at 3432E 7443N.



The Rio Ola enters the Salars de Olaroz and Cauchari through the Archibarca alluvial fan from the southwest. Its catchment area is approximately 1,200 km^2, but relief is much less than that of the Rosario catchment with a maximum elevation of 4,400 m. Intermittent flow monitoring at 3415E 7387N (Figure 1) where the river leaves the catchment and infiltrates the fan at 4,000 m indicates variable rates of baseflow between 3-7 L/s. Using the same techniques described above for the Rio Rosario, annual flood flow is estimated at 0.02×10^6 m^3.

Additional small surface water flows are anticipated from the mountain ranges either side of the Salar de Olaroz, but are insignificant in comparison with the Rio Rosario and Rio Ola.

With the components of the water balance known reasonably well, it is possible to assess the natural (pre-development) flow balance (Table 11.2). It must be remembered that all inflows, both surface and groundwater through the Archibarca fan enter both the Salars de Olaroz and Cauchari. Thus for the Olaroz water balance the figures noted above have been halved, on the assumption that 50% of the flows enters each salar.

The results indicate that the total basin flux is approximately 94 million m^3 per annum. The slight error (0.4%) in the above balance is well within the limits of accuracy for the individual measurements. The annual water balance in million m^3 (with an error = $\mathcal{E}$) is thus:

$$P + I_{SW} + I_{GW} = E \pm \mathcal{E}$$

$$42.9 + 9.9 + 40.8 = 94.4 - 0.8$$

Table 11.2 Water balance under average natural conditions for the Salar de Olaroz.

INFLOWS							OUTFLOWS				
Precipitation	rate	130	mm/a	0.13	m/a		Evaporation				
	area	330	km^2	330,000,000	m^2						
	total			42,900,000	m^3/a		zone 1				
							area	50,000,000	m^2		
Rosario	surface water baseflow	270	l/s	8,514,720	m^3/a		rate	1.1	mm/d	20,531,250	m^3/a
	surface water flood	1500	l/s	1,296,000	m^3/a						
	permeability K	20	m/d				zone 2				
	gradient i	0.0025					area	105,000,000	m^2		
	cross sectional area A	2,100,000	m^2				rate	0.05	mm/d	1,916,250	m^3/a
	groundwater Q	105,000	m^3/d	38,325,000	m^3/a						
							zone 3				
Archibarca flow to Olaroz		0.5	fraction to Olaroz from Archibarca				area	80,000,000	m^2		
	surface water baseflow	5	l/s	78,840	m^3/a		rate	1.6	mm/d	46,720,000	m^3/a
	surface water flood	28		12,000	m^3/a						
	permeability K	20	m/d				zone 4				
	gradient i	0.0075					area	115,000,000	m^2		
	cross sectional area A	90,000	m^2				rate	0.6	mm/d	25,185,000	m^3/a
	groundwater Q	13,500	m^3/d	2,463,750	m^3/a						
TOTAL				93,590,310	m^3/a					94,352,500	m^3/a

12. EXPLORATION

12.1 General

Orocobre Ltd contracted with Wellfield Service Ltd to undertake both gravity and audio-magnetotelluric (AMT) surveys at various sections across the Salar de Olaroz. The objective of the gravity survey was to obtain first order estimates of the geometry and depth of the basin, and if possible, to establish the main sedimentary sequences within the basin. The objective for the AMT surveys was to define the limits of the brine body hosted in the basin sediments, and to define the brine-fresh water interface.

A total of 26 km of gravity profiling and 34 km of AMT were conducted between October 5 and November 2, 2009. The location of the sections carried out is shown in Figure 12.1 on the next page. All coordinates and elevations are referred to the Gauss Krueger Projection, Zone 3, and the reference system Posgar 94. Subsequently, two further gravity profiles were undertaken by Quantec Geosciences Argentina S.A. across the Rosario and Archibarca fan-delta and alluvial delta to provide information for the water balance and fresh water supply.

Gravity techniques measure the local value of the acceleration, which after correction, can be used to detect variations of the gravitational field on the earth's surface that may then be attributed to the density distribution in the subsurface. Since different rock types have different densities, it is possible to infer the likely subsurface structure and lithology, although various combinations of thickness and density can result in the same measured density; a problem known as non-uniqueness.

AMT measures temporary variations in the electromagnetic field caused by electrical storms (high frequencies >1 Hz), and the interaction between the solar wind and the terrestrial magnetic field (low frequencies <1 Hz), which allows variations in the electrical subsurface to depths of 2 km or more. The electrical properties of the subsurface depend on Archie's Law:

$$R_t = a\ R_w / P^m$$

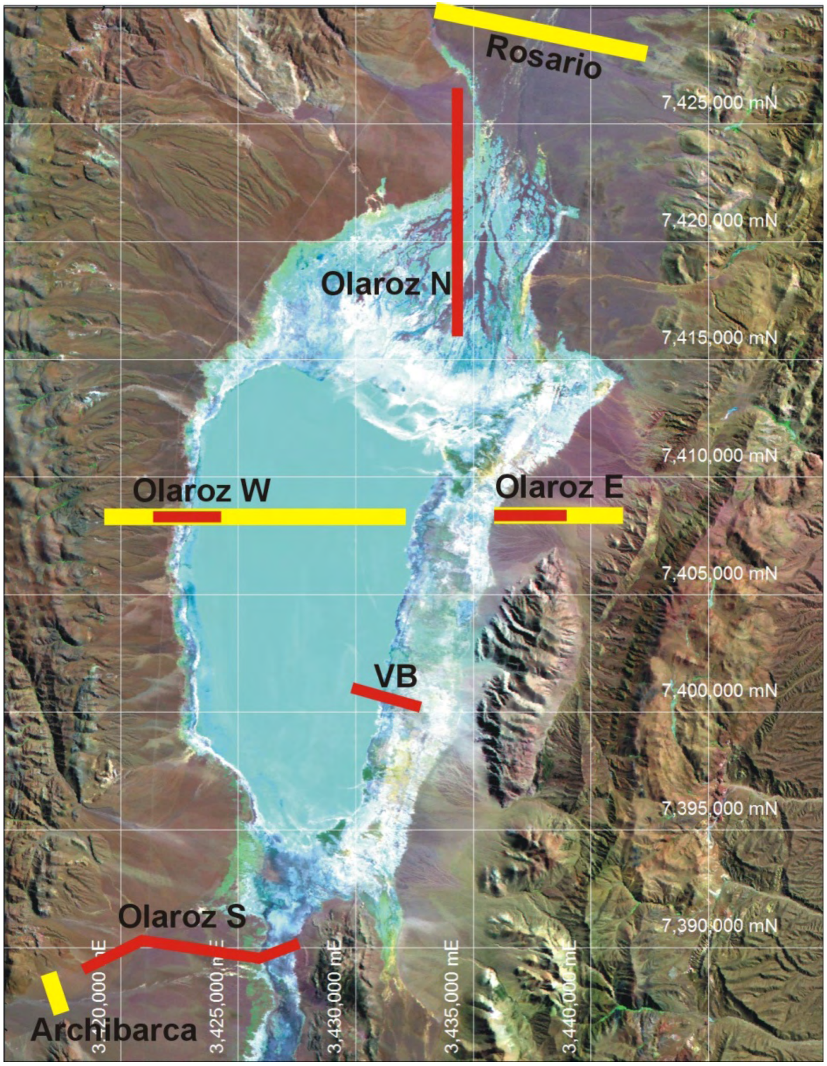
where R_t is the measured total resistivity, R_w is the resistivity of the fluid in the rock pores and P is the rock porosity, a and m are constants. Hence, it is possible to infer the subsurface variations in fluid resistivity and porosity, although it is important to note that once again the problem of a non-unique solution always exists.

12.2 Gravity

12.2.1 Data acquisition

Data was acquired at a total of 130 gravity stations spaced at 200 m, coupled with high precision GPS survey data. A Scintrex CG-5 gravimeter (the most up-to-date equipment available) was used, and measurements taken over an average 15 minute period in order to minimise seismic noise. A base station was established with readings taken at the beginning and end of each day's activities in order to establish and subsequently eliminate from the data the effects of instrument drift and barometric pressure changes. The daily base stations were referred to the absolute gravity point PF-90N, close to Salta where a relative gravity of 2149.136 mGal was obtained. Since this point is distant from the Salar de Olaroz, intermediate stations were used to transfer the absolute gravity to Pastos Chicos where a relative gravity base station was established with a value of 1425.313 mGall.

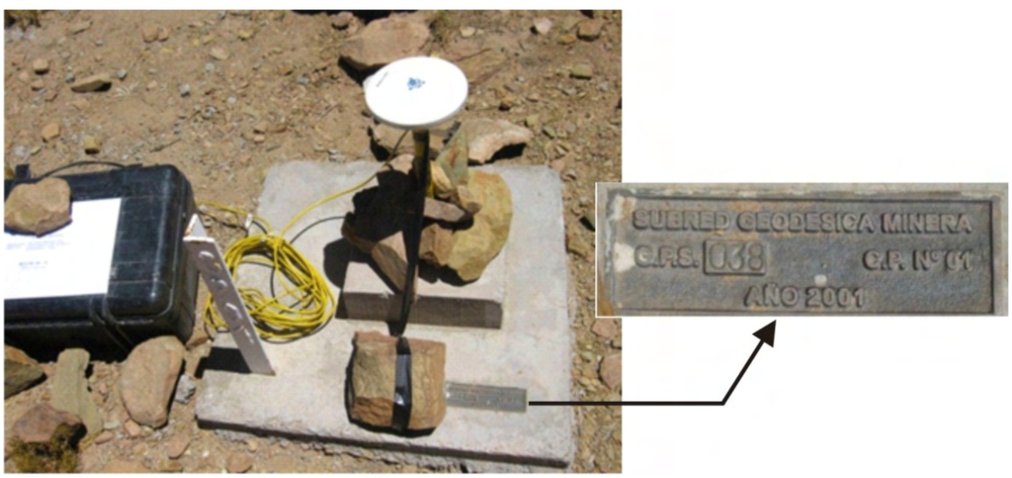
Figure 12.1 Location of gravity (yellow) and AMT (red) sections



To measure the position and elevation of the stations, a GPS in differential mode was used with post-processing (Trimble 5700). This methodology allows centimeter accuracies, with observation times comparable to or less than the gravity observation. Using a mobile GPS (Rover) the gravity station position data is recorded. Simultaneously, another GPS (Fixed) records variation at a base station located within a radius of 10 to 20 km, to correct the Rover GPS. Both data sets are post-processed to obtain a vertical accuracy of 1 cm.

Figure 12.2 Gravimeter base station

Figure 12.3 GPS base station



12.2.2 Data processing

In order to arrive at the complete Bouger anomaly which can be used to interpret the subsurface the following corrections to the acquired data must be made:

- Tidal correction.
- Drift, instrumental height and ellipsoid corrections.
- Free air, latitude, Bouguer and topographic corrections.

Tidal correction compensates for variations in gravity caused by the sun and moon. Using TIDES software, the acceleration due to gravity for these effects can be determined corresponding to the location and time of measurements. The data acquired in the survey were translated to UTC time to facilitate data handling. The exported data were converted from µGal to mGal and used to correct the acquired data.

Instrument drift was calculated from the difference in gravity measured at the base station. This difference is then linearly distributed with respect to time of each reading and used to correct the acquired data.

Each reading was corrected for the height of the instrument using the following formula:

$$r_h = r_t + 0.308596\ h_i$$

where r_h is the corrected instrument height, r_t is the tidal correction, and h_i is the observed instrument height.

The formula employed to correct variations in gravity associated with the ellipsoidal shape of the earth corresponds to the 1980 model:

$$gl = 978032.7\ [\ 1 + 0.0053024\ \sin^2(l) - 0.0000058\ \sin^2(2l)\ ]$$

where gl is the theoretical gravity in milligals and l is latitude

The free air anomaly is calculated as:

$$g_{free\ air} = -0.3086\ (\Delta h)$$

where $g_{free\ air}$ is the correction factor and Δh refers to the difference in altitude of the station with respect to the base.

To eliminate the effect of the rock masses between the reference level and observation station, the Bouguer correction was employed.

$$g_{CB} = 0.04191(\Delta h)\ \rho$$

where g_{CB} is the correction factor, the value Δh refers to the difference in altitude between the observation point and the base station, and ρ is the mean rock mass density in the area calculated using the graphical Nettleton method to be 2.07 gm cm^{-3}.

The topographic correction is used to compensate the effects of the relief in the gravity measurements. It takes into account the topography at different levels of accuracy and importance, according to its distance from the gravimetric station to correct. Centered areas are considered at the station with radii of 100 m, 2.5 km and 150 km respectively.

The result of applying all corrections is the Bouger anomaly.

12.2.3 Gravity data modeling and interpretation

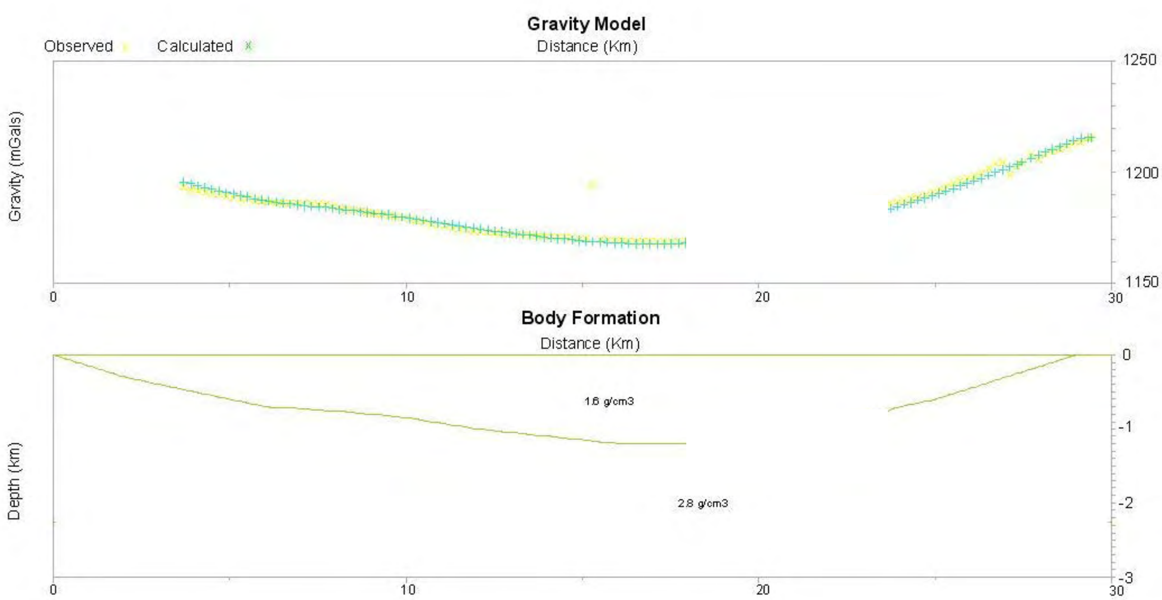
The Bouger anomaly can be modeled to represent the subsurface geology. However any model is non-unique and it is essential to take into account the known geology and rock density. The following table provides some representative values for the rock types in the Olaroz basin.

Table 12.1 Density values measured on rock samples taken from the Olaroz basin

Sample	Weight (gm)	Volume (cm^3)	Density (gm cm^{-3})
Pastos Chicos Formation – Late Miocene	751.49	440.00	1.71
Sijes Formation - Miocene	389.84	214.00	1.82
Sta.Barbara, Subgroup – Late Cretaceous	336.93	163.00	2.07
Ordovician metasediment	349.42	160.00	2.18
Intrusive dacite	72.43	37.45	1.93

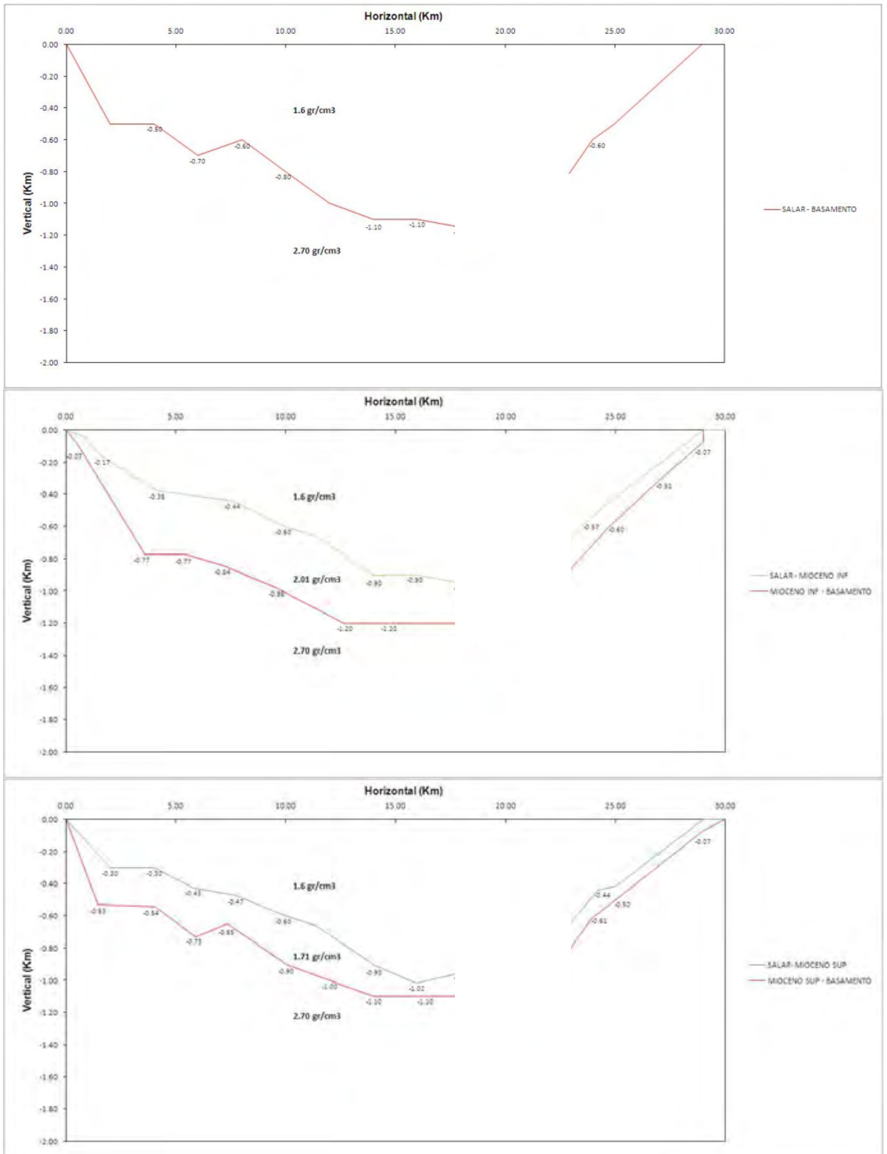
The Bouguer anomaly was inverted using Talwari software to produce a series of possible 2D stratified models. The results for a simple two-layer system (see figure 12.4 below) show a good fit within the basin, although the boundary conditions are not well defined. For the two-layer model the salar deposit density is modeled as 1.6 gm cm^{-3}, which although light is not exceptional given the considerable quantity of carbonaceous material it contains. Bedrock was assumed to be 2.8 gm cm^{-3}. This simple representation suggests that the salar deposits are 1.25 km deep in the centre of the basin. However, no model is unique and further, increasingly complex interpretations were undertaken.

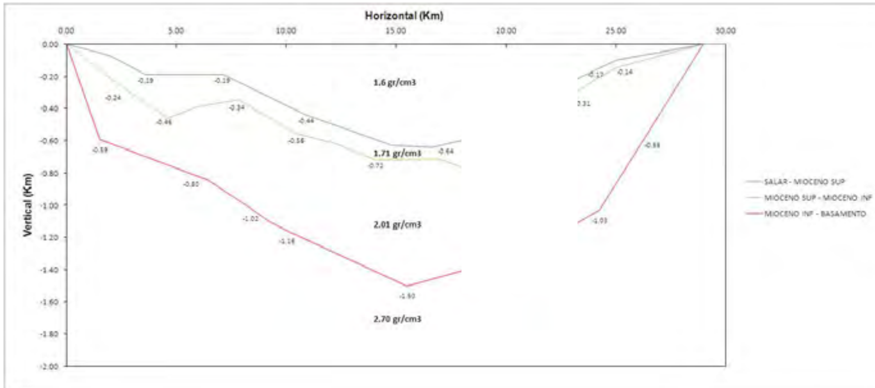
Figure 12.4 A simple two-layer interpretation of the Bouger anomaly



Additional models were based on 1) a two-layer system with salar deposits over bedrock; 2) a three-layer system with salar deposits overlying ?Plio-Pleistocene unconsolidated gravels, over bedrock; 3) a three-layer system with salar deposits overlying Late Cretaceous-Early Miocene consolidated sediments, over bedrock; and 4) salar deposits overlying ?Plio-Pleistocene, overlying Cretaceous-Miocene, over bedrock. The results of these interpretations are shown in Figure 12.5 below.

Figure 12.5 Possible Bouger anomaly interpretations of increasing complexity and representing alternative interpretations of the known geology.

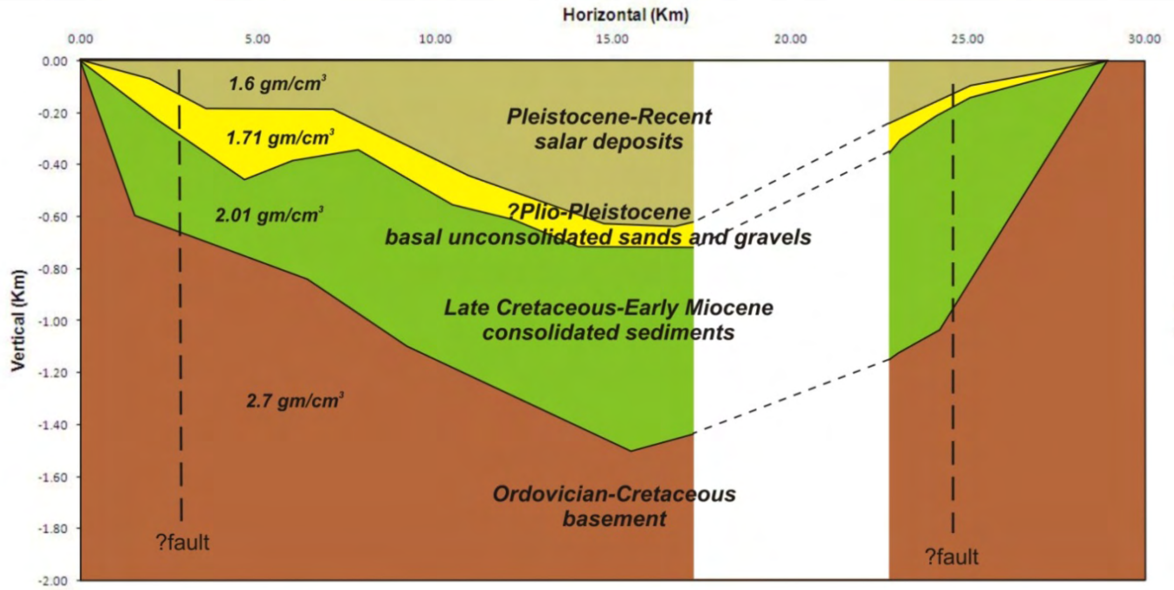




Horizontal (Km)
Vertical (Km)
1.6 gr/cm3
1.71 gr/cm3
2.01 gr/cm3
2.70 gr/cm3
SALAR - MIOCENO SUP
MIOCENO SUP - MIOCENO INF
MIOCENO INF - BASAMENTO

The four layer model is considered to be the best representation of the known geology and suggests that the salar deposits may be around 600 m deep, with underlying unconsolidated gravel occupying deeper channels on the west (up to approximately 400 m thick). The salar margins are not well defined in the present model and may be fault-bounded as indicated. This requires further work to better define the boundary geometries.

Figure 12.6 Preferred interpretation of the subsurface sedimentary sequence at Olaroz (subject to calibration with deep well data as soon as available).



12.2.4 Additional gravity profiles

Gravity data were collected along a 23 km west to east profile across the Rosario basin at approximately 7428N. The modeled gravity profile (Figure 12.7) show that the flood plain sediments may have a thickness of up to 400 m and a width up to 8 km.

Gravity data were also collected along a 2 km north-south profile across the Archibarca fan at 3418E. The gravity model results (Figure 12.8) show that the alluvial sediments may have a thickness of up to 120 m and a width of approximately 1 km.

Figure 12.7 Observed and modeled gravity profile across the Rosario fan-delta at 7428N.

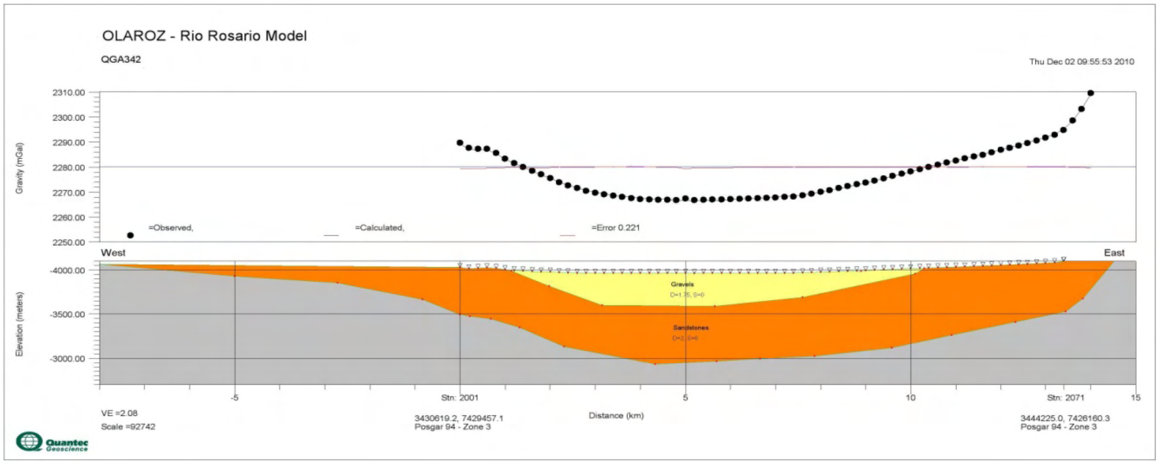
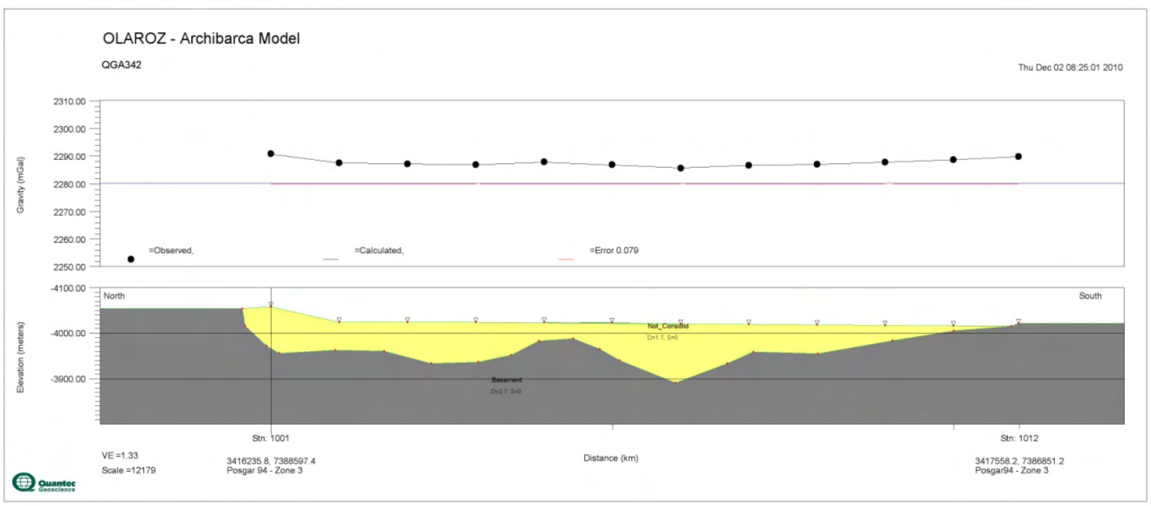


Figure 12.8 Observed and modeled gravity profile across the Archibarca alluvial fan at 3418E.



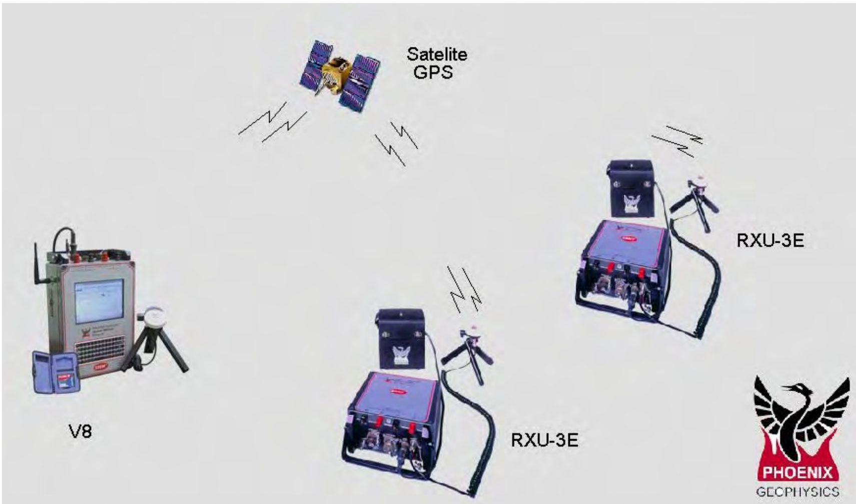
12.3 Audio magnetotelluric

12.3.1 Data acquisition

Data at a total of 136 AMT stations, spaced at 250 m intervals was acquired using Phoenix Geophysics equipment within a range of 10,000-1 Hz, using up to 7 GPS synchronized receptors. The equipment includes a V8 receptor with 3 electrical channels and 3 magnetic channels that serves also as a radio controller of auxiliary RXU-3E acquisition units. Three magnetic coils of different size and hence frequency are used at each station, and non-polarizable electrodes that improve signal to noise ratios. The natural geomagnetic signal during the acquisition period

remained low (the Planetary A Index was <= 6 for 90% of the acquisition time) requiring 15-18 hours of recording at each station.
All stations were surveyed in using differential GPS to allow for subsequent topographic corrections.

Figure 12.9 Schematic of AMT equipment arrangement



AMT requires a Remote Station, far from the surveyed area, in a low level noise location to act as a baseline for the acquired data. In Olaroz the remote station had two different locations during the project depending on the sub sector where work was being undertaken.

12.3.2 Data Processing and Modeling

Processing of the AMT data requires the following stages:

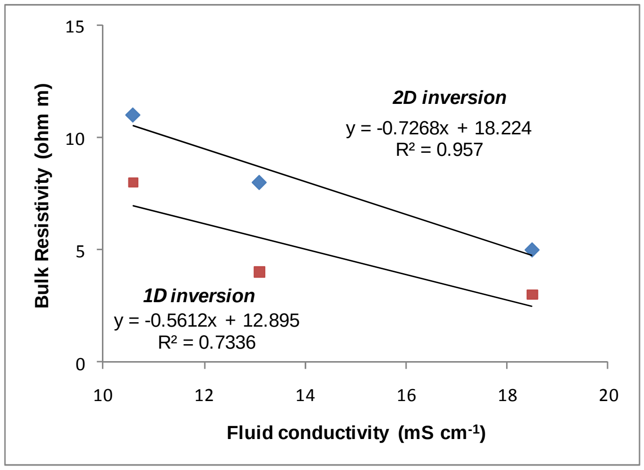
- Filtering and impedance inversion of each station
- 1D inversion for each station
- Development of a resistivity pseudosection
- 2D profile inversion (including topographic 3D net)

The WinGlink software package was used for filtering, inversion and development of the pseudosection and eventually the 2D model output.

12.3.3 Model output and interpretation

The 2D model results for the five sections at Olaroz are presented below (Figures 12.11 through 12.15). Assuming that the major controlling factor is the fluid resistivity (or conductivity) it is possible to establish a provisional calibration in terms of the brine to freshwater interface. The calibration is based on a series of surface samples of the electrical conductivity (the reciprocal of resistivity) of the fluid in the northern part of the salar across the Rio Rosario delta. As can be seen the calibration for the 2D inversion particularly is significant, suggesting that the main control on bulk AMT resistivity is indeed the fluid resistivity.

Figure 12.10 Plot of AMT resistivity against fluid conductivity used to calibrate the AMT profiles.



Where other factors (changes in rock matrix resistivity or porosity) are thought to come into play, based on geological survey and well data, they are indicated on the sections.

Figure 12.11 Resistivity profile N (see figure 12.1 for location).

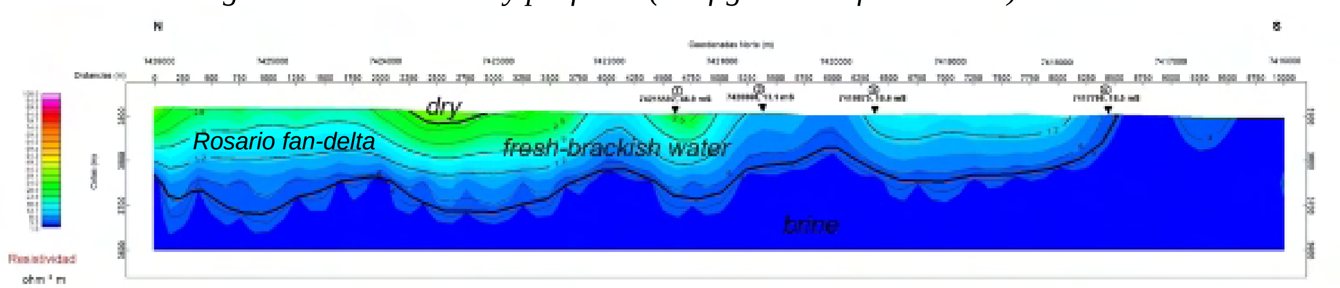


Figure 12.12 Resistivity profile E (see figure 12.1 for location).

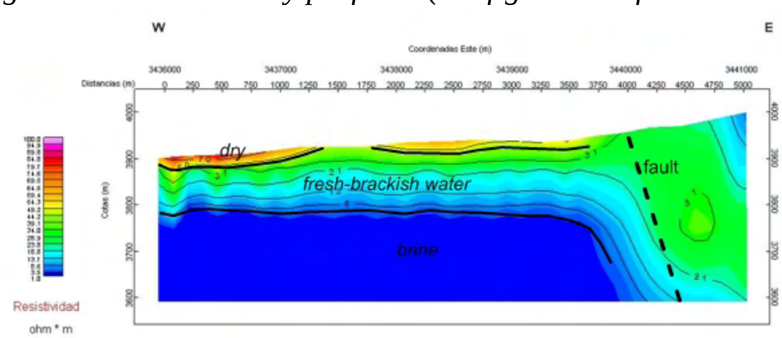


Figure 12.13 Resistivity profile VB (see figure 12.1 for location).

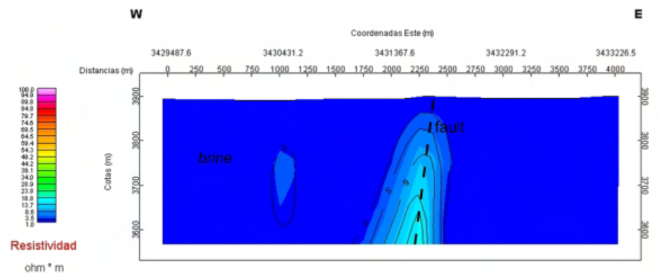


Figure 12.14 Resistivity profile S (see figure 12.1 for location).

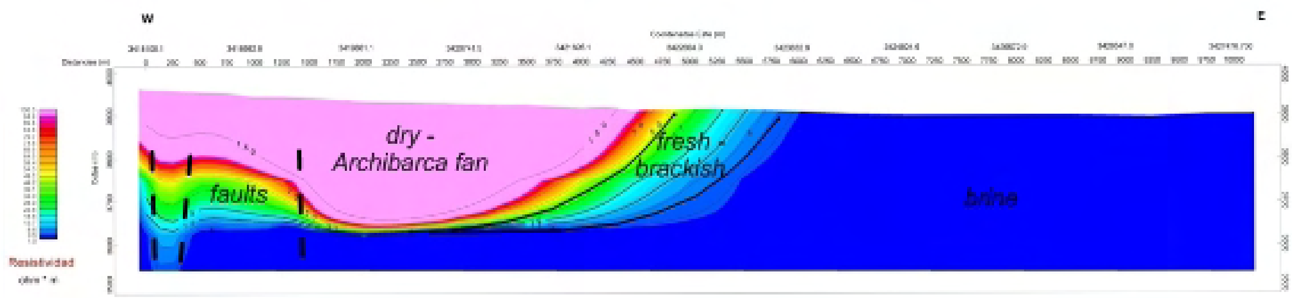
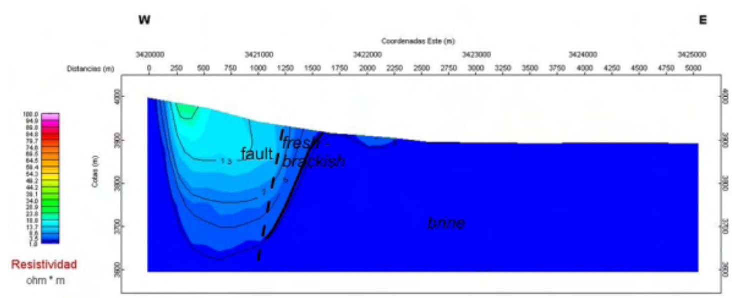


Figure 12.15 Resistivity profile W (see figure 12.1 for location).



13. DRILLING AND RELATED ACTIVITIES

13.1 Philosophy and approach to drilling

Three factors were considered critical in designing the drilling program for resource estimation at the Salar de Olaroz. Firstly, the requirement to maximize recovery of high quality, undisturbed core for geological analysis and porosity determination. Secondly, the requirement to obtain in-situ formation fluid, uncontaminated with over- or underlying brine, or with drilling fluid. Given that the formations were known to be unstable and unconsolidated, it was clear in advance that packer testing would not work as has conventionally been used in halite dominated salars, thus this requirement became extremely important and new techniques were established to ensure sample validity (section 14.3). Thirdly, the well spacing required to give adequate data density consistent with the determination of Indicated and Measured Resources. Both these factors were considered particularly important in the Salar de Olaroz which is a clastic dominant, immature salar, where the sediments are unconsolidated and liable to disturbance by conventional drilling techniques.

13.2 Well numbers and density

The area of the salar within the Orocobre claims used to estimate the resource is 93 km^2 (see section 19). Within this area a total of twenty cored sonic wells were drilled to 54 m each, and six cored triple-tube diamond wells were drilled to an average depth of 197 m. For the upper 54 m, this represents a density of 4.7 wells per km^2, equivalent to an average spacing of 2.2 km. For the interval 54-197 m, the well density is 15.5 km^2, equivalent to an average spacing of 3.9 km. The location of all wells is shown in Figure 13.1).

For comparative purposes, the proven reserves estimated at the Salars de Atacama in Chile and Hombre Muerto in Argentina that have been in production for twenty years, were determined using average well spacings of 5 km and 4.2 km respectively.

13.3 Sonic drilling

Boart Longyear was contracted by Orocobre to perform the Sonic Drilling program at the Salar de Olaroz for the purpose of obtaining continuous geological and brine sampling. The program (C series) involved the drilling and sampling of 20 boreholes to a depth of 55 m each using a 4" (100mm) core by 6" (150mm) casing Sonic sampling system, for a total of 1,080 m drilled.

The objective of the sampling was multipurpose: to obtain a near undisturbed sonic core and an undisturbed split spoon (SS) sample for each 1.5 meter Sonic Core run, and a brine sample of approximately 2 liters every second (equivalent to every 3 m) Sonic Core run.

Sonic technology utilizes high-frequency vibration generated by a highly specialized sonic oscillator, which creates vibration known as "resonance". The resonance is transferred to the drill pipe, which reduces friction and allows the drill bit at the pipe end to penetrate the formation with minimal disturbance. The rig used was a track mounted 300C ATV Sonic Rig with associated support equipment (Figure 13.2).

Figure 13.1 Location of sonic C series (cross), diamond drill CD series (circle), and rotary DW series (square) wells.

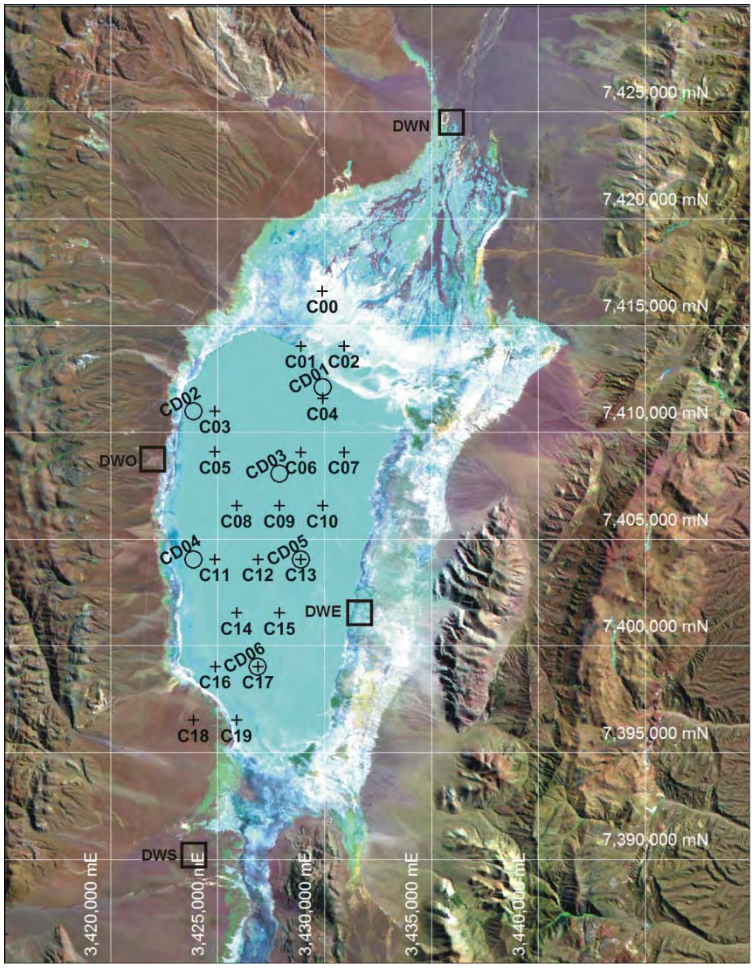


Figure 13.2 Sonic drilling rig at Salar de Olaroz.

An outline of the procedure for each well was as follows:

1. Set up sonic rig at each location,
2. The formation was sonically sampled using a 4" (100 mm) core barrel with a polycarbonate (lexan) core barrel liner of 1.5 meter length (Figure 13.3a). The retrieved core barrels were capped and sealed with PVC tape at each end on retrieval at the surface.
3. At the end of each 1.5 m run 6" (150mm) casing was advanced over the core barrel. No drilling fluids were used for the drilling operation.
2. A 2" diameter x 12" long (in an 18" long SS) was then pushed ahead of the casing (Figure 13.3b). The SS had a plastic liner in the barrel, and was capped and sealed at the surface.

Figure 13.3 Retrieval of lexan (left) and SS core samples (right).

5. On every other sample run, after the SS was removed from the boring, a "push ahead" brine sampling tool was be advanced on the drill string to allow for sampling of the brine, from the space left by the withdrawal of the SS sample (Figure 13.4a). Prior to insertion of the sampling tool, flourescene dye was added to the well to enable rapid visual identification of well fluid, as opposed to in-situ formation fluid.
7. Once in place, brine was bailed out from within the drill rods using a "bailer" or low flow pump until a representative brine sample was obtained. The sample was identified as in-situ, uncontaminated formation fluid as soon as the fluid being extracted came free of flourescene (Figure 13.4b).
8. This procedure was repeated to full depth.
9. Once the 6" casing is at the targeted depth, the hole was be made available to the geophysical contractor to undertake down-hole geophysical logging. Logging inside the steel casing does not present a problem for natural gamma, density and neutron logs.

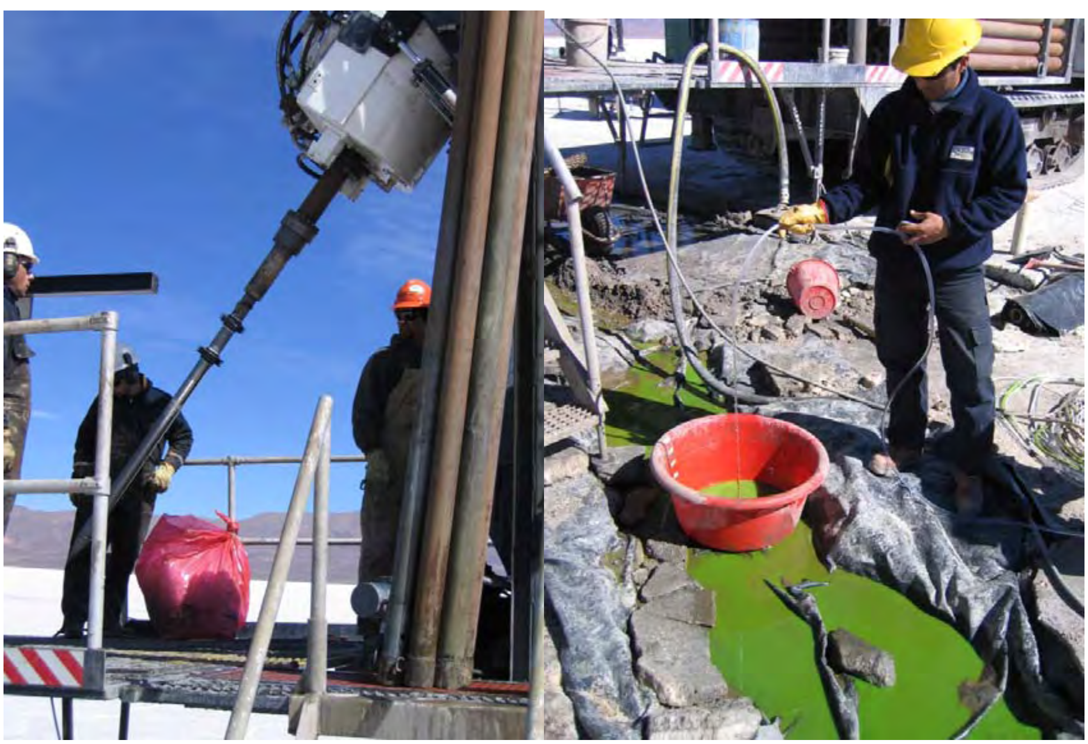
All 20 C series wells, drilled to 54 m depth were drilled with the Boart Longyear sonic rig. Fifteen of these wells (C00-C10 and C15-C18) were completed as piezometers by the installation of 2" diameter PVC pipe slotted over the basal 1 m, which was gravel packed, and then sealed above with bentonite-cement grout, in order to ensure future monitoring from the desired sample depth only.

Core recovery for the sonic drilling is given in Table 13.1.

Table 13.1 Core recovery from sonic drilling

Well ID	Drilled (m)	Not Recovered		Recovered	
		meters	%	meters	%
C-00	54	1.50	2.8	52.50	97.2
C-01	54	3.24	6.0	50.76	94.0
C-02	54	1.83	3.4	52.17	96.6
C-03	54	1.63	3.0	52.37	97.0
C-04	54	1.81	3.4	52.19	96.6
C-05	54	0.68	1.3	53.32	98.7
C-06	54	1.01	1.9	52.99	98.1
C-07	54	2.24	4.1	51.76	95.9
C-08	54	2.79	5.2	51.21	94.8
C-09	54	1.50	2.8	52.50	97.2
C-10	54	1.08	2.0	52.92	98.0
C-11	54	2.53	4.7	51.47	95.3
C-12	54	0.75	1.4	53.25	98.6
C-13	55.5	0.35	0.6	55.15	99.4
C-14	54	0.22	0.4	53.78	99.6
C-15	63	0.16	0.3	62.84	99.7
C-16	54	0.00	0.0	54.00	100.0
C-17	54	0.66	1.2	53.34	98.8
C-18	54	2.20	4.1	51.80	95.9
C-19	54	1.26	2.3	52.74	97.7
Average					97.5%

Figure 13.4 Brine sampling. Push-ahead wellpoint (left) and fluid sample coming free (note clear fluid in plastic pipe) of flourescene (green fluid - right).



13.4 Diamond drilling

Major Drilling was contracted to drill the deep CD series wells. The objectives were the same as for the C series wells, namely to obtain undisturbed samples of formation and fluid. Drilling was with a Major-50 diamond drill rig with triple tube coring capacity. Drilling was usually accomplished using only the fluid encountered in the well during drilling. However, in difficult conditions some drill fluid additive was used. This drill fluid was based on brine taken from a pit dug immediately adjacent to the well at the surface. Since this may introduce sampling issues for the in-situ formation fluid, extra care was taken with the addition of flourescene to all drill fluid used. In addition core samples taken were spun in a centrifuge at the BGS research laboratories in order to extract the pore fluid, which was subsequently analyzed and checked against the in-situ samples (see section 14).

A total of six wells were drilled using this method to an average 200.7 m depth, for a total of 1,204 m drilled. Depths for individual wells are given in Table 13.1, together with the depth of the last sample, which is taken as total depth for the purposes of resource evaluation.

Table 13.1 CD series wells drilled with triple-tube diamond rig.

	Drilled depth (m)	Last sample (m)
CD01	200.0	197
CD02	199.5	199
CD03b	199.5	186
CD04b	200.0	200
CD05	200.0	195
CD06b	205.0	204

Core recovery for the diamond drilling is given in Table 13.3.

Table 13.3 Core recovery from diamond drilling

Well ID	Drilled (m)	No Recoverd		Recovered	
		meters	%	meters	%
CD-01	195.5	9.54	4.9	185.96	95.1
CD-02	199.7	35.93	18.0	163.77	82.0
CD-03	200	48.59	24.3	151.41	75.7
CD-04	200	89.65	44.8	110.35	55.2
CD-05	200	11.50	5.8	188.50	94.3
CD-06	199.5	74.67	37.4	124.83	62.6
Average					77.5%

13.5 Wire-line geophysical logging

In all sonic and diamond drilled wells, Wellfield Services Ltda were contracted to run wire-line logs from surface to full depth. The logs were run inside temporary steel casing, but this does not present a problem for nuclear logs that are able to penetrate the casing with their sensors. The following logs were run: caliper, natural gamma, density, neutron logs. Electronic data is captured on a continuous centimetric basis down the well. Since the logs had to be run inside steel casing because the holes were unstable if not supported, no electrical logs could be run. The logs are particularly useful to extrapolate lithology and porosity data into the few zones where there was no core recovery.

Caliper logs are run to ensure that the borehole width is constant within the casing so that the other logs may be corrected for borehole diameter. The caliper log was sufficiently accurate that it was able to identify casing joints throughout the wells.

Natural gamma logs indicate the received gamma ray intensity at the sonde. Since gamma rays are emitted by uranium, thorium and potassium minerals in rocks, the log typically responds to clay minerals and volcanic horizons. Evaporitic minerals such as halite and gypsum have a very low radioactive mineral content and can usually be identified by their low count rate. Thus the gamma is a useful tool for identifying certain types of lithology and for correlating beds across multiple wells.

Density logs emit and receive gamma rays and are thus sometimes known as gamma-gamma tools. This technique measures the bulk density of the rock matrix and pores. Since minerals have characteristic densities, the tool is used for lithological identification when coupled with natural gamma logs. Since it also measures the porosity of the formation it can be used quantitatively to determine total porosity. Since the bulk density depends both on the mineralogy and porosity, any porosity determinations must account for the rock mineralogy. In rapidly changing sequences such as the Salar de Olaroz, it becomes extremely difficult to correct the log for these changes. Thus its principal use is in the assessment of lithology.

Neutron logs measure the hydrogen ion content of the formation and pores adjacent to the sondes. Two sondes are used with different spacings so that penetration is both “near” and “far”, with respect to the well diameter. Since the hydrogen ion content is largely determined by the fluid (water) content of the pores, the log can be calibrated to determine the in-situ total porosity.

13.6 Test production wells

Three test production wells were drilled by Valle drilling using a conventional rotary rig to depths of 50 m (P and O series). In some cases it was possible to drill using only formation fluid, but in several cases, drill fluid had to be used to advance the well. The test production wells were not used for sampling for the resource estimation. The wells were drilled at 12” diameter and completed with 8” slotted PVC screen with gravel pack to full depth. Immediately after completion the wells were developed by air-lift surging for periods up to 10 days to ensure that all drill fluid and fines were removed from the well.

At test production well site P1, three observation wells were drilled at nominal radial distances of 7 m and 18 m from the pumped wells toward the north and east. These observation wells were drilled at 8” diameter to full depth and completed with 4” slotted PVC casing and gravel pack.

At test production well sites P2 and P3, the same configuration was used, except that the observation wells were doubled at each locality and drilled to depths of 28 m and 40 m with screens 0-27 m and 29-39 m (P2), and drilled depths of 13 m and 38 m with screens 0-12 m and 15-38 m (see Appendix C for full details).

Two deep test production wells, PD1, adjacent to CD01, and PD2, adjacent to CD06 have also been drilled by Valle at a completed diameter of 8” and depths of 200 m. Wells CD01 and CD06 were completed with slotted plastic piezometers in order to enable their use as observation wells during subsequent pumping tests.

13.7 Pumping tests

Pumping tests were designed and carried out on test production wells P1-P3 according to the methodology given in Kruseman and de Ridder (1990) and Dawson and Istok (2000). The pump used was an electric submersible, powered by a diesel generator. Discharge from the pump was via a pipe to a V notch discharge tank at least 500 m distance from the well to minimize recirculation. Water levels were measured in the pumping and observation wells continuously throughout the duration of the test using pressure transducers.

Initially, step discharge tests were undertaken with increasing flow rates in order to determine the well efficiency, which in all cases was above 87% (Appendix C), indicating the development had been effective.

Constant rate tests started on the 25 August 2010 and ran through until 26 January 2011 when they were stopped as a result of surface water flooding throughout the Salar. This represents a period of 154 days, or just over 5 months and provides not only detailed hydraulic and chemical data, but also a high degree of confidence that pumping rates and brine quality can be maintained in the long-term.
The detailed analysis of the pumping tests is provided in Appendix C and discussed in section 10.4.

13.8 Boundary condition wells

Four 200 m deep off-salar wells were drilled by Valle (DW series) using rotary techniques in order to investigate the marginal hydrogeological conditions. Their location is shown in Figure 13.1. Drill cuttings were analyzed to provide geological logs and geophysical logs were run to assist (Appendix D). Where possible, formation fluid samples were taken to establish density and total dissolved solids content.

14. SAMPLING METHOD AND APPROACH

14.1 Philosophy and approach to sampling

Two aspects of the quality control and assurance of samples required for resource analysis were considered paramount when the sampling program was designed and implemented. The first, and most frequently neglected, is the assurance that samples taken in the field are truly representative of the in-situ formation and in-situ brine, and that the results obtained from these sample have a high degree of repeatability. Sample provenance and repeatability were investigated using several different techniques for both fluid chemistry (downhole sampling, pump testing, piezometer monitoring, and pore fluid extraction), and porosity (neutron logs, site moisture content, laboratory effective porosity and specific yield, petrological image determination). The second aspect is the requirement for strict analytical controls on the determination of aquifer porosity and brine chemistry in the laboratory. In this section sampling methods are considered.

14.2 Sample numbers and frequency

Twenty cored sonic wells were drilled to 54 m each, and six cored triple-tube diamond wells were drilled to an average depth of 197 m. A total of 1,964 samples were taken for brine analysis, of which 1,043 were taken from the twenty six wells drilled for the resource analysis, the remaining 921 were taken from pumping test and associated observation wells, and monitoring piezometers installed across the Salar. Of the 1,043 brine samples taken from the resource analysis wells, 453 represent standards, replicates and duplicates, leaving 591 carefully quality controlled samples that were included in the resource evaluation. Sample frequency with depth for those analyses used in the resource estimation averaged 2.5 m per sample in the upper 54 m, and 6.9 m per sample in the 54 m to 197 m interval.

A total of 1,555 samples were taken for porosity analysis from the cores. Of these 1,402 (90%) were taken from the upper 54 m, the remaining 153 (10%) from the 54 m to 197 m interval. All were analyzed for P_t in the site laboratory. 698 samples were duplicate P_t lexan-split spoon samples (see section 15.2). 314 samples were not included in the subsequent analysis because they did not reach a stable weight during the laboratory determination of P_t. All remaining P_t determinations (543) were used in the resource estimation process. Of these 543 P_t samples, 511 had P_e determined and 205 S_y determined at the BGS research laboratories. Sample frequency with depth for those analyses used in the resource estimation averaged 2.8 m per sample in the upper 54 m, and 7.1 m per sample in the 54 m to 197 m interval.

14.3 Fluid chemistry

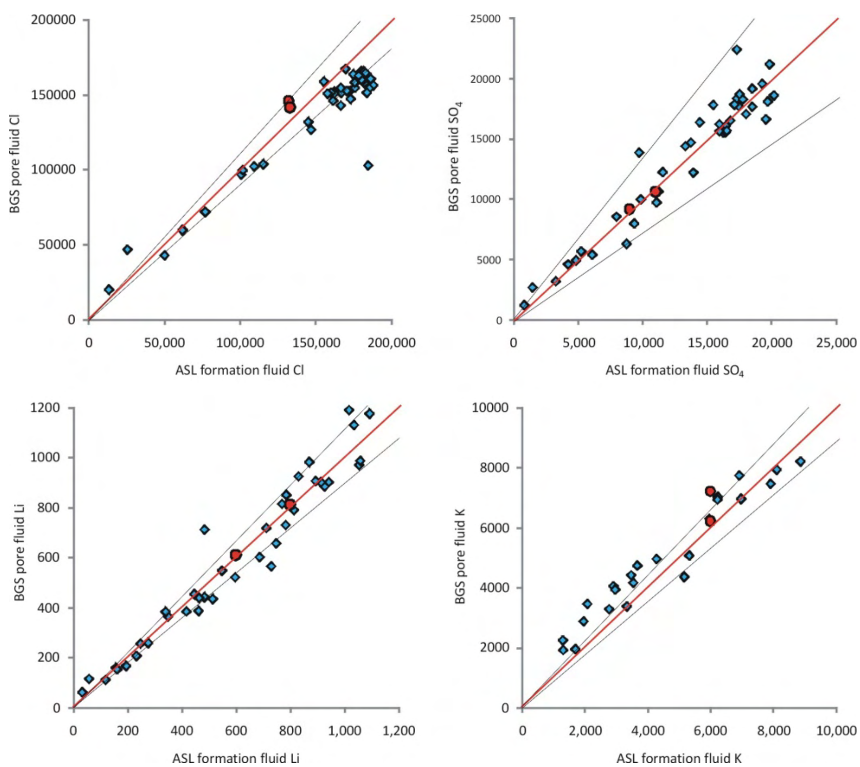
14.3.1 Fluid chemistry sampling program

Samples for fluid chemistry analysis were taken every 3 m depth interval in all sonic and diamond drilled holes where possible. Some depths were not possible to sample because the formation permeability was insufficient for to allow hole purging and sample recovery within a reasonable time. Protocols for sampling were prepared and explained to drillers and field staff.

For the sonic drilled wells a push-ahead well point with double packers was attached to the base of the rods and inserted into the formation ahead of the well casing advance. The packers sit inside the casing and so affect a seal between the well point and the hole above inside the casing. In addition, flourescene was added to the well before insertion of the well point in order to demonstrate conclusively that the sample was not contaminated by brine already in the well. Brine was extracted from inside the rods which were attached to the well point by means of a bailer or a low-flow submersible pump. During the insertion of the well point some brine from the well flows up inside it and the rods. Since this fluid contained flourescene it was possible to identify when this well fluid had been evacuated and pure formation fluid was being extracted since the latter contained no dye. A detailed experiment to prove this sampling technique was carried out on three wells and is described in detail below.

Several samples of the cores obtained from the wells were sealed on-site and sent to the laboratories of BGS in the UK. These samples were prepared in the laboratories by removing the packing and outer layer of the core (ie. subsampling the core center) and placed in a refrigerated MSE25 centrifuge where it was spun at 14,000 rpm for 40 minutes to drain all contained fluid. This pore fluid was then analyzed in the BGS laboratories for major and minor ions. The result of the pore fluid chemistry compared with the well samples extracted from the push-ahead well point are shown in Figure 14.1. Clearly there is no difference in the chemistry of the pore fluid from that extracted from the well, thus providing great confidence in the provenance of the samples used in the resource analysis.

Figure 14.1 Analytical results for pore fluid extracted from core at same depth as well sampled from well point. Red line is equality; black lines show 10% variation.



Piezometers were installed in several of the C series wells at specific horizons (Table 14.1). These piezometers were sampled on a regular basis (weekly) over periods up to 2 months. The results of the analyses of these samples, using Li as an example ion, is shown in Figure 14.2.

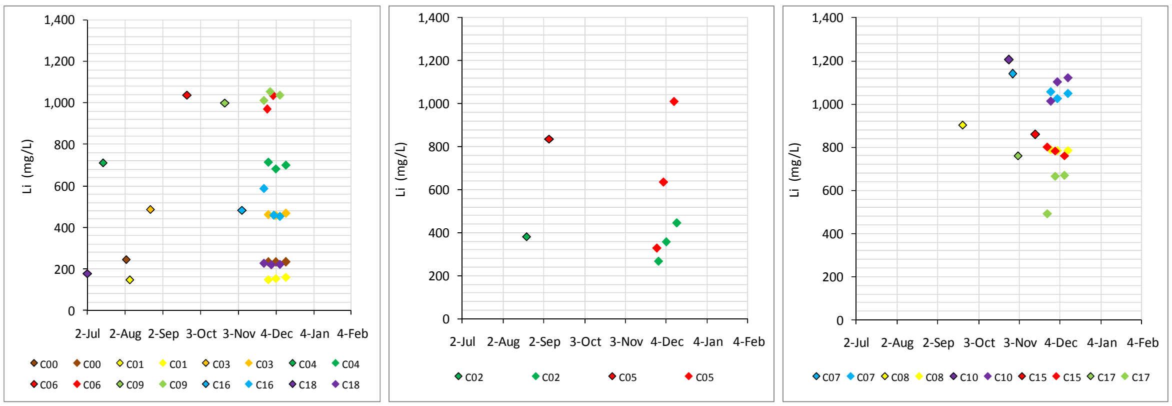
Table 14.1 Piezometer depth settings in C series wells.

Well ref.	Depth of p/z installation (m bgl)
C00	51.0
C01	16.5
C02	45.0
C03	27.0
C04	34.5
C05	16.5
C06	48.0
C07	37.5
C08	22.5
C09	37.5
C10	45.0
C15	27.0
C16	31.5
C17	39.0
C18	51.0

Seven wells (50%) showed no change in concentration within the limits of analytical accuracy. Two wells (14%) showed rather variable concentrations, both above and below the value used in the resource analysis, and five wells (36%) showed declines varying between 7-35% (although in the latter case subsequent analyses showed only an 11% decline from the initial value). These fluctuations are thought to represent natural variations in brine concentration possibly caused by wet season groundwater inflows since a) all decreases took place after the end of November and b) the wells affected were generally closer to the margins of the salar.

Fluid samples were also taken during the pumping tests. Samples were taken directly from the discharge line every five days. The results are given in graphical form in Appendix C. The results indicate constant values (±10%) for all ions including Li, K and B, as well as for density and pH, over a period of five months. This is taken as good evidence for the likely maintenance of grade during operational conditions, at least in the early stages.

Figure 14.2   Li concentrations (mg/L) with time in piezometers. Initial symbol with black outline is the value used in the resource analysis for the piezometer depth. Left plot shows no change over time; center plot shows a decrease followed by an increase; and right plot shows a decrease but with later values recovering somewhat.



14.3.2 Fluid chemistry sampling protocol

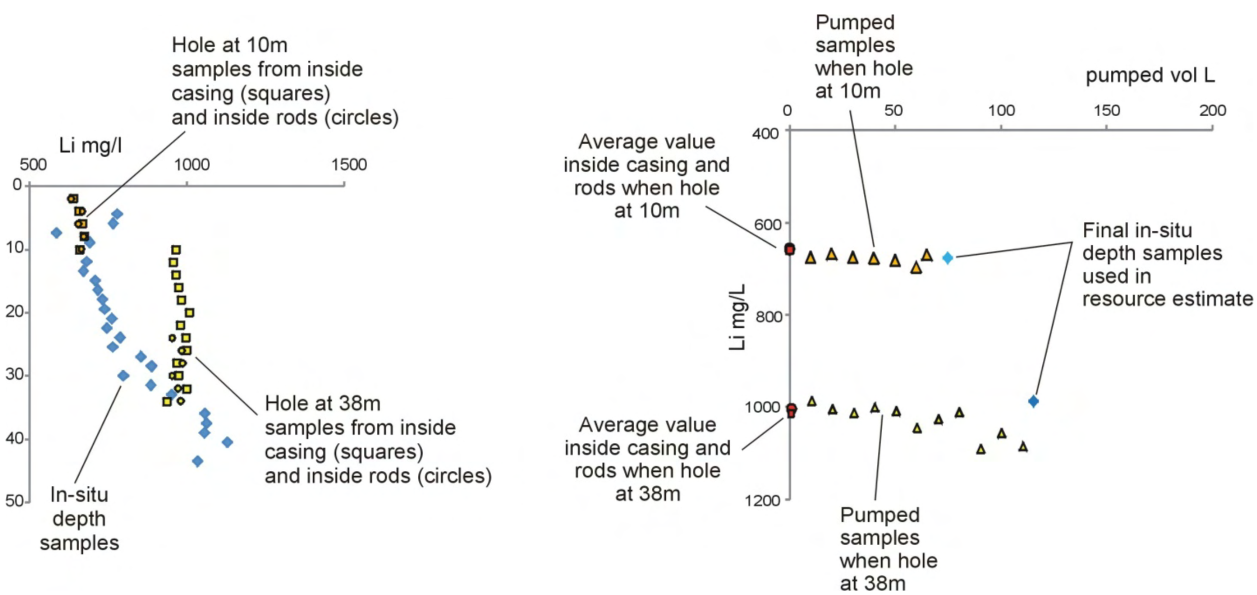
The protocol used for taking depth fluid samples is outlined below.

At the wellhead, prior to filling, two x one liter bottles and their caps were rinsed out with a small amount of sample. The sample was then transferred to the two bottles. Each bottle was labeled using a permanent marker with the borehole number and the depth of the sample. A small amount of sample was used to determine pH, dissolved oxygen and temperature at the wellhead. Bottled samples were then returned to the field laboratory on the salar at least once every day. The need for filtration and/or decanting was determined on a sample by sample basis. Samples that were clearly opaque as a result of contained fines were filtered at the on-site laboratory. Next, one bottle of the sample pair was given a unique sample number label (talonario) attached with the following information: well number, sample depth and date. This labeled bottle was then stored as backup in a cool, dark location. From the second bottle in the pair, a small sample was taken to rinse two 100 ml sample bottles and caps. Once rinsed, the 100 ml bottles were filled with sample. One of the bottles must contain filtered sample using a syringe and millipore filter. In each case all air was expelled from the bottle, the caps screwed tight and sealed with tape. Each 100 ml bottle was then attached with the same unique sample number label (talonario), and marked as “salmuera” (brine) to ensure that the laboratory understood the required instrument calibration. One of the 100 ml sample bottles was then batched up in lots of twenty with a standard, a duplicate sample from a previous batch, and a replicate from well 16B, and sent to the analytical laboratory. The second 100 ml sample was put aside in a cool, dark place to await a decision on whether it would be sent to BGS for isotope analysis. The remainder of the sample from the one liter bottle was be used to determine Eh, density, electrical conductivity, and alkalinity in the site laboratory on the same day that the sample was taken.

14.3.3 Fluid sample provenance experiments

An experiment was carried out on three wells (C02, C05, and C13) during the drilling and sampling program to investigate the source of fluid inside the casing, and rods, and pumped sample used for the resource analysis. When the wellpoint is driven ahead of the casing, which is at drilled depth, fluid is present inside the wellpoint and rods, as well as inside the casing (and outside the rods). With the casing at a given depth in the well and the wellpoint (connected to the rods) approximately 30 cm deeper than the depth of the well (and casing), depth samples were taken every meter depth in the annulus between the casing and the rods, as well as inside the rods. The fluid inside the rods was then evacuated and sampled every 10 liters during the evacuation process. Finally the resource sample was taken after the fluids had come free of flourescene dye. This procedure was repeated at two depths in several wells. The results are shown for C13 in Figure 14.3. Similar results were obtained in C02 and C05. It can be seen that the formation fluid increases in concentration with depth. At the particular depth chosen to carry out the provenance sampling, all the fluid inside the casing, inside the rods and during evacuation, all had the same Li concentration as the in-situ formation fluid at the given depth. This is clear and unequivocal proof that the samples used for the resource estimation are truly in-situ formation samples.

Figure 14.3 Experiment to determine provenance of fluid samples used in resource analysis, inside drill casing and inside drill rods during the sampling process.



14.4 Neutron porosity measurement

The neutron sonde measures the formations response to the bombardment of fast neutrons at two radial distances from the sonde. The sonde used was a Robertson Research model which has the following specific calibration:

$$NPt = \left(\left(\frac{NPfar - NPnear}{64}\right) * \text{caliper}\right) + \left(NPnear - \left(\left(\frac{NPfar - NPnear}{64}\right) * 150\right)\right)$$

where NPt is the neutron total porosity, NPfar and NPnear are functions of the count rate for the far and near receivers, and caliper is the borehole diameter. The sonde is lowered down the well at a velocity consistent with obtaining repeatable measurements and varies somewhat between wells depending on lithology and bed thickness. Measurements are recorded every cm and the corrected logs are presented in Appendix A for all C and CD series wells. For the purpose of direct comparison with laboratory determinations of porosity made on 10 cm cores, the raw data is filtered with an 11 point running mean, and it is this value which is presented in the well composite logs (Appendix B).

14.5 Porosity sampling

In the 54 m deep C series wells, 10 cm long core samples for porosity determination were cut from the sonic drilled lexan core tubes every 1.5 m (Figure 14.4a). From the integrity of sedimentological features examined in the lexan core tube it is possible to confirm that virtually no disturbance of the sample occurred (Figure 10.7). The cut length of core was then sealed with a plastic cap and tape to prevent any fluid escape (Figure 14.4b), and stored with the remainder of the core in the core box (Figure 14.4c) until such time as it was batched up and sent to the BGS laboratories in the UK.

Immediately after the lexan core had been withdrawn a split spoon was pushed ahead into the formation to recover an additional undisturbed sample. The core sample with its rigid polycarbonate lining was extracted from the split spoon (Figure 14.5a), and sealed to prevent drainage or evaporation of the contained fluid (Figure 14.5b). The split spoon sample was nominally 30 cm long and therefore approximately 30 cm below the lexan sample. The total number of samples in the depth interval 0-54 m is 1,402.

Figure 14.4 Sub sampling the core for porosity samples. Left shows the core barrel with core held inside the grey plastic tube while being cut. Center shows the cut length being sealed and stored (right) in the core box.

Figure 14.5 Extracting the split spoon cored sample (left), and sealing (right). Note the presence of laminations in the sample indicating lack of disturbance.

14.6 Petrological samples

A subset of the cores sent to BGS in the UK were selected for porosity characterization by petrographic image analysis (PIA). The cores received, sub-sampled and analyzed are listed in Table 14.2. To characterize porosity, materials need to be prepared as polished thin sections. This presents a two dimensional slice through the internal structure of the sediment, enabling the porosity to be imaged and then described using image analysis procedures. Methods of sampling, sample preparation and analysis, and the results of the PIA, are given in the BGS Report included as Appendix E.

Table 14.2 Selected samples for petrographic image analysis of porosity.

Well ref.	Sample depth (m bgl)	BGS ref.	Lithology
C00	23.8	MPLQ082	Sand
C01	47.8	MPLQ083	Sand
C02	11.9	MPLQ084	Sand
C02	23.9	MPLQ085	Sand
C03	35.8	MPLQ052	Sand with clay
C04	11.8	MPLP054	Clayey sand
C04	23.8	MPLP055	Sand with clay
C04	35.8	MPLP056	Sand with clay
C04	47.8	MPLP057	Sand
C05	11.8	MPLQ053	Sand
C06	35.9	MPLQ054	Sand and gravel
C07	35.9	MPLQ055	Sand with clay
C09	23.9	MPLQ056	Sand with clay
C10	47.0	MPLQ057	Clay with sand and halite
C17	11.9	MPLQ058	Clay with sand
C17	35.9	MPLQ059	Sand
C17	47.9	MPLQ060	Clay with sand

15. SAMPLE PREPARATION, ANALYSIS AND SECURITY

15.1 Fluid chemistry

15.1.1 Sample Preparation

One liter samples from the wells were checked for pH, temperature, and dissolved O_2 at the wellhead. Density, EC, Eh were checked in the site laboratory on the same day as the sample was taken. Each sample was given a unique reference number. Samples for analysis were then transferred to the site laboratory, and filtered from 1 L field bottles to 100 mL polyethyelene bottles with screw caps, sealed with tape, the day of sampling from the well. The remaining fluid was retained as backup and stored in a cool, dark location.

15.1.2 Sample Analysis

Samples were batched into lots of approximately twenty, with the addition of a standard solution, a duplicate from the previous batch, and a replicate from a standard brine (well 16b from the previous study), and sent by courier to Alex Stewart Laboratories (ASL) in Mendoza via the Orocobre offices in Jujuy. Each batch was accompanied by a “planilla de envio”, and ASL confirmed receipt of each batch. Time of transfer from the wellhead to ASL laboratories averaged 14.3 days.

ASL completed the analyses in an average of 20.7 days, using the methods outlined in Table 15.1. ASL have extensive experience analyzing brines from the Altiplano and Puna. They are accredited to ISO 9001:2000 and operate to their own internal standards consistent with ISO 17025. Tables 15.1 and 15.2 present the method of analysis and the detection limits used by ASL for all determined parameters.

Certificates of analysis, together with excel data files of the results were then sent by ASL to Orocobre. The data transposition was checked twice by Orocobre staff. All analyses were subjected to QA/QC as described in the following sections.

Ion	Method	Reference
Na, K, Ca, Mg, Li, B, Ba, Sr, Fe, Mn, As, Si	Induced coupled plasma (ICP)	Standard Methods for the Examination of Water and Wastewater (APHA-AWWA-WPCF) 21st ed., Part 3120-Chapters 3-59. USEPA-SW-846 Method 200.7: Determination of metals in water and wastes by Inductively Coupled Plasma – Atomic Emission Spectography. Determination of metals in brines by ICP-AES, July 1993 – Varian Instruments.
Cl	Ag titration	IMA-17-Versión 3: SM-4500-Cl-B
SO_4	Gravimetric with combustion of residuals	IMA-21-Versión 1: SM-2540-C
NO_3	Cadmium reduction	HACH-Method 8039
Alkalinity	Titration	SM-2320-B
HCO_3	Calculated from alkalinity & pH	
CO_3	Calculated from alkalinity & pH	
TDS	Drying at 180^{o}C	IMA-21-Versión 1: SM-2540-C
Density	Picnometry	IMA-28-Versión 00
pH	H gas electrode	IMA-05-Versión 02: SM-4500-H+-B

Table 15.1 Methods of analysis used by Alex Stewart Laboratories.

Table 15.2 Detection limits for parameters determined at ASL (without dilution).

	units	detection limit
TDS 180°C	mg/L	10
SO_4	mg/L	10
Cl	mg/L	5
Alkalinity total	mg $CaCO_3$ /L	5
CO_3	mg/L	5
HCO_3	mg/L	5
NO_3	mg/L	0.5
B	mg/L	1
Ba	mg/L	0.01
Ca	mg/L	2
Fe	mg/L	0.3
K	mg/L	2
Li	mg/L	1
Mg	mg/L	1
Mn	mg/L	0.01
Na	mg/L	2
Sr	mg/L	0.5
As	mg/L	0.105
Si	mg/L	0.06

15.1.3 Quality Control – Standards

Standards 4G and 5G were inserted blind into all sample batches sent to ASL. A total of 70 standards were analyzed, equivalent to 5.4% of all samples. The results of the standard analyses are presented in table 15.3, and shown in figure 15.1 for Li, K and Mg.

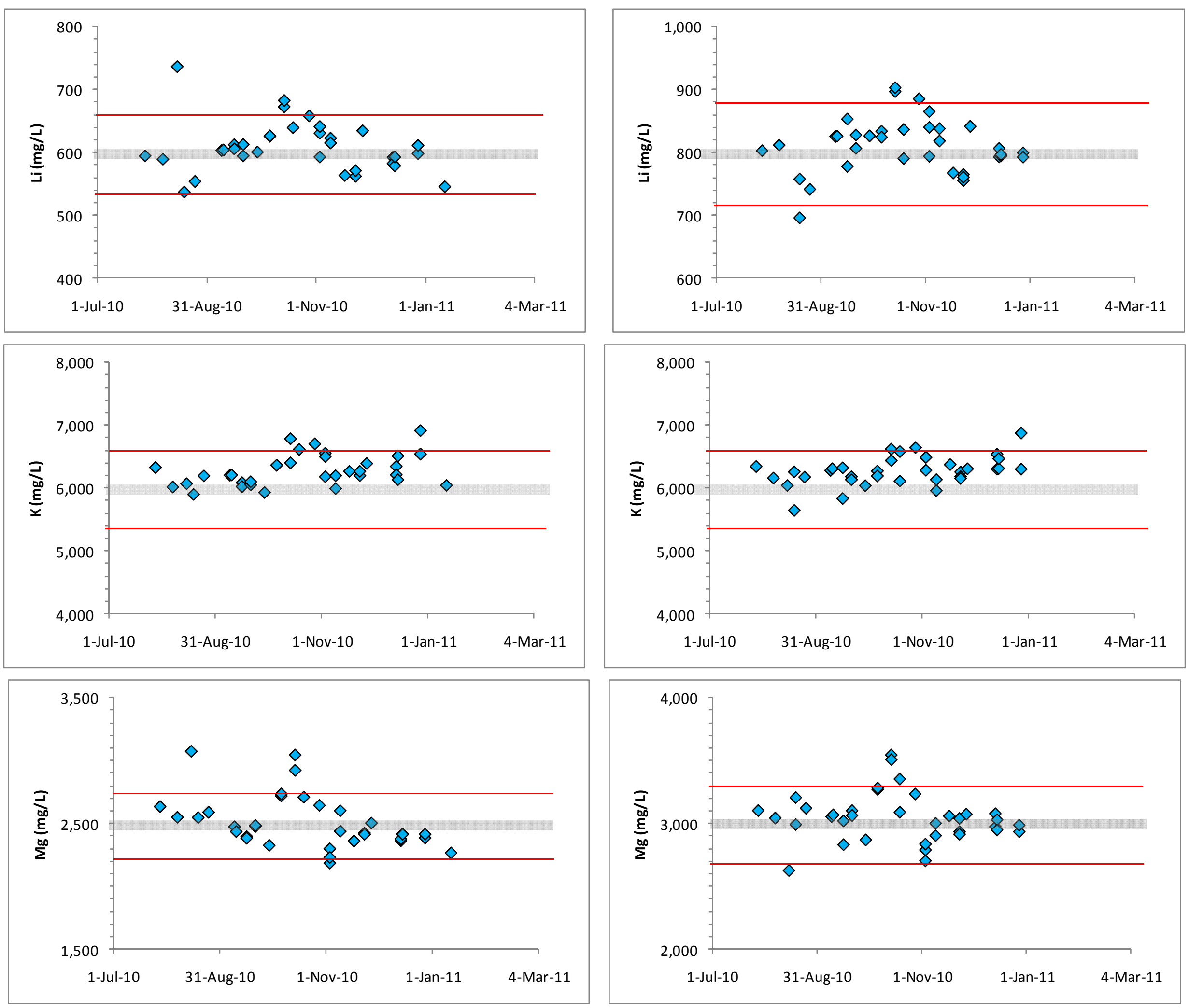
Table 15.3 Comparison of Orocobre standards with ASL values.

	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Li (mg/L)	B (mg/L)	Cl (mg/L)	SO_4 (mg/L)
Std 4G	**80,000**	**6,000**	**200**	**2,600**	**600**	**600**	**132,281**	**9,000**
N ASL	34	34	34	34	34	34	34	34
Mean ASL	81,624	6,275	189	2,504	609	581	125,342	9,367
SD ASL	3,464	248	24	210	40	69	5,773	582
RSD ASL	4.2%	4.0%	12.7%	8.4%	6.6%	11.9%	4.6%	6.2%
Std 5G	**80,000**	**6,000**	**100**	**3,000**	**800**	**800**	**133,126**	**11,000**
N ASL	36	36	36	36	36	36	36	36
Mean ASL	80,723	6,280	101	3,043	803	780	124,734	11,101
SD ASL	3,288	233	18	193	62	60	5,363	625
RSD ASL	4.1%	3.7%	17.9%	6.3%	7.7%	7.7%	4.3%	5.6%

All ASL mean assay values fall within one standard deviation of the standard sample, except for Cl and K, which are marginally outside. Mean ASL Li values in particular are extremely close to the standard values (1.5% and 0.4% difference respectively for 4G and 5G). RSD values (a measure of precision) for ASL analyses are all within acceptable 10% limits, except Ca, which is only present in low concentrations, and B for standard 4G.

The ASL analyses can be seen (Figure 15.1) to be within 10% of the standard for the most part. Analyses falling outside this range occurred on 15 August 2010, 14 October 2010, and 28 December 2010. Samples sent for assay within the same batch as these standards were subject to re-analysis by ASL.

Figure 15.1 ASL analyses of standard Li, K and Mg values (4G left, 5G right) over time (10% difference limits shown as red line).



15.1.4 Quality Control – Replicates

Well 16B, drilled in the earlier study, was used to test for analytical repeatability. A total of 39 repeats equivalent to 3% of all samples were analyzed. Table 15.4 below provides details for the analyses carried out by ASL on the brine from well 16B. Well 16B was drilled in the previous (2009) study and is not to be confused with well 16 in this study.

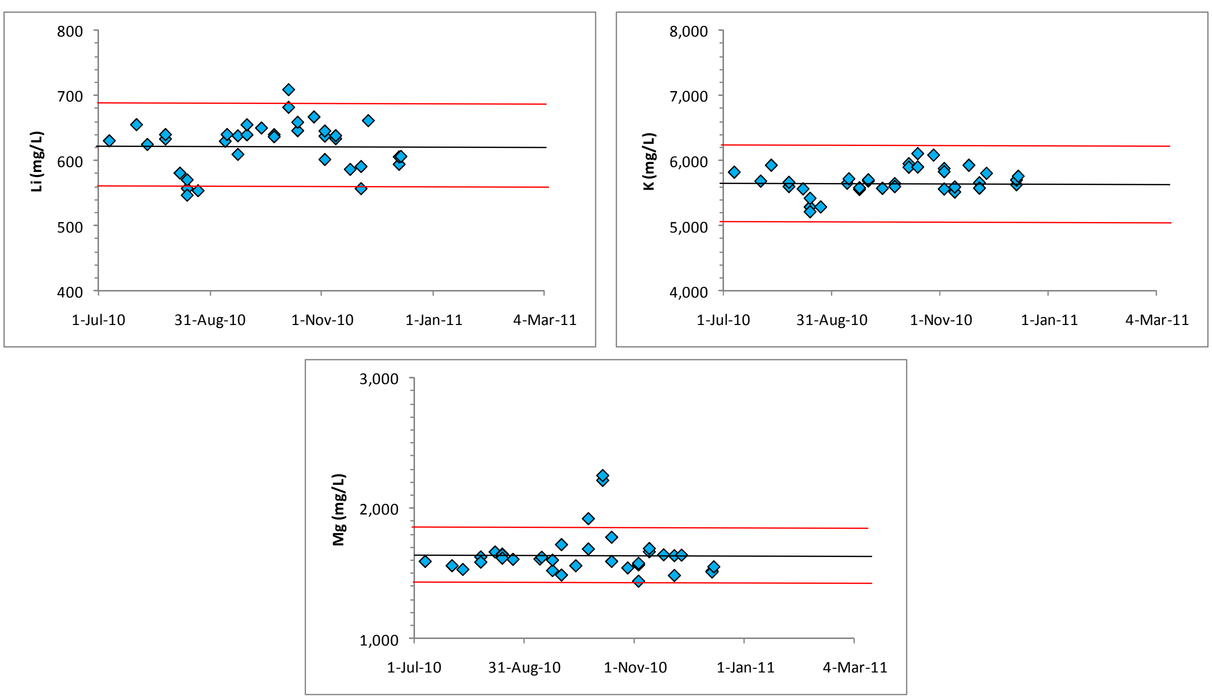
Table 15.4 shows that repeatability was good with only one species (Mg) falling marginally outside an acceptable 10% limit for Relative Standard Deviation (RSD).

Table 15.4 Replication of ASL analyses on well 16B.

	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Li (mg/L)	B (mg/L)	Cl (mg/L)	SO_4 (mg/L)
N ASL	39	39	39	39	39	39	39	39
Mean ASL	120,324	5,684	565	1,638	625	686	179,620	12,948
SD ASL	5,680	204	37	165	37	51	8,278	750
RSD ASL	4.7%	3.6%	5.9%	10.1%	3.6%	7.4%	4.6%	5.8%

Figure 15.2 shows how the analytical results vary with time. It can be seen that analytical differences greater than 10% occur on 19 August2010, and 14 October 2010, coincident with similar differences in the standard analyses. All samples in the same batches were subject to re-analysis by ASL.

Figure 15.2. ASL replicate analyses on well 16B (10% difference limits shown as red lines).



15.1.5 Quality Control – Duplicates

Sixty eight duplicates were inserted into the analytical stream from previous sample batches. The duplicates were taken from the same 1 L sample as the original. Sixty eight duplicates represents 5.2% of all samples. The results of the duplicate analysis are given in table 15.5, and graphs are shown in figures 15.3-4.

Table 15.5 Results of the duplicate analysis for species of interest.

	Li		K		Mg		B	
	sample	duplicate	sample	duplicate	sample	duplicate	sample	duplicate
N	68		68		68		68	
Mean	598	624	5,047	5,244	1,443	1,619	785	818
SD	300	295	2,323	2,299	965	948	362	363
Paired RSD	6.7%		7.1%		13.2%		5.7%	
Bias	4.4%		3.9%		12.2%		4.2%	
r	0.979		0.973		0.957		0.983	

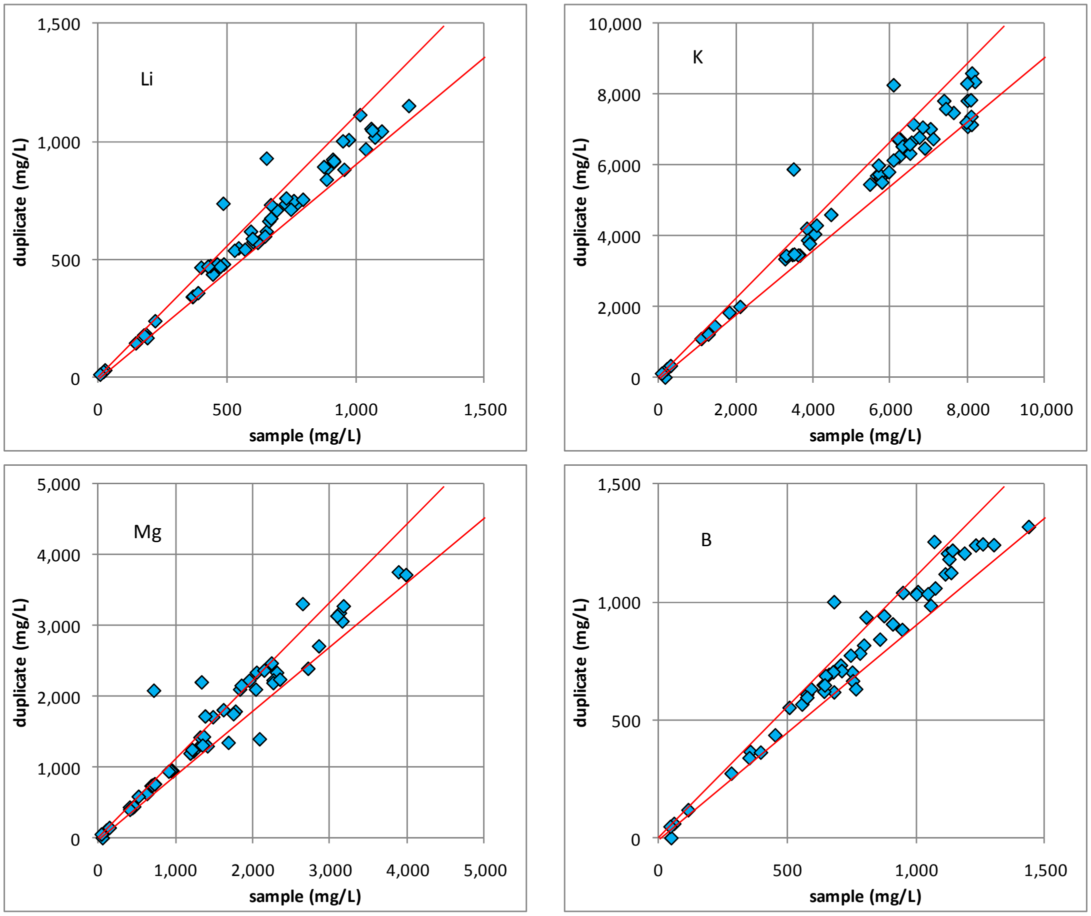
Paired RSD is within an acceptable 10% for Li, K and B, but slightly higher for Mg. Similarly, bias is within acceptable limits for Li, K and B, but somewhat outside for Mg. The correlation coefficients (r) are all significantly high ($p<0.001$) and the means are within 1 SD for all species. F tests show that there is no significant difference between the variances of paired samples, and t tests show no significant differences between the means.

Table 15.7. Results of the duplicate analysis for physical parameters.

	TDS		density		pH	
	sample	duplicate	sample	duplicate	sample	duplicate
N	68		68		68	
Mean	288,673	285,521	1.189	1.186	6.86	6.87
SD	89,759	88,416	0.051	0.052	0.36	0.34
Paired RSD	1.4%		0.4%		2.0%	
Bias	-1.1%		-0.2%		0.2%	
r	0.997		0.989		0.842	

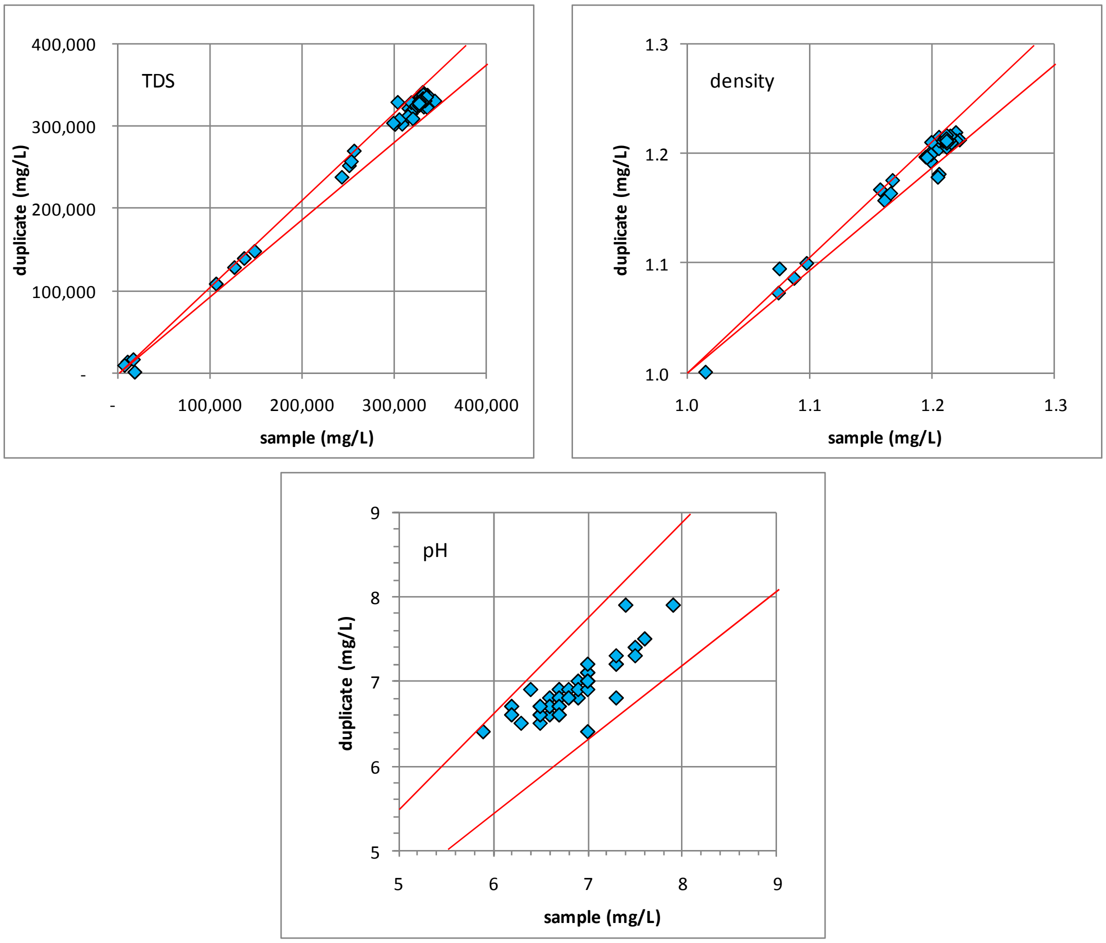
Paired RSD is within an acceptable 10% for TDS, density and pH. Similarly, bias is within acceptable limits for TDS, density and pH. The correlation coefficients are all significantly high ($p<0.001$) and the means are within 1 SD. F tests confirm that there is no significant difference between the variances of paired samples, and t tests confirm no significant differences between the means.

Figure 15.3 Plots of duplicate values of Li, K, Mg and B (red lines indicate 10% error bounds).



All duplicates are within the 10% error bounds, except for two. These two duplicates were part of the batches noted already as having issues (see section on standard analysis) and were re-analyzed by ASL.

Figure 15.4. Plots of duplicate values of TDS, density and pH (red lines indicate 10% error bounds).



Two values of TDS are outside the 10% error bounds, but one of these is related to an off-salar near fresh water. Four density duplicate are outside the 10% error bound, but two of these are related to low density off-salar fluids. All pH values are within the 10% error bounds.

15.1.6 Quality Control – Ionic balance

Excluding samples analyzed for QA/QC purposes, a total of 1,372 samples were analyzed and used in the resource estimation. The cation-anion balance for these samples were calculated as follows:

$$\frac{\Sigma cations - \Sigma anions}{(\Sigma cations + \Sigma anions)} * 100$$

where both cations and anions are in millequivalents per liter. Since solutions should be electrically neutral (ie. the balance should = zero), the balance is a good indicator of the accuracy of the analysis.

The average ion balance for the samples is 1.8 ±0.02%. Normal practice is to accept all samples with ion balance errors less than 5% as accurate. Samples with ion balance errors between 5-10% may be considered suspect, and those above 10% must be rejected. No samples had ion balance errors greater than 10%; the maximum was 7.4%. In these 1,372 samples, 83 (6.1%) have ion balance errors between 5-10%. These samples were investigated further, and only two of these 83 samples had ion balance errors greater than 6% and were eliminated from the resource estimation process. The remaining 81 samples with ion balance errors between 5-6% were largely associated with the more dilute brines that did not get incorporated into the resource estimation process.

15.1.7 Summary

Analysis of standards, replicates, duplicates, and the ion balance all show that the ASL fluid chemistry analyses have acceptable accuracy and precision, allowing the results to be used for the resource analysis with high confidence. Where standards were outside analytical tolerance limits the batch was sent for re-analysis.

15.2 Aquifer porosity

15.2.1 Core Sample Preparation

Lexan samples were taken at the end of every core run (1.5m) from the C series sonic wells. A length of approximately 10 cm was cut from the base of each core run, at the drill site as soon as the core barrel was extracted from the hole, maintained in the lexan tube and fitted with tight caps and tape to prevent evaporation or drainage of any moisture.

Split spoon samples were pushed ahead of the drilling, after taking the lexan core. The split spoons were lined with polycarbonate tubing, which was extracted intact from the split spoon and capped and taped at the wellhead to prevent evaporation or drainage of any moisture.

Samples from the diamond drilling cores were taken at the end of every core run (3 m) where possible. The samples were enclosed in HQ sized core barrels, cut from the base of each core run, and capped and taped at the wellhead to prevent evaporation or drainage of any moisture.

The lexan samples were analyzed for total porosity (P_t) in the on-site laboratory (see below). The split spoon sample was subdivided into four lengths, one of which was analyzed for total porosity (P_t) in the on-site laboratory, one was sealed in cling film and kept as backup, two were sent to BGS in the UK for determination of total porosity (P_t), effective porosity (P_e), and specific yield (S_y). Since the process to determine specific yield (S_y) is quite lengthy (see below), not every sample was analyzed for S_y. A selection of lithologies from the duplicate split spoon samples were sent to the laboratories of DB Stephens in the US for the determination of "Relative Brine Release Capacity", a surrogate for S_y.

In addition, a selection of split spoon duplicates sent to BGS were analyzed in their petrological laboratory (see below) using resin injection and point counting to determine total porosity, pore size distribution and equivalent surface area.

15.2.2 Core sample analysis – site laboratory

Lexan and split spoon samples were taken directly from the wellhead to the site laboratory every day and immediately weighed. The samples were then accurately measured, and extracted from the core tube and disaggregated. They were then dried in a controlled 60^{o}C oven for periods up to 172 hours, with reweighing at regular intervals to determine their drying curve. Temperature control is important as anything over 60^{o}C is likely to cause the loss of water of crystallization in commonly occurring gypsum as it converts to anhydrite. Due allowance was also made for the precipitation of salts (assumed to be largely NaCl) during the drying process. The moisture content so determined represents P_t.

15.2.3 Core sample analysis – BGS laboratory

Since most lithologies in the salar deposits are poorly cemented and that excessive core handling will modify the physical structure of the core and effect porosity and drainage measurements (as noted above), it was important to keep core handling to a minimum. From the split spoon sample, three 5 cm long plugs were cut with a diamond saw and resealed (Figure 15.5).

Figure 15.5 Split spoon samples as received at BGS in sealed, rigid polycarbonate tubes (center) and after trimming to plugs (right).

Samples for analysis were selected on the basis of some combination of the following criteria:

- to be representative of variations in the lithology of the recovered core,
- where there is limited lithological variation, samples selected at regular intervals along the length of the recovered core,
- to include selected samples taken from anomalous or unusual lithologies,
- samples taken either side of any distinct lithological boundaries, and

- where there is adequate core material to obtain multiple samples for the different core analysis methods.

One set of sample plugs was tested to duplicate moisture content drying as undertaken on-site in Argentina. Samples were weighed at daily intervals at the start of the process and weekly intervals thereafter until weights did not vary by more than 0.02g. Calculations are performed to express moisture content as a percentage of sample original wet weight and its dried weight after taking account of the weight of the sample sleeve.

Porosity by Liquid Resaturation: effective porosity, bulk density and grain density were measured using a liquid resaturation method based on the Archimedes principle. Samples to be tested are dried, weighed and placed in a resaturation jar, which is evacuated, and then flooded with saturant (Figure 15.6). If samples are dry then isopropanol can be used as it is relatively inert with respect to the core and in particular reduces the potential for swelling clays to modify the porosity during testing. Where samples contain halite (NaCl) the use of isopropanol reduces solubility to approximately 0.01% w/w, compared with in pure water, which is 3600 times greater. Where wet, the samples were resaturated with simulated formation brine. The sample is allowed to saturate for at least 24 hours. The saturated sample is then weighed, firstly immersed in the saturant and then, still saturated, in air. For each sample, a record is made of dry weight (w), saturated weight in air (S_1) and saturated weight immersed in saturant (S_2). The density of the saturant (ρ_f) is also noted using a hygrometer or calibrated density bottle. From these values, sample dry bulk density (ρ_b), grain density (ρ_g) and effective porosity (ϕ) can be calculated as follows:

$$\rho_b = (w\rho_f)/(S_1-S_2)$$
$$\rho_g = (w\rho_f)/(w-S_2)$$
$$\phi = (S_1-w)/(S_1-S_2)$$

Figure 15.6 Sample plugs after resaturation (left), and stored after testing (right) at BGS research laboratories.

Porosity by Helium Injection: the grain volume of a sample plug is defined as the volume of the plug not occupied by interconnected pore space. The equipment used is a Helium Gas Expansion Volume Meter, manufactured by Robertson Research, together with precision digital pressure gauges manufactured by Druck Ltd (Figure 15.7). The grain volume, V_g (cm^{-3}) of a sample is determined by conducting a series of expansions of helium gas from a reference volume at a known pressure into a test chamber which is calibrated by conducting a series of tests whilst progressively changing known reference volumes. The sample is placed within the test chamber after calibration, and pore volume is calculated using Boyle's Law. The pore volume V_p of a sample can be determined if the bulk volume V_{bulk} is known by:

$V_p = V_{bulk} - V_g$

If samples are encapsulated either in a sleeve, or resin of known volume V_{sl} then this equation is modified to:

$V_p = V_{bulk} - V_g - V_{sl}$

The effective porosity (P_e) of the sample can then be determined from:

$$P_e = 100 * (V_p/V_{bulk})$$

Porosity by Mercury Intrusion: a limited number of consolidated samples from deeper boreholes were tested for pore size distribution and porosity using a mercury intrusion technique. Testing methodologies for this technique are specialised and involve a two staged approach whereby the equipment characterizes a material's porosity by applying various levels of pressure to a sample sealed in a calibrated capillary tube housing immersed in mercury (Figure 15.x). Since mercury does not wet most substances and will not spontaneously penetrate pores by capillary action, it must be forced into the pores by the application of external pressure. The required equilibrated pressure is inversely proportional to the size of the pores, only slight pressure being required to intrude mercury into large macropores, whereas much greater pressures are required to force mercury into small pores. Mercury porosimetry analysis is the progressive intrusion of mercury into a porous structure under stringently controlled pressures. From the pressure versus intrusion data, the instrument generates volume and size distributions using the Washburn equation. Clearly, the more accurate the pressure measurements, the more accurate the resulting pore sizedata. Technical references and research literature are available at the equipment manufacturer's website at ***www.micromeritics.com***

Specific yield is measured using a centrifuge technique, which allows relatively rapid determination. The same samples used in the porosity and permeability measurements can be tested for direct comparison. In this method samples are saturated with simulated formation brine and weighed (w_1). They are then placed in a low-speed refrigerated centrifuge (MSE Harrier 18/80) with swing out rotor cups (Figure 15.7). They are then removed from the centrifuge and weighed for a second time (w_2). The centrifuge speed is selected to produce a suction on the samples equivalent to 3430 mm H_2O, which was considered by Lovelock (1972), and Lawrence (1977) to be characteristic of gravitational drainage. Most samples are spun for 2 hours although samples have been tested for varying durations up to 14 hours in order to investigate the effect of time and repeated sample handling. Lovelock (1972) and Lawrence (1977) have shown for example, for a wide range of sandstones, that drainage was complete after 2 hours. This has also been found to be the case for subsequent tests on other samples. Temperature control has also shown to be critical in determining specific yield by this means. Specific yield is then calculated as follows

$$S_y = (w_1 - w_2) / AL$$

where A is sample area and L is sample length.

Figure 15.7 Helium injection testing (left), and centrifuge for specific yield determination (right) at BGS research laboratories.

15.2.4 Core sample analysis – DB Stephens laboratory

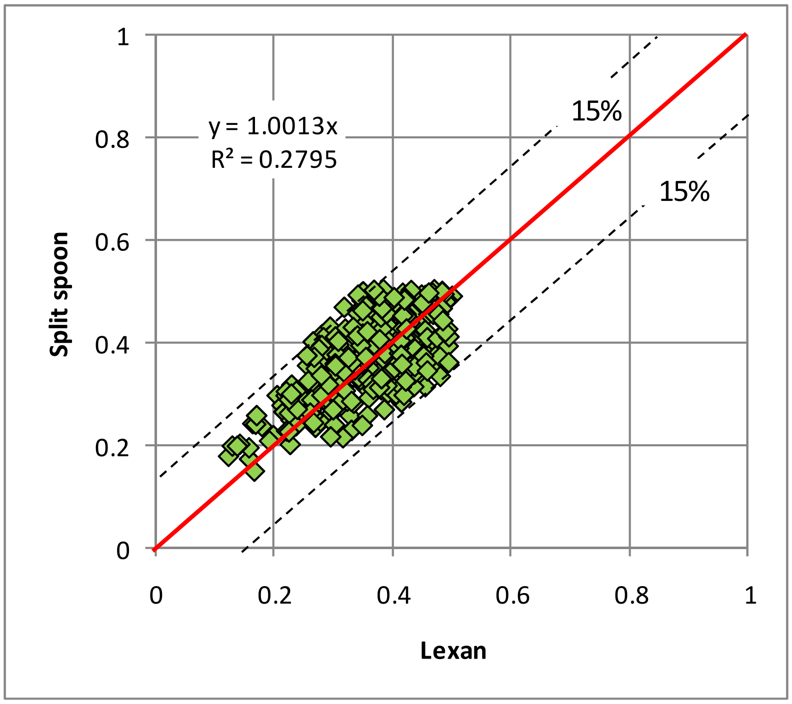
DB Stephens (DBS) use the "Relative Brine Release Capacity" (RBRC) method, developed by themselves and as yet unpublished.

On receipt of samples from Argentina, the split spoon cores were cut to a nominal length of 7.5 cm for analysis. Thereafter, DBS state: "This method predicts the volume of solution that can readily be extracted from an unstressed geologic sample. Undisturbed samples from the site are saturated in the laboratory using site specific brine solution. The bottom of the samples are then attached to a vacuum pump using tubing and permeable end caps, and are subjected to a suction of 0.2 to 0.3 bars for 18 to 24 hours. The top of the sample is fitted with a perforated latex membrane that limits atmospheric air contact with the sample. The samples are then oven dried at 110°C. Based on the density of the brine, the sample mass at saturation, and the sample mass at 'vacuum dry', the volumetric moisture (brine) contents of the samples are calculated. The difference between the volumetric moisture (brine) content of the saturated sample and the volumetric moisture (brine) content of the 'vacuum dry' sample is the specific yield or "relative brine release capacity."

15.2.5 Quality control - Site laboratory determinations of P_t

Repeatability of site laboratory determined P_t was assessed by comparing the results from split spoons and lexan samples (Figure 15.8). There is some scatter, which is a result partly of analytical error, partly the result of differing sample volumes (split spoon ~54 cm^3, lexan ~700 cm^3), and partly the result of the different location for the lexan and split spoon samples. P_t values above 0.5 are unlikely to occur in-situ and have been excluded from further analysis. Lexan and split spoon samples are separated by 30 ±9 cm depth difference. As a result, in thin bedded sequences such as those found at Olaroz, there is likely to be slight changes in lithology and hence porosity over the 30 cm depth difference. Consequently, where paired P_t values differed by more than 0.20 the values were excluded from further analysis. Such exclusions mean that the values used in further analysis are conservative.

Figure 15.8 Comparison of P_t determined in the site laboratory on lexan and split spoon samples (after exclusion of P_t>0.50 and ΔP_t>0.20).

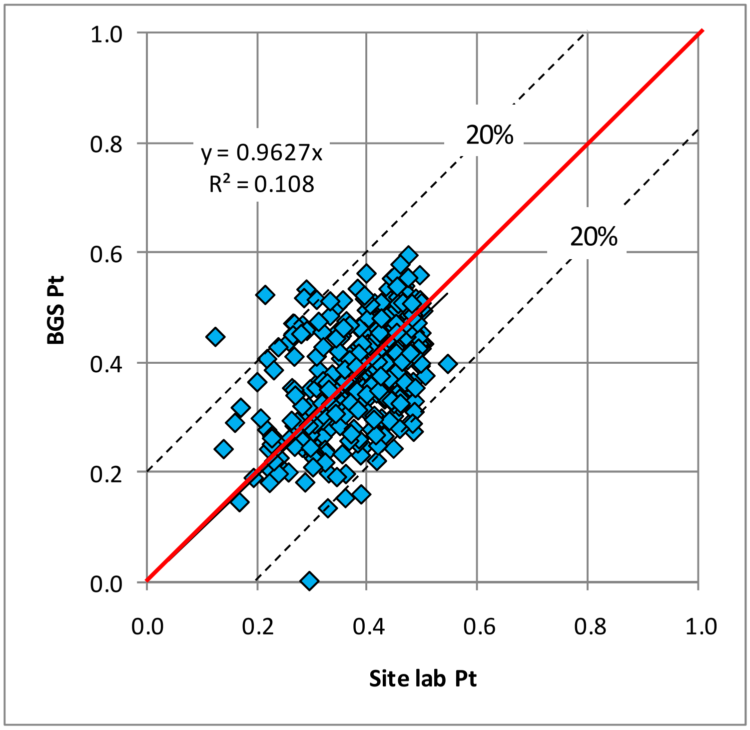


15.2.6 Quality control - BGS determination of P_t.

Comparison of the P_t values determined in the site and BGS laboratories was made between lexan samples on site and split spoon samples in BGS (Figure 15.9). These samples suffer from being not directly comparable on account of the depth difference of 30 ±9 cm between them and the consequent potential for lithological variation.

Nevertheless, and despite the scatter in the data, the relation is significantly correlated with an effective ratio of 1:1.

Figure 15.9 Comparison of P_t determined from lexan core samples in the site laboratory with split spoon samples in BGS.



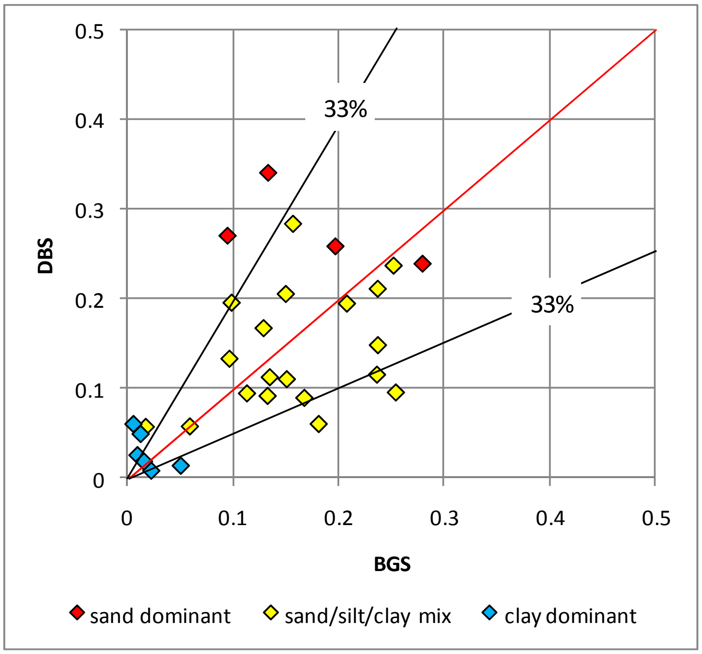
15.2.7 Quality control - DBS laboratory determinations of S_y

The repeatability of S_y determinations was assessed by sending paired samples to both BGS and DBS. The samples were of adjacent split spoon sections and thus as reflect similar lithologies as closely as possible, although it must be understood that there is no way of repeating the analysis on exactly the same sample. Furthermore, it must be remembered that the techniques for determining Sy are different in the two laboratories. The results are shown in Figure 15.10 and Table 15.8, related to lithology. There is significant scatter in the results, but very little bias, except for sand, where DBS results tend to be higher.

Table 15.8 Results of inter-laboratory comparison for S_y.

	Sand dominant		Sand-silt-clay mix		Clay dominant	
	BGS	DBS	BGS	DBS	BGS	DBS
N	4		19		6	
Mean	0.18	0.28	0.16	0.14	0.02	0.03
SD	0.08	0.04	0.07	0.07	0.02	0.02
RPD	28%		22%		49%	

Figure 15.10 Plot of inter-laboratory comparison of S_y.



15.2.8 *Relation between porosity and lithology*

In order to assess the relationship between the porosity parameters (P_t, P_e, and S_y) and lithology, all samples were split into four categories of lithology:

- sand dominant
- silt & sand-clay mixtures
- clay dominant
- halite dominant

Histograms and sample statistics were computed for each class and are shown in Figures 15.11, 15.12, and a summary is given in Table 15.9.

The results show good agreement between site laboratory P_t and BGS P_t, as expected from the previous inter-laboratory comparison. P_t and P_e both show increase from sand>silt and sand-clay mixes>clay. Mean values are in good agreement with literature values for these types of sediments (Morris and Johnson, 1967). S_y on the contrary decreases, thus: sand<silt and sand-clay mixes<clay. Mean values for S_y are in good agreement with literature values for these types of sediments (Johnson, 1967). Halite samples show a relatively wide range of total porosity (Figure 15.12), with the suggestion of bimodality with means of 0.14 and 0.41. Relatively few halite samples were analyzed at BGS, but those that were gave a mean Sy value of 0.40, which is in good agreement with values determined at Atacama and Hombre Muerto for unfissured halite.

It is important to note that there is considerable overlap in values between the different lithological classes, and as a consequence it is not possible to assign a single value to a lithological type for the purpose of resource estimation. Instead, an objective approach is required as explained in section 15.2.6.

Figure 15.11 Lithologically classified P_t distributions and statistics. Site laboratory plots to left, BGS laboratory plots to right. The curve in each plot is the best fit normal curve.

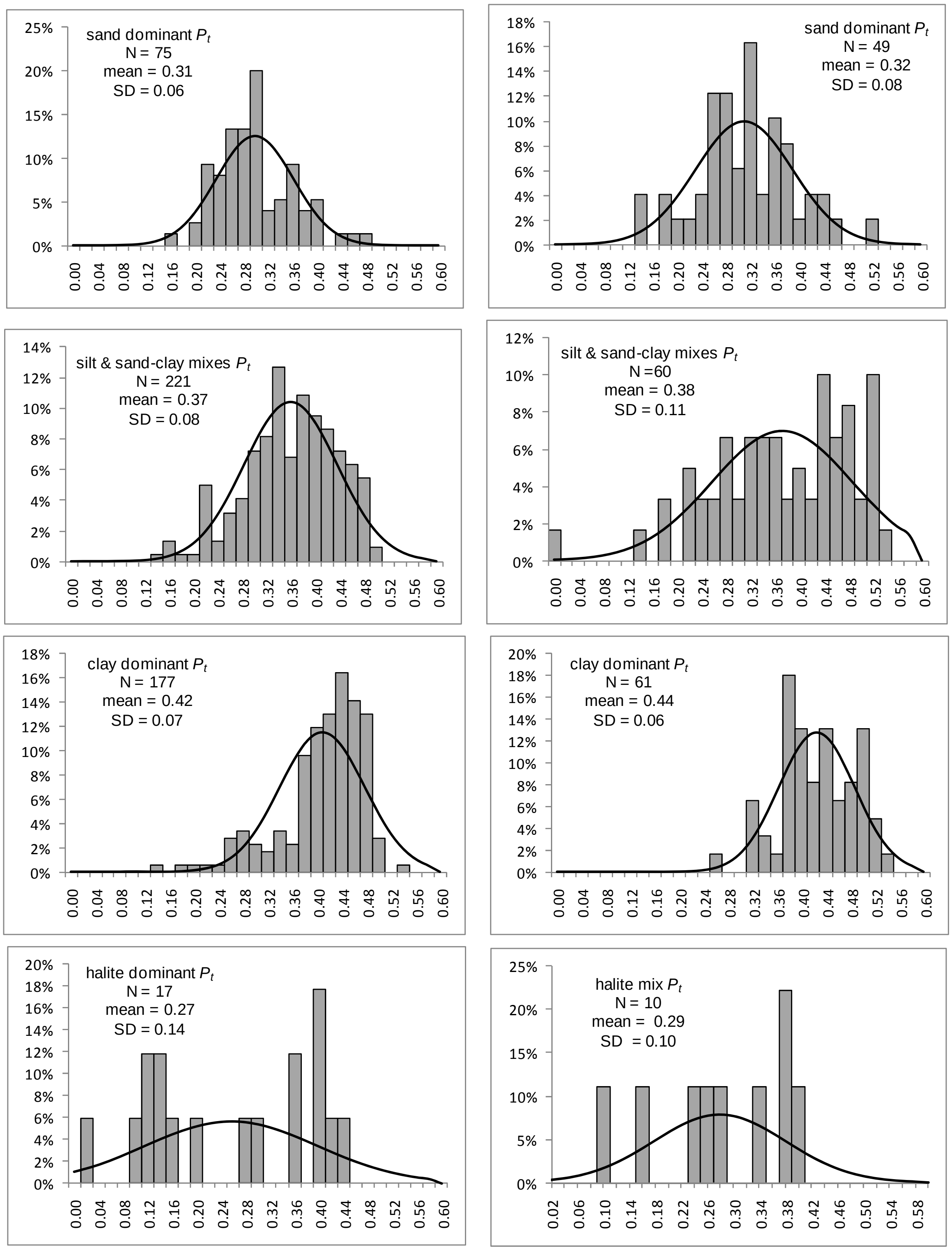


Figure 15.12 Lithologically classified P_e (left) and S_y (right) distributions from the BGS laboratory. The curve in each plot is the best fit normal curve

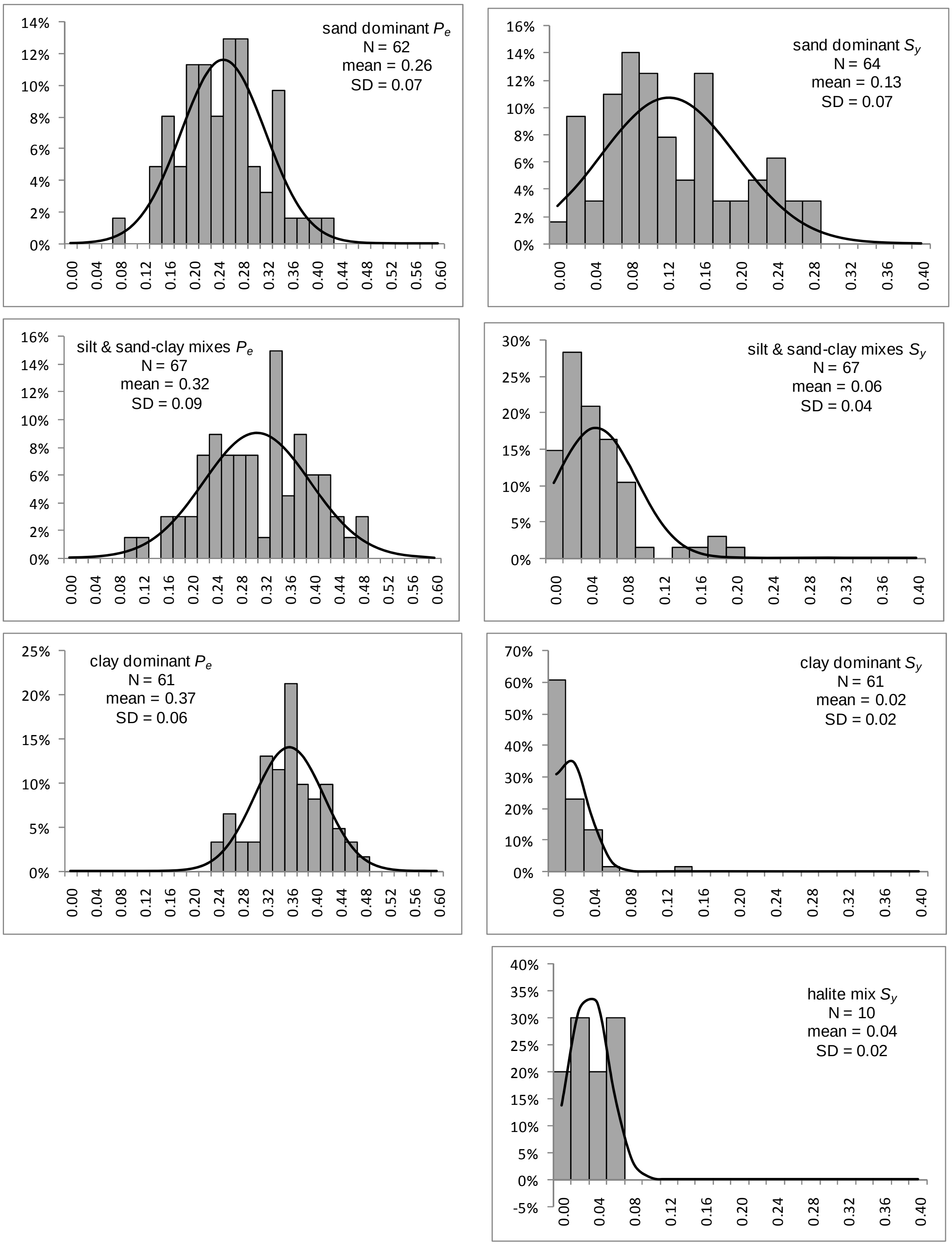


Table 15.9 Summary of porosity statistics for different lithologies.

	P_t site lab		P_t BGS lab		P_e BGS lab		S_y BGS lab	
	mean	SD	mean	SD	mean	SD	mean	SD
Sand dominant	0.31	±0.06	0.32	±0.08	0.26	±0.07	0.13	±0.07
Silt & sand-clay mixes	0.37	±0.08	0.38	±0.11	0.32	±0.09	0.06	±0.04
Clay dominant	0.42	±0.07	0.44	±0.06	0.37	±0.06	0.02	±0.02
Halite dominant	0.27	±0.14	0.29	±0.10	nd	nd	0.04	±0.02

15.2.9 Protocol for the development of a continuous downhole estimate of S_y

Neutron logs, coupled with caliper to correct for hole diameter allow a near continuous (1 cm spacing) profile of total porosity (N-Pt) downhole.

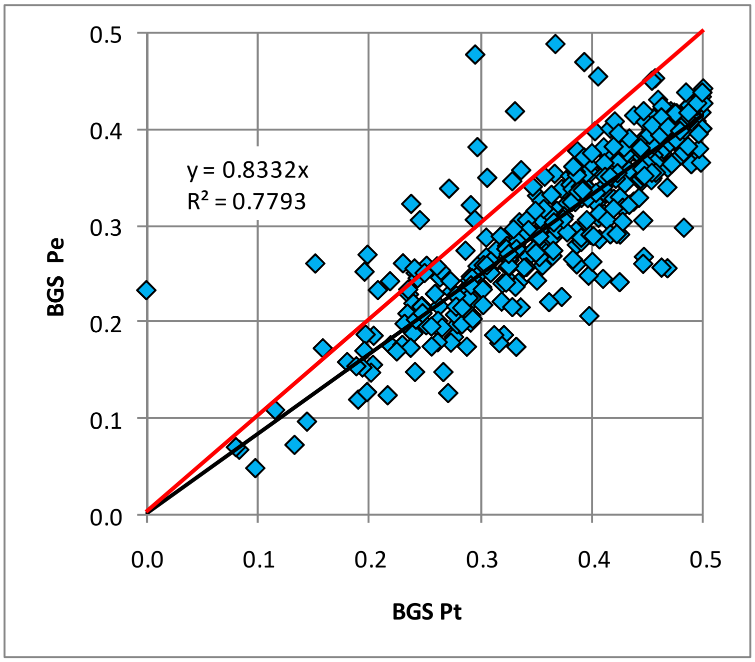
It is possible to relate the laboratory determination of P_t to N-Pt, and laboratory P_e to P_t, as well as laboratory S_y to P_e, thus enabling a continuous profile of S_y to be generated. This then can be used to effect the resource calculation. It is particularly important to use this methodology where there is so much overlap and variation in the porosity parameters; it is not possible to assign a single value of S_y to any one lithological type.

P_e shows a clear relation with P_t (Figure 15.13), such that for 511 samples

$$P_e = 0.83 * P_t$$

and this relationship is significant at 99.9%.

Figure 15.13 Relation between P_e and P_t. Red line indicates equality; black line best fit regression.



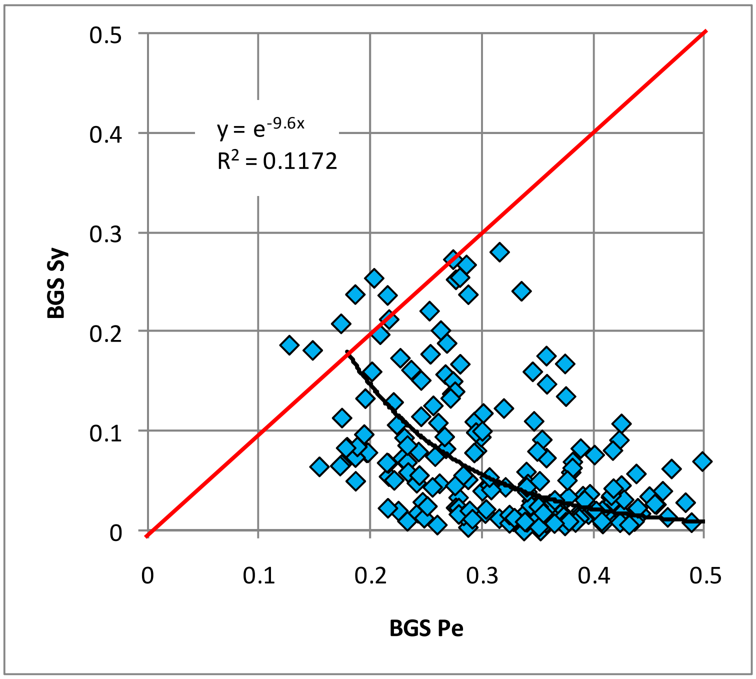
S_y shows a clear inverse relationship with P_e (Figure 15.10) above P_e = 0.18, such that for 201 samples

$$S_y = e^{-9.6 * Pe} \qquad \text{for } P_e > 0.18$$

and this relationship is significant at 95%.

For values of P_e less than 0.18 it can be assumed S_y is equal to P_e, since such values of P_e are typical for coarse sand and gravel, where there is little specific retention.

Figure 15.14 Relation between S_y and P_e. Red line indicates equality, black line best fit regression.

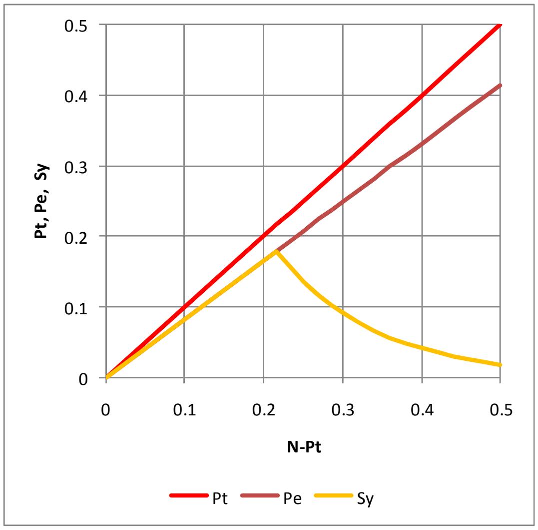


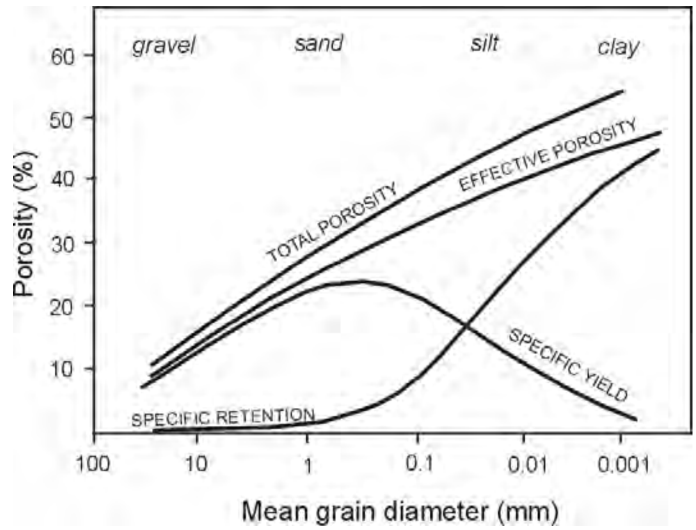
Based on these relations, it is possible to erect an algorithm of the conversion of N-Pt to S_y as follows

$$P_e = 0.83 * \text{N-Pt} (=P_t)$$
$$\text{for } P_e<0.18 \;\; S_y = P_e$$
$$\text{for } P_e>0.18 \;\; S_y = e^{-9.6 * Pe}$$

and this is shown graphically in Figure 15.15, alongside a typical porosity graph for sedimentary materials (eg. Davies and DeWeist, 1966).

Figure 15.15 Graphical representation of algorithm to determine Sy from N-Pt (left) and typical porosity relationships for unconsolidated material under lithostatic (normal) loads in the upper 30 m of the crust (right).





15.2.10 Petrological analysis

The petrographic analysis, undertaken on 17 samples, show very little or no evidence of the precipitation of salts in the cores. Thus, porosity values determined in the laboratory are likely to be directly representative. The sediments are generally poorly sorted, showing a wide range of specific surface area for the matrix grains, leading to the conclusion that S_r is likely to be relatively high for these sediments.

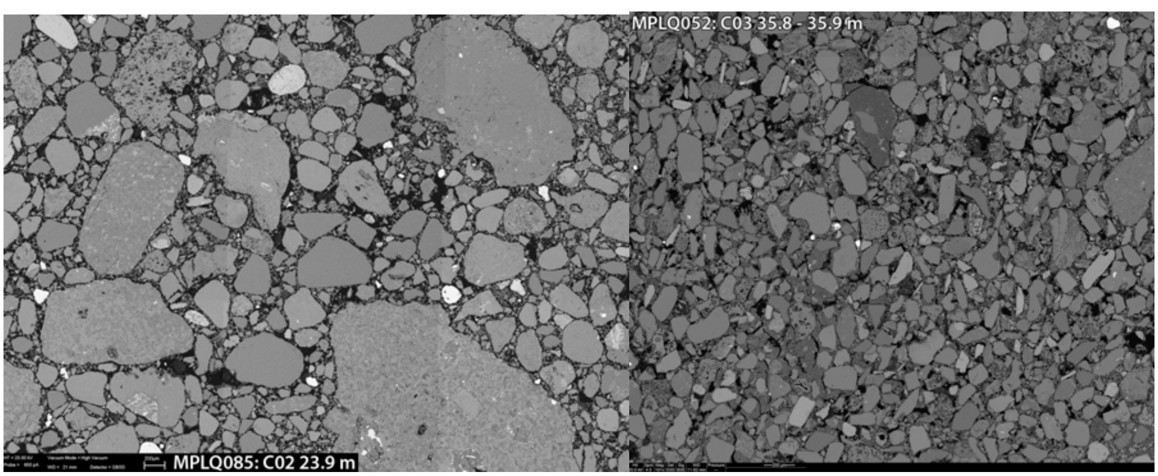


Figure 15.16 Aquifer matrix thin sections from cores. Poorly sorted, grain supported silty sand, composed of lithic fragments, quartz and feslpar, no salt precipitation; total porosity porosity 14.7% (left). Moderately sorted, grain supported, muddy, fine sand, composed of volcanic fragments, quartz, pyroxenes and mica, no salt precipitation; total porosity 10.5%.

15.2.11 Summary

The porosity values determined in the laboratories are highly consistent for different lithologies. However, there is a very wide range of porosity for any particular lithology precluding the use of a single value for any lithology. An objective approach to the determination of porosity for use in the resource estimation has been developed which allows for a high degree of confidence to be placed on the resource analysis.

15.3 Sample security

All Olaroz samples were labeled with permanent marker pen, and transported from the field site to the Salta office of Orocobre in wooden crates. Samples were received at the Salta office and re-packaged into labeled cardboard cartons. The cartons were dispatched to the laboratory in Mendoza, with a sample list and analytical instructions, which were also sent to the laboratory by email. Samples were hand delivered to the laboratory of the University of Salta, with instructions regarding the required analyses. In the case of samples destined for the UK, both cores and bottles, extra packaging precautions were taken. All samples were subject to a chain of custody protocol, that ensured no samples were mistaken or lost between wellhead and their ultimate laboratory destination.

16. DATA VERIFICATION

16.1 General

Author, John Houston, is retained as an independent consultant to provide on-going advice in his field of expertise. As such, there is regular and open interaction between him and the Company's professional staff, consulants and technicians. Author, Mike Gunn, has visited the project site and has met the Company's staff and process engineering team. The authors have observed both a high degree of professionalism amongst the Company's professional staff and consultants, and a diligent attitude towards the work being undertaken. John Houston has provided training as required to the Company's personnel on tasks being currently undertaken.

The available data is subject to the limitations described in Sections 12, 13, 14 and 15 and summarized below. Within these limitations, there is good reason to have a high level of confidence in the reliability, repeatability and veracity of the results.

16.2 Site visits

The first author has spent several months on site at various times between April 2009 and February 2011. All on-site activities were observed, reviewed and discussed with the Orocobre geologists and technicians. Author, Mike Gunn, has visited the project site and has met the Company's staff and process engineering team, including Consulting Processing Engineer and Qualified Person, Peter Ehren, during April 2011. Peter Ehren has been involved in the design, supervision and development of all process aspects at the Salar. He has spent many weeks on-site between May 2009 and up to date. Noel Merrick visited the site in November 2010 in the company of the first author and was able to gain first-hand knowledge of the salar and its hydrogeology.

16.3 Assay data

The author has been on-site during a significant part of the sampling program. He has worked with the Orocobre technicians to design and develop the techniques described in the technical Report to ensure that they are representative of the in-situ fluids and that once sampled the brines were carefully labeled and sent for laboratory analysis. Orocobre carried out an internal validation of all available assay and location data for the drill samples in the current database. Original copies of the analytical certificates from Alex Stewart laboratories have been reviewed by the first author. Analytical and sampling quality control measures employed by the company are discussed in Section 15 above.

16.3 Geological data

Geological data collected has been fully verified by the author. Field note books used by geologists have been sighted and selectively checked against information in the current database. Drill cores have been extensively viewed and compared with data recorded by the on-site geologists. Core sampling protocols for porosity determinations were developed in conjunction with Orocobre staff and the on-site laboratory for Pt analysis was established under the author's supervision. All procedures were reviewed from time to time as the project developed and found to be consistent and repeatable.

16.4 Survey data

All wells, monitoring points and related locations on the Salar were surveyed using differential GPS equipment by Gamma 3D of Jujuy. They quote maximum errors as being ±5 m horizontally and ±0.05 m vertically, but are probably much better. Data was collected in the Argentine co-ordinate system with the Gauss Krueger UTM projection, Zone 3, and the Posgar 94 datum.

17. ADJACENT PROPERTIES

17.1 General comments

Two salars in the region have been producing Li, K and B products from brines for more than fifteen years: the Salars de Atacama in Chile, and Hombre Muerto in Argentina. Both salars are mature, inasmuch as the host aquifer is a large halite body in both cases. Although the Orocobre Olaroz project is not located in the immediate vicinity of a current lithium producing salar, it is clear from the table below that lithium values are highly elevated throughout the region, and Olaroz is no exception.

Table 17.1 Comparison of Salar de Olaroz with other salar brine chemical compositions (mg/L).

	Salar de Atacama Chile	Hombre Muerto Argentina	Salar de Rincon, Argentina	Salar de Olaroz Argentina	Salinas Grande* Argentina	Guayatayoc* Argentina	Cauchari* Argentina	Salar de Cauchari Argentina	Salar de Uyuni Bolivia	Silver Peak Nevada
	mean	FMC	Sentient	……….....	Orocobre		…...…….	(LAC)		CFC
Li	1,835	744	397	690	775	67	191	618	424	245
K	22,626	7,404	7,513	5,730	9,289	2,185	1,596	5,127	8,719	5,655
Mg	11,741	1,020	3,419	2,270	2,117	115	453	1,770	7,872	352
Ca	379	636	494	460	1,450	628	569	401	557	213
B	783	420	331	1,050	232	144	244	1,360	242	85
Density	1.223	1.205	1.220	1.211					1.211	1.297
Mg/Li	6.4	1.4	8.6	2.4	2.7	1.7	2.4	2.9	18.6	1.4

* mean values include all pit samples from nucleus and margins and are not necessarily representative of possible production values

Data for Salars de Atacama, Hombre Muerto, Rincón, and Uyuni as well as Silver peak, taken from "Evaluation of The Potential of Salar del Rincon Brine Deposit as a Source of Lithium, Potash, Boron And Other Mineral Resources, by Pedro Pavlovic and Jorge Fowler, 2004. Salar de Cuachari (LAC), from NI43-101, Lithium Americas Corporations, February 15th 2010.

17.2 Adjacent properties

Orocobre holds tenements in the nearby salars of Cauchari and Salinas Grande-Guayatayoc. Both these properties contain brine with elevated levels of Li, K and B, as described in the NI43-101 compliant Technical Reports dated 30 April 2010, and are currently the focus of further investigations.

Lithium Americas Corporation holds tenements in Cauchari and on the eastern side of the Salar de Olaroz. (Figure 17.1). LAC report a total Measured and Indicated Resource over an area of approximately 26 km x 4 km of their Cauchari properties of 1.0 million tonnes of lithium metal at 656 and 637 mg/L lithium respectively, and 9.0 million tonnes of potassium metal at 5.9 and 5.7 gm/L respectively (NI43-101 Technical Report dated 6 December 2010).

Lithium One owns properties in the eastern part of the Salar de Hombre Muerto. In their NI43-101 compliant Resource Statement, dated 7 March 2011, Lithium One report average grades from a drilling program of 695 mg/L for Li and 7,590 mg/L for K, with Inferred Resources of 1.02 million tones of Li and 11.2 million tones of K.

The Author has been unable to verify the information in this section relating to adjacent properties, and the mineralization on such adjacent properties is not necessarily indicative of the potential of mineralization on the properties that are the subject of this Report, except insofar as the Salar de Olaroz properties lie within the Argentine Puna province which is rich in Li and K bearing brine resources.

18. MINERAL PROCESSING AND METALLURGICAL TESTING

18.1 Process Development Overview

The brine resource defined at the Olaroz Project has the potential to produce lithium, potash and boron chemicals. The economic value of the lithium is by far the largest, and lithium production has thus been the focus of process development work over the past two years. As market growth for lithium is concentrated on the Li-ion battery segment, the objective has been to produce battery grade lithium carbonate product.

Initial assessment of the brine chemistry in 2008 indicated that it had a low magnesium to lithium ratio, moderate levels of sulphate and was suitable for application of the 'Silver Peak' method used at the world's first lithium brine treatment operation in Nevada, USA since the mid 1960's. However, the 'Silver Peak' process, although generally applicable to the Olaroz brine chemistry, required modification to suit the differences in brine chemistry and the different climatic conditions at the Olaroz Project. The process route also required some enhancement to produce a lithium product to meet the more demanding current day specifications for the rapidly growing lithium battery sector.

The Feasibility Study undertaken relies on the results of a process development program that has sequentially defined the performance of each stage in the process, resulting in a flow sheet that is capable of producing battery grade lithium carbonate. Test work has been undertaken at the Company's facilities at the Olaroz project site and also at commercial and university laboratories. The process development program has resulted in a process route incorporating a number of proprietary innovations.

Early work focussed on evaporation rate testing to understand the phase chemistry of the brine evolution during a twelve month weather cycle. This was followed by lime addition test work to remove magnesium. Subsequently, the focus of the project test work moved to the removal of boron by multi-stage solvent extraction processing, and then on to the final stage of lithium carbonate purification.

The lithium is present at concentrations that are potentially economic, but are low in comparison to the other salts in the brine. Before final purification the other salts must be selectively rejected, and this is done primarily by evaporation, causing the salt concentrations to increase beyond their solubility limits, and by simple and well established methods of chemical treatment. Based on test work and phase chemistry, over 70% of the lithium is modelled to be recovered in this process to a high specification product, with the majority of the lithium losses incurred by inclusion of brine in the pores of the solid salts formed during the evaporation process.

By September 2010, Orocobre was producing its first pilot scale lithium carbonate and on 8 April 2011, the Company announced that it had successfully produced battery grade specification lithium carbonate at its process development facilities from Olaroz brines. This is considered to be a prerequisite for completion of a Feasibility Study for the

production of 100% of battery grade material. Analysis showed the material to be of greater than 99.9% purity and to exceed specifications of battery grade material sold by existing producers.
Although the primary focus has been development of the high specification lithium carbonate production flow sheet, there has been a secondary focus on production of potash and boric acid. Test work has shown that potash of commercial grade can be produced by froth flotation of mixed halite and potash (sylvite) salts. The deeper 2010 drilling and more detailed testing program revealed significantly higher levels of sulphate in the expanded resource than had been expected based on the shallower 2008 drilling program results. This higher sulphate level had an impact on expected potash recoveries, due to the formation of glaserite ($Na_2SO_4.3K_2SO_4$). The process is now expected to produce approximately 0.6 tonnes of potash per tonne of lithium carbonate or 10,000 tonnes per annum in the Feasibility Study production case.

The Company is planning to undertake additional process development work with the aim of reducing the impact of the increased levels of sulphate and increasing potash production to the level of previous estimates, and even potentially higher levels. As the potash circuit is only required two years after the production of lithium carbonate has commenced, this work will be completed well in advance of the deadline for finalising the design and construction of the final potash circuit.

Some test work has been successfully undertaken on the potential to recover boron as boric acid. Further test work and process analysis will be undertaken on the alternative strategy of retaining the boron values in the brine through the evaporation process and recovering the boron to a commercial product.

18.2 Brine Composition Analysis

The brine composition throughout the deposit is relatively uniform, which is advantageous for process performance, as only minor brine composition changes are expected due to a small decline in grades over time. This also has significant advantages in undertaking a test work program as there is only one type to assess.

For all the experimental work well FD-16B was used which was drilled during the 2008 drilling program. Analysis of the brine chemistry of the 2010 drilling data and 2011 resource estimate show FD-16B brine to be representative of the current resource.

The average brine composition is plotted in the Janecke projection (see **Error! Reference source not found.**11.2), which indicates the types of salt that can be expected to crystallize during the solar evaporation process. This diagram indicates the relative concentrations of the major ionic species.

Almost all the salt lakes are saturated in sodium chloride, since they are embedded completely in, or contacted partly with, rock salts (halite). The Salar de Olaroz brine is located at the border of the Janecke glaserite ($Na_2SO_4.3K_2SO_4$) field and the ternadite

(Na_2SO_4) field. Low ambient temperatures at the Salar will cause the crystallization of sulphate as glauber-salt ($Na_2SO_4.10H_20$) in the evaporation ponds.

The low Mg:Li ratio of the brine makes magnesium removal with slaked lime a feasible process step. The Olaroz brine has high sulphate contents (high SO_4:Mg); hence sodium and potassium sulphate salts are likely to crystallize. As it has a SO_4:Mg ratio higher than 4, there is also enough sulphate available in the brine to precipitate the calcium liberated during the formation of magnesium hydroxide as gypsum. The only disadvantage of the high sulphate level is that it tends to lock up potassium as glaserite, constraining potential potash yields and at higher concentrations of lithium, causes lithium losses as lithium schoenite.

These brine chemistry characteristics have shaped the path of process testing and development.

18.3 Solar Evaporation Testing

The evaporation of water from the solar evaporation ponds is a critical factor in the processing of the brines. The feasibility study contains extensive climate data and pan evaporation testing data conducted at the Olaroz site, including comparison of data from tests conducted on water and partly saturated brine in standard Pan A equipment, and the data from concentrated brine evaporation in the pilot plant ponds. The solar radiation levels, ambient temperature, local humidity and prevailing wind conditions all impact on evaporation rates. These factors have been examined in detail in the Feasibility Study, and a summary is presented below.

The evaporation information is coherent in that the pilot scale pond testing on saturated brine provides an annual rate of 1,733 mm which is the value used in the SKM design criteria. This is conservative in the context of the Pan A test result of 3900mm per year on water and 2,600 mm per year on unsaturated brine. The actual ponds area has been designed on the basis of 1,300 mm of annual evaporation. This is a reasonable base line in the context of brine activity factors that range from 75 – 80% depending on saturation levels, and industrial factors of 75% applied to small pond data to predict large pond evaporation rates. This also allows a generous margin to compensate for any unusually high rainfall event.

Table 18.1 Brine evaporation rates – SKM design criteria

Pilot Pond Data	$L/m^2/day$ (=mm/day)
Annual average	4.75
Summer average	5.85
Winter average	3.65

The most relevant and reliable information has been provided by the data gathered from the large number of open evaporation test ponds operating in sequence on the salar. The weather variables need to be defined to assist with assessing the potential for variance in the pilot plant data.

Evaporation is driven by solar radiation, ambient temperatures, wind impact and humidity, and must take into account the variable rainfall. The average annual temperature at the project site is approximately 7° C, with extremes of 30º C and -15º C. The coldest months with temperatures below zero correspond to May through August. The solar radiation at the Salar de Olaroz is almost as strong as at the Salar de Atacama. The Solar radiation is the most important factor in evaporation.

Rainfall at the Salar is very low and during 2009-2010 no significant rain was registered at the stations. During the summer months (January –March) wind comes frequently from the east with humid air and the rain falls very locally. Summer of 2011 was very wet and more rain and lower evaporation was registered (Figure 18.1). At the Salar de Atacama and Salar de Hombre Muerto normally no more than 100 mm/year is registered. Strong winds are frequent in the Puna, reaching speeds of up to 80 km/hr during warm periods of the dry season.

Figure 18.1 below summarises the site evaporation data, comparing other sites and showing the pan test data. The significance of the Pan A bis data is that this was an unsaturated brine test and is compared to Pan A on just water. Figure 18.2 shows how the brine evaporation rate varies compared to a standard water test as brine concentration increases.

Figure 18.1 Site Net Evaporation Rate Test Data and Other Sites

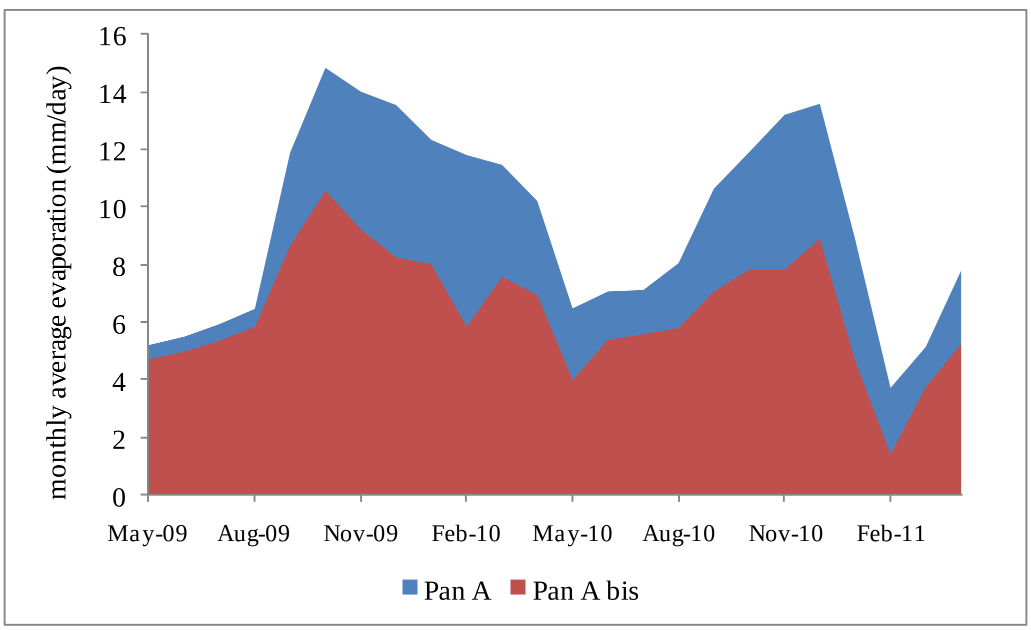
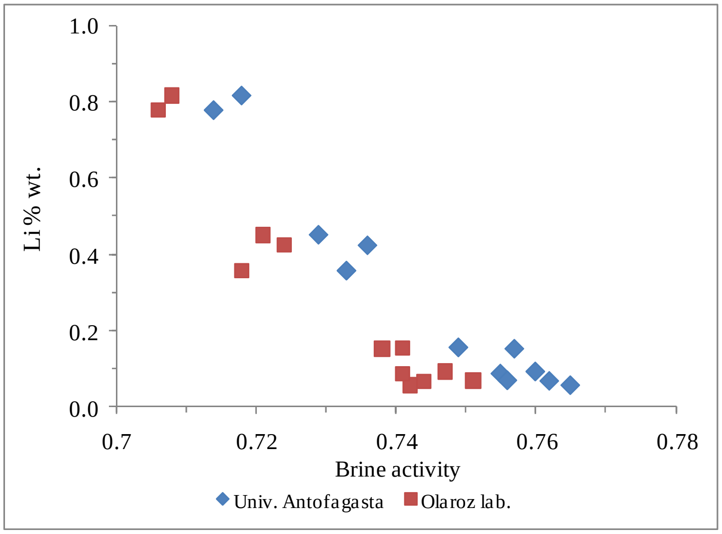


Figure 18.2 Brine activity vs lithium concentration



18.3.1 Evaporation Pond Brine Temperatures

Temperatures in the ponds are manually registered at 09:00 and 16:00 every day. Some ponds have continuous temperature registration using data loggers placed in the ponds.

For brine phase chemistry analysis the lowest daily brine temperature is an important parameter as it will indicate which salt will precipitate.

Figure 18.3 Operational ponds L3 and L4

18.3.2 Phase Chemistry

The pilot ponds have been operating under conditions representative of the industrial operation for over one year generating the required phase chemistry data, which defines the amount and types of salts that form as solids in the ponds through the changing ambient temperature, wind and humidity conditions over time. Enough information has been collected for the modelling of the behaviour of the evaporation system for the Feasibility Study to enable definition of the brine chemistry in the feed to the lithium carbonate plant, and for detailed engineering of the pond system.

18.3.3 Crystallized Salts

In all the ponds it is mainly sodium chloride (NaCl > 94%) that is crystallized. Other salts that crystallize are glauber salt ($Na_2SO_4.10H_20$: 2-6%) and calcium sulphate ($CaSO_4.2H_20$: 1%). In the most concentrated ponds halite and silvite (KCl) crystallise, with minor concentrations of glaserite ($Na_2SO_4.3K_2SO_4$) and borate salts. Under these alkaline conditions the boron is precipitated as sodium and calcium borate [$Na_2B_4O_7$ and CaB_4O_7], and to assist in the final lithium purification process this precipitation may be encouraged by addition of calcium chloride.

The optimal lithium concentration for the recovery plant was defined by the loss of lithium at concentrations greater than ~0.7% by precipitation of lithium as schoenite [$Li_2SO_4.K_2SO_4$].

18.4 Liming Testwork

Initially Orocobre was using hydrated lime ($Ca(OH)_2$) from a provider located near Jujuy for its experiments. This was replaced by active or burnt lime (CaO) from the same provider, with the advantage of reducing product and transportation costs. The active lime is of a high grade and contains 83% active CaO. At pilot scale the lime reacted very well and completely fulfilled the process requirements.

Magnesium reacts instantaneously with the slaked lime. Subsequently the liberated calcium starts to react with the available sulphate and some boron reacts early with calcium from the liberated lime. Brine at higher levels of concentration could be treated with lime, but the material handling for the concentrated brine becomes more difficult, and lithium losses increase. Data from the pilot scale trial is shown below.

Table 18.2 Results of liming at pilot scale

Test	Indentification	Date	Mg	Ca	Li	SO4	B	pH	B Loss	Lime excess	Mg removal
1	W16	22-Nov	0.137	0.04	0.05	1.17	0.06	11.14	15%	131%	99.4%
	W16-Out		0.001	0.143	0.051	0.578	0.056				
2	W16-Out	22-Nov	0.141	0.042	0.051	1.160	0.059	11.39	3%	135%	99.4%
	W16		0.001	0.144	0.050	0.694	0.049				
3	L1-P1	2-Dec	0.200	0.045	0.078	1.587	0.085	10.60	12%	113%	93.6%
	L1-P1-Out		0.012	0.126	0.079	0.774	0.077				
4	L1-P1	3-Dec	0.178	0.042	0.077	1.659	0.081	10.40	20%	115%	100.0%
	L1-P1-Out		0.000	0.161	0.076	0.721	0.074				
5	L1-P2	4-Dec	0.293	0.028	0.112	2.415	0.118	11.40	11%	115%	99.7%
	L1-P2-Out		0.001	0.109	0.105	0.946	0.104				

18.5 Boric Acid Process

In order to recover the boron, its behaviour in the solar ponds has been studied. Several different process options were tested at lab scale to recover the boron. Some tests have been conducted which showed potential for high recovery rates, but this process is still in the preliminary development phase.

18.6 Potassium Chloride Process

Preliminary froth flotation tests have been conducted at the University of Jujuy with salts obtained from the pilot ponds. During the test the most important parameters (collector type and addition, liberation, etc) were defined in order to obtain an acceptable concentration of silvite salts (KCl). Future testwork is planned with some additional bench flotation test followed by pilot scale testing.

18.7 Lithium Carbonate Process

The pilot plant has been operating successfully since the 3rd Quarter of 2010, producing technical grade lithium carbonate.

At the beginning of 2011 the pilot plant testing process included an alternate purification step in order to achieve battery grade lithium carbonate. Analysis showed the material produced from Olaoroz brines to have purity >99.9 % lithium (not including moisture and loss on ignition) as analysed by two Japanese laboratories.

Table 18.3 Analytical data for lithium carbonate product

		Specification	Lab 1	Lab2
Li_2CO_3	%	99.40	99.17	100.07
Na	ppm	600	5.5	4
Fe	ppm	5	1.4	1
Ca	ppm	100	1.8	3
SO4	ppm	300	50	173
K	ppm	10	0.5	1
Cl	ppm	100	50	17
Mg	ppm	60	1.6	1
Cr	ppm	5	0.5	1
Ni	ppm	5	0.5	1
Cu	ppm	5	0.5	1
Pb	ppm	5	0.5	1
Al	ppm	5	20	1
Zn	ppm	5	0.5	1
B	ppm	10	0.7	1
Si	ppm	10	50	2
H_2O	%	0.2	0.05	0.477
Insol. in HCl	%	0.01	0.01	-
LOI	%	0.5	0.3	0.317
Based on assayed impurities		99.878	99.982	99.979
Including moisture LOI and insolubles		99.168	99.622	99.185

18.8 Analytical Quality Control

The Feasibility Study contains a detailed presentation of the quality control procedures adopted for analysis of the various plant streams emerging from the testwork program.

These analyses are complicated since the solutions have a high concentration of ions generating interference in the measurements with the analytical equipment. Only a selected amount of laboratories have the experience to analyse brines and those laboratories have been selected to do Orocobre´s quality control.

The samples from Salar de Olaroz were analysed by Alex Stewart Assayers [ASA] of Mendoza, Argentina, who have extensive experience analysing lithium bearing brines.
The Alex Stewart laboratory is accredited to ISO 9001 and operates according to Alex Stewart Group (AS) standards consistent with ISO 17025 methods at other laboratories.
Duplicate process samples were sent to:

- University of Antofagasta (UA), Chile

- ALS-Environment (ALS) laboratory located in Antofagasta, Chile, which is ISO 17025 and ISO 9001:2000 accredited

Both the University and the ALS laboratory, have a long history in brine analysis, however the university is not certified.

Physical parameters, such as pH, conductivity, density and total dissolved solids are determined directly upon brine subsamples. Determination of lithium, potassium, calcium, sodium and magnesium is achieved by fixed dilution of filtered samples and direct aspiration into atomic absorption or inductively coupled plasma analysis systems.

In summary,

- ASA analyses show acceptable accuracy and precision with an acceptable anion-cation balance.
- Check samples analysed at University of Salta display acceptable accuracy and precision, with a high degree of correlation with ASA analyses for K and Li. Mg is biased lower than corresponding analyses at ASA
- Check samples analysed at ALS Environment display acceptable accuracy and precision, with a high degree of correlation with ASA analyses, but the inorganic analytes (Li, K and Mg) are biased higher than corresponding analyses at ASA.
- Check samples analysed at University of Antofagasta display acceptable accuracy and precision, with a high degree of correlation with ASA analyses, but the inorganic analytes (Li, K and Mg) are also biased higher than corresponding analyses at ASA.
- The lower bias observed in the ALS and UA data is most likely due to calibration differences between the ICP and AA instruments used to analyse the samples.

The quality control systems are well designed and under continuous improvement in order to achieve adequate performance of the laboratories. Data analysis of the QA results produced by the laboratories is considered to have sufficient accuracy for the purposes for process design. The improved performance of the principal laboratory, ASA, as shown by the improvement in ionic balance over time and the reproducibility of the analytical results is noteworthy, and shows the benefit of a close working constructive relationship between the Company and laboratory.

Future refined quality control with newly designed standards has the objective to improve the accuracy of certain elements for the samples related to lithium carbonate production at pilot scale.

19. MINERAL RESOURCES AND MINERAL RESERVE ESTIMATES

19.1 Resource area, data density and resource category

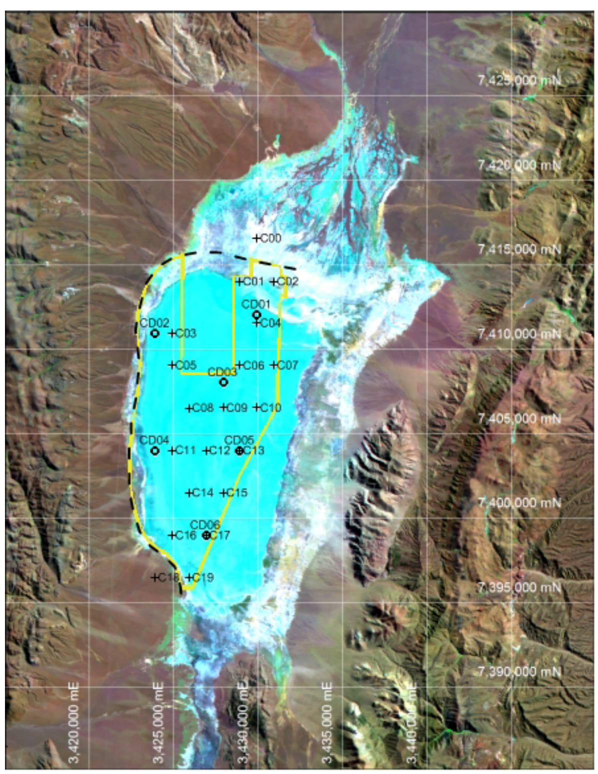
The area within which the resource has been estimated is given by the Orocobre claim boundaries within the salar (excluding small leases on the eastern and southern margins), and the 1.1 gm/cm^3 brine density contour for the upper 54 m, where this lies inside the claim boundary. The 1.1 gm/cm^3 brine density contour for the upper 54 m excludes some higher densities and concentrations in the lower layer (54-197 m), and thus the estimate is conservative. The resource is estimated with no additional cutoff since the 1.1 gm/cm^3 brine density is approximately equivalent to the following elemental concentrations:

Table 19.1 Approximate elemental concentrations at 1.1 gm/cm3 brine density.

	mg/L
Li	220
K	1,700
B	440

No internal cut-offs are allowed since the movement of brine through the aquifer precludes the possibility of excluding low grades from the brine pumped out of the wells.

Figure 19.1 Resource area, defined by claim boundaries (in yellow) and 1.1 gm/cm3 density contour where this lies inside the claim boundary. Also shown are the locations of the wells used in the resource analysis.



The well density in the upper 54 m of the aquifer is 1 per 4.7 km^2 (equivalent to a mean well spacing of 2.2 km), and mean downhole sample frequency is 2.5 m for brine chemistry and 2.8 m for porosity.

In the deeper part of the aquifer (54-200 m), well density is 15.5 km^2 (equivalent to a mean well spacing of 3.9 km), and mean downhole sample frequency is 6.9 m for brine chemistry and 7.1 m for porosity.

The Standing Committee on Reserve Definitions of the Canadian Institute of Mining and Metallurgy and Petroleum (CIM) adopted the following definitions on 11 December, 2005:

A 'Measured Mineral Resource' is that part of a Mineral Resource for which quantity, grade or quality, densities, shape, and physical characteristics are so well established that they can be estimated with confidence sufficient to allow the appropriate application of technical and economic parameters, to support production planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough to confirm both geological and grade continuity.

An 'Indicated Mineral Resource' is that part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics can be estimated with a level of confidence sufficient to allow the appropriate application of technical and economic parameters, to support mine planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough for geological and grade continuity to be reasonably assumed.

Consequently, in the opinion of the Qualified Person (John Houston) the resource estimate in the 0-54 m interval can categorized as "measured", whilst that in the 54-200 m interval can be categorized as "indicated".

19.2 Resource estimation methodology

The following methodology has been used to estimate the in-situ resource:

1. Assess the geology of the aquifer(s) and subdivide into seven correlatable Units (A-G) (see section 10),
2. Develop a non-linear regression relationship between the continuous N-Pt log, and sample determinations of P_t, P_e and S_y (see section 15.2),
3. Use this relationship to provide a continuous estimate of downhole S_y (see Appendix B)
4. Determine the average S_y for each Unit at each well from the derived S_y log,
5. Prepare point kriged maps of S_y for each Unit (see section 10),
6. Calculate the equivalent brine thickness for each Unit at each well as:

$$\textit{Equivalent brine thickness} = \textit{Unit thickness} * \textit{Unit } S_y$$

7. Determine the average depth weighted concentration of Li, K, and B for each Unit, at each well,
8. Prepare point kriged maps of concentration for Li, K, and B for each Unit (see section 11),
9. Determine the grade of each element, for each Unit, at each well as:

   *Grade = equivalent brine thickness * concentration*
10. Sum the grades for each Unit over the 0-54 and 54-200 m layer thicknesses, which are now expressed in kg/m^2 over the full 54 and 143 m thicknesses,
11. For each layer (ie. 0-54 m and 54-200 m) determine the variogram for each elemental grade (see discussion below),
12. Block krige each layer elemental grades using the estimated (linear) variogram,
13. Prepare maps of elemental grade distribution for each layer (see below),
14. Calculate volume under each grade surface for various grade values from 0-maximum,
15. Convert to tonnes, and produce grade-tonnage curves for each element (see below),
16. Calculate the standard deviation of the resource estimate, and provide a 95% probability estimate (Table 19.2).

19.3 Resource estimation

19.3.1 Discussion of the kriging process

Distribution maps of elemental concentrations (Figures 11.5-11.15) and specific yield (Figures 10.14 and 10.15) used linear variograms with point kriging techniques (Isaaks and Srivastava, 1989). The resulting data was not fed directly into the resource estimate; they were used as a means of identifying trends and patterns within the datasets.

For the resource estimation the raw data used were the grade values determined for each Unit, based on its elemental concentration and specific yield. Variograms were developed for each layer and elemental grade. The best fit variograms proved to be linear with a slight anisotropy, equal to 1.3 for 0-54 m and 2.0 for 54-197 m, at angles of 130^o and 115^o, respectively. This quantifies the visual appearance of a slight NE-SW trend in the data, stronger in the lower layer. Based on these variograms the data was block kriged, using a block size of 300 m square and the resulting grade distributions are considered below.

19.3.2 Grade distribution

Grade maps were prepared for each element (Li, K, B) and each layer (0-54 m, 54-197 m). Since the Unit concentration x specific yield data was summed for each layer, the resultant grades are in kg/m^2 over the layer thicknesses (54 m for the upper layer; 143 m for the lower layer).

Clearly, grade reflects the concentration and specific yield of each layer, with highest grades located in the center-east part of the upper 54 m of the salar, and the northeast and south parts of the lower 54-197 m of the salar. It is interesting to note that whilst highest grades occur in the upper layer, they peak relatively sharply compared with the lower layer, which has larger areas of moderately high grade.

Figure 19.2 Distribution maps of lithium grade (kg/m²) for 0-54 m (left), and 54-200 m (right).

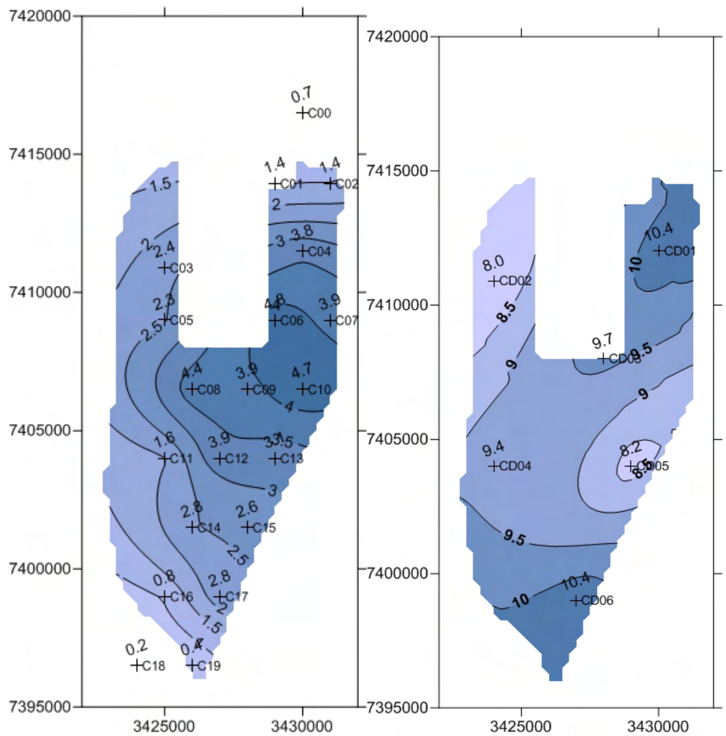


Figure 19.3 Distribution maps of potassium grade (kg/m²) for 0-54 m (left), and 54-200 m (right).

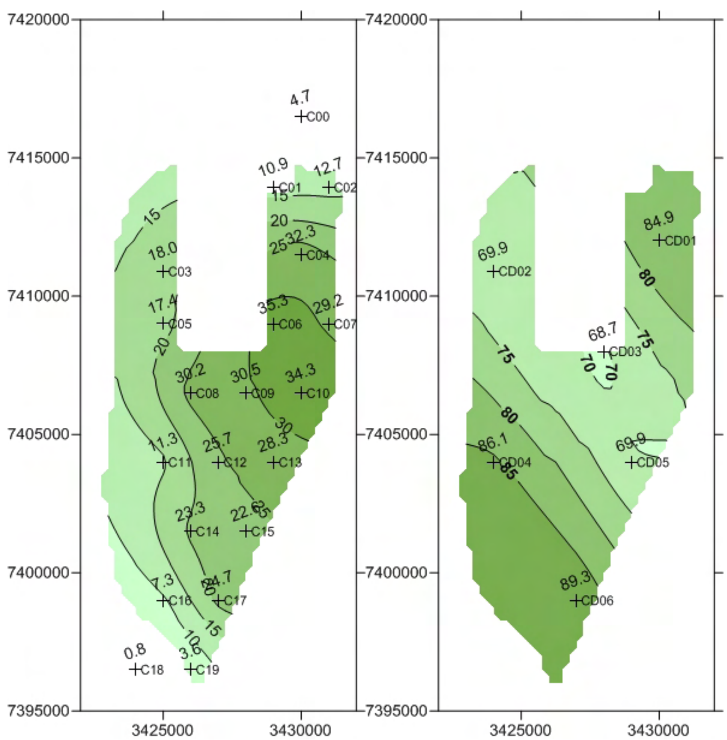
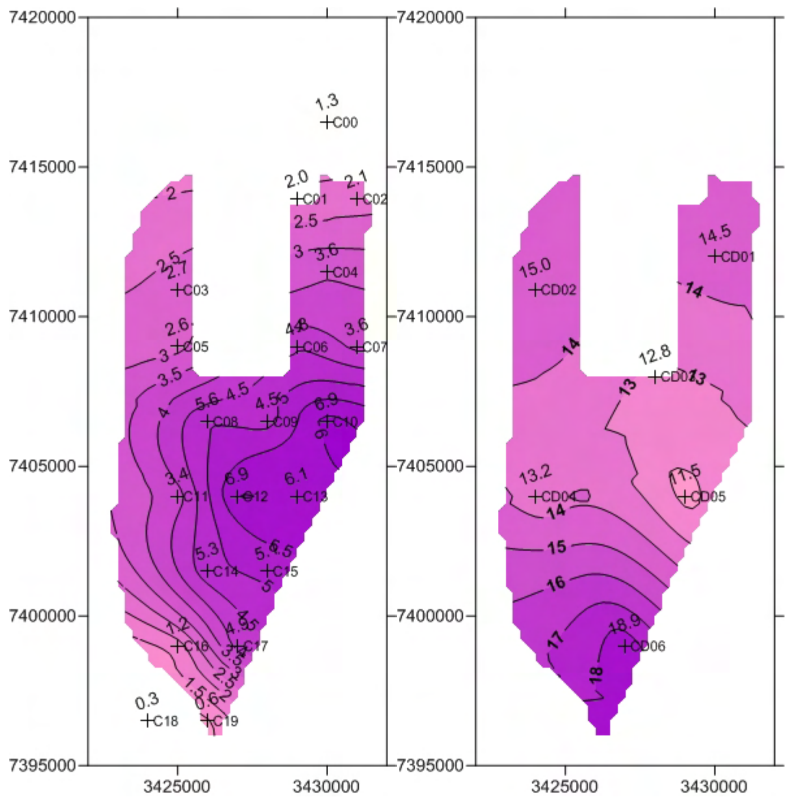


Figure 19.4 Distribution maps of boron grade (kg/m^2) for 0-54 m (left), and 54-200 m (right).



19.3.3 Resource estimate

The resource estimate was calculated as the volume under the grade contours. It should be noted that the resource is open everywhere at depth, and beyond the current cut-off boundary, particularly in Units F and G towards the north and south. The estimates below thus represent a conservative estimate of the resource.

Table 19.2 Measured and indicated resources for the Salar de Olaroz Project.

	Measured			Indicated			Total		
	Li	K	B	Li	K	B	Li	K	B
Aquifer area (km^2)*		93.03			93.03			93.03	
Aquifer thickness (m)**		54			143			197	
Aquifer volume (km^3)		5.02			13.30			18.33	
Mean specific yield		0.084			0.100			0.096	
Brine volume (km^3)		0.42			1.33			1.75	
Mean grade over aquifer thickness (kg/m^2)	2.87	22.4	4.20	10.1	86.2	15.70	8.13	68.7	12.5
Equivalent concentration (mg/l)***	632	4,930	927	708	6,030	1,100	690	5,730	1,050
Resource p<0.5 (million tonnes)	0.27	2.08	0.39	0.94	8.02	1.46	1.21	10.10	1.85
Resource p<0.05 (million tonnes)	0.23	1.71	0.32	0.87	7.33	1.37	1.10	9.04	1.70

* taken as claim boundary, or 1.1 gm/cm^3 density contour, whichever is smaller

** lower limit taken as lowest brine sample, resource open below

*** depends on specific yield at a location

all grade, concentration, specific yield figures rounded to 3 significant figures

resource figures rounded to 2 decimal points

19.3.4 Grade-tonnage estimates

Grade-tonnage curves have been prepared for each of the elements in both layers.

Figure 19.5 Grade-tonnage curves for lithium, 0-54 m (left), and 54-200 m (right).

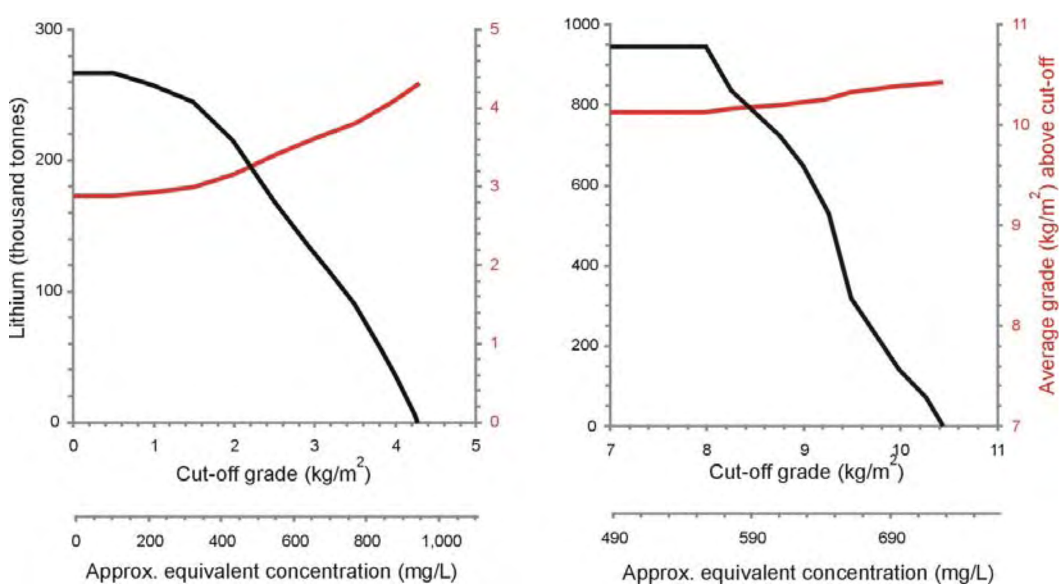


Figure 19.6 Grade-tonnage curves for potassium, 0-54 m (left), and 54-200 m (right).

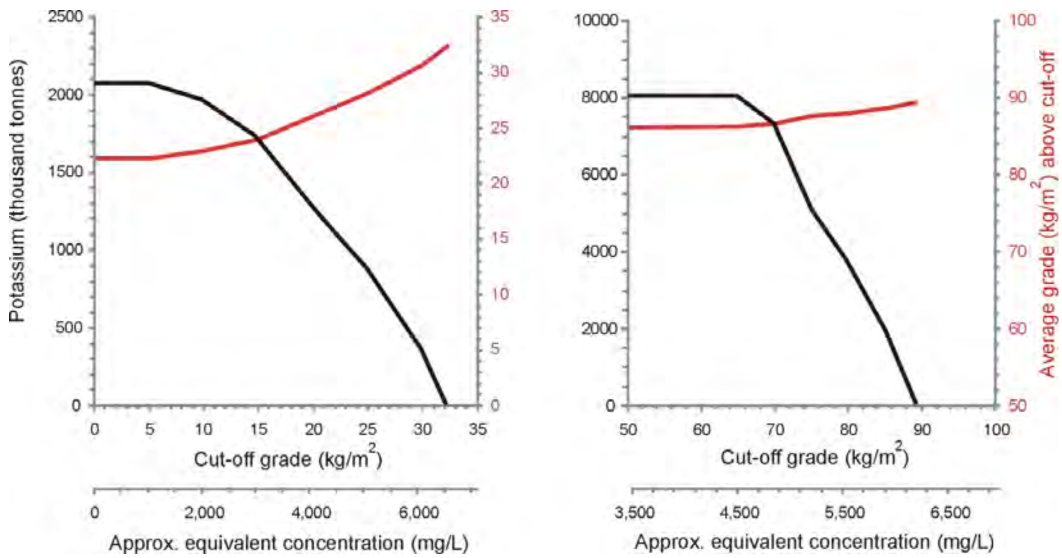
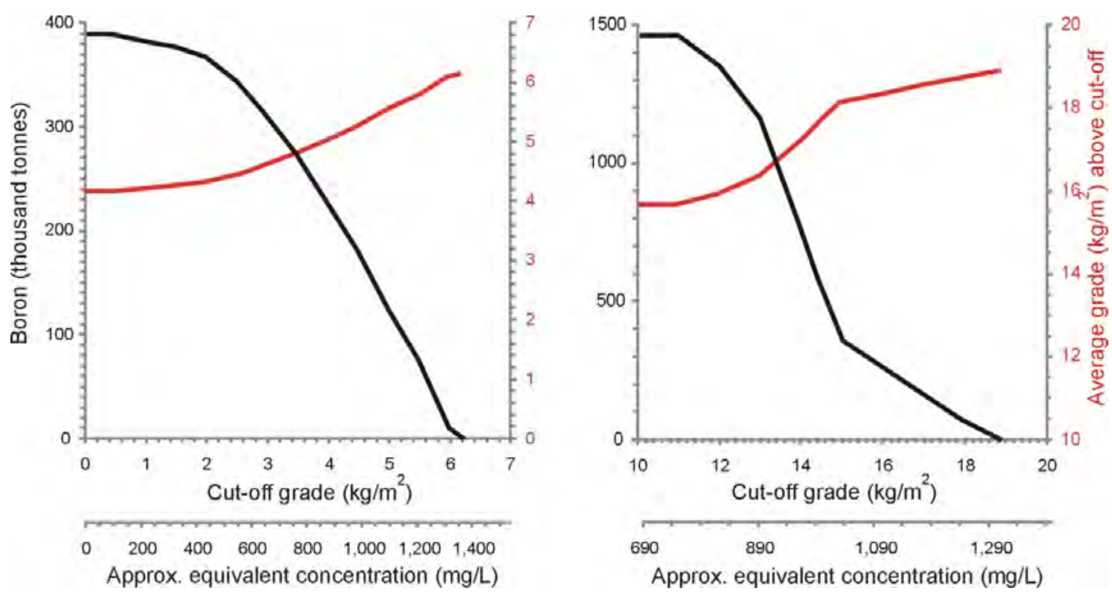


Figure 19.7 Grade-tonnage curves for boron, 0-54 m (left), and 54-200 m (right).



19.4 Resource recovery

As shown in Figures 19.2 through 19.4, the area of highest grade occurs in the center of the salar in the upper 54 m, but in the northeast and south in the lower 54-197 m. The design of the wellfield to access these higher grades, whilst at the same time minimizing any intrusion from dilute off-salar sources, will require optimization.

A finite-difference digital model is currently being prepared using the Seawat code, based on the well tried and tested Modflow, which allows variable density to be simulated in three dimensions. This is a complex process for a brine resource, especially when fluids with a significant density differential interact since they may be immiscible, and as far as we are aware has only ever been attempted at the Salar de Atacama previously. The model will be calibrated against known steady state conditions and once validated will be used to design and locate the optimal wellfield to maintain high grade brine feed to the solar ponds.

At this stage, wells will be designed to intercept the sites of both the upper and the lower high grades, thus allowing the initial brine feed to have a concentration approximately 12% higher than the average (Table 19.3).

Table 19.3 Estimated initial brine feed composition from a wellfield designed to extract from the known high grade locations.

Density (gm/cm^3)	SO4 (mg/L)	Cl (mg/L)	B (mg/L)	Ca (mg/L)	K (mg/L)	Li (mg/L)	Mg (mg/L)	Na (mg/L)
1.211	18,630	176,653	1,136	476	6,227	774	2,005	119,463

Some modifications to the general wellfield design may be expected once the model has been calibrated and run, but these are not expected to alter the capital cost estimates significantly.

The Feasibility Study undertaken by the Company and discussed in Section 20 considers a 40 year project life. This results in cumulative production of 650,000 tonnes of lithium carbonate. This production rate, allowing for process recovery, is less than 14% of the current measured and indicated resource.

Orocobre is advised that it is reasonable to consider a maximum recovery factor of one-third of the resource. Although some grade dilution is anticipated during the project life, it is realistic to expect a considerable extension to the 40 year life currently provided in the Feasibility Study.

The current brine production profile is based on the project's resource base. Estimates of ultimate extractable reserve can be made following the finite difference modeling of the resource currently being undertaken and calibrated with early operational data.

20. OTHER RELEVANT DATA AND INFORMATION

20.1 Introduction

The Company has recently completed a Feasibility Study on the Olaroz project. The study was based on the resource estimate discussed in Section 17, a process flowsheet and mass balance developed by Consulting Processing Engineer, Peter Ehren based on the process development work discussed in section 19, and engineering design and cost estimates produced by Sinclair Knight Merz with inputs from other independent specialist consultants and the Company

20.2 Production

Brine will be extracted by pumping from a wellfield in the center of the salar nucleus. The current design calls for a wellfield of twenty wells, spaced at 1 km intervals, with eighteen operational at any one time. Two standby wells take into account maintenance of pumps and wells. Each well will pump at 10 L/s, producing a total of 180 L/s. The wells will be drilled at 12” diameter to 200 m depth, and completed with well screen at 8” diameter surrounded by a gravel pack designed to increase well efficiency.

Wells will be sited so as to draw from the high grade brine in the nucleus. This allows the initial brine feed to be 12% above the average resource grade at approximately 770 mg/L Li. As the project progresses, the brine feed will become closer to the average grade and eventually dilute slightly further. Groundwater model studies are underway to predict more closely the optimum production profile.

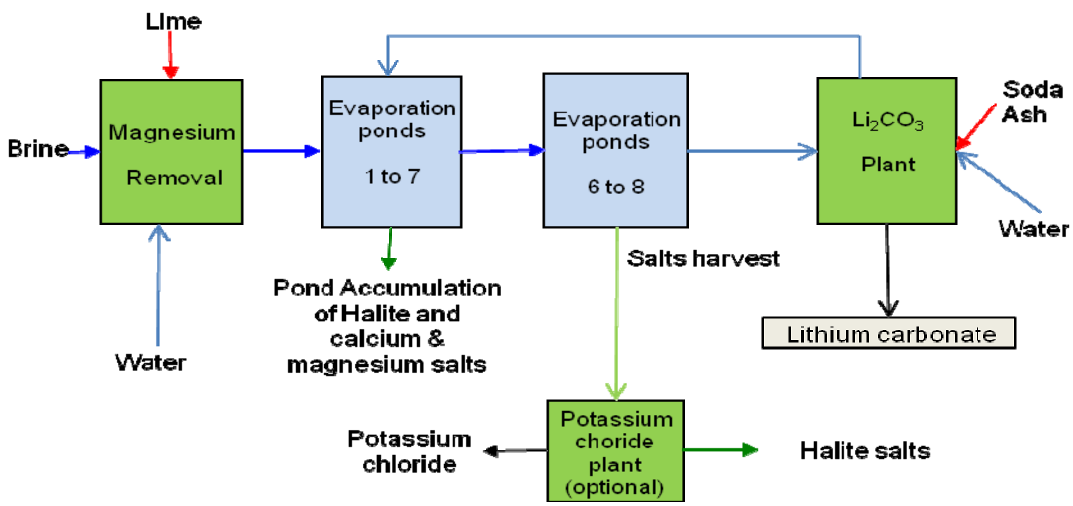
Based on the initial extraction rate and a lithium grade of 770 mg/L lithium carbonate production is forecast at 16,400 tonnes of lithium carbonate each year reflecting a 74% recovery of lithium from the brine feed to the process to the battery grade lithium carbonate product.

20.2 Process Flowsheet

20.2.1 Overview

Brine will be pumped from the salar bore field into collector ponds, the first stages of the solar evaporation ponds located on the south-west margin of the salar and feeding the liming process. The general sequence of the process stages from this point is shown in Figure 20.1.

Figure 20.1 Summary process flowsheet



Initially four process alternatives were simulated for the lime addition and provide a baseline approach for the ongoing process development testwork. Taking into account the initial evaporation test data and climate data the main process alternatives were reduced to:

1. Lime addition directly to the well brine
2. Lime addition after initial evaporation

The Feasibility Study has considered both options. Further analysis is planned by the Company. More than 98.8% of the impurity salts have been removed at this stage following approximately ten times concentration of the lithium. Effectively all of the 14,850 m^3/day pumped from the wellfield is evaporated in the solar ponds.

The sequence of processing post evaporation ponds is briefly described below. The brine feed to the lithium carbonate process plant is limited to around 0.7%, as at higher concentrations losses are incurred by the formation of solid lithium schoenite ($Li_2SO_4.K_2SO_4$). In the lithium carbonate plant, remaining impurities are removed in a number of extraction stages and lithium carbonate is precipitated first, as a lower purity product and second, following repurification, as a battery grade product. This is then dried and micronized prior to packing for shipment.

The Feasibility Study base case does not address the production of boron, but the production of 10,000 tonnes per annum of potash (KCl) is considered as an option. Further process development work is underway to optimise conditions of potash recovery at which stage the plant can be properly designed and costed.

The key aspect of the process is the rejection of the various impurities. These are removed as follows:

- Magnesium is largely rejected as its solid hydroxide [$Mg(OH)_2$] in the liming process using calcium hydroxide [$Ca(OH)_2$] with collateral gypsum formation [$CaSO_4.2H_20$]
- The bulk of the potassium and sodium salts are crystallised out by evaporation as their chloride salts early in the evaporation process and as their sulphate salts later in the evaporation process. The boron is precipitated by the relatively high pH (9 - 11) as tetra-borate [$Na_2B_4O_7$ and CaB_4O_7]. This could be enhanced by addition of calcium chloride.
- The remaining calcium, magnesium, boron and other elements are removed from the concentrated brine in the lithium carbonate plant. The conventional process involves the removal of boron by solvent extraction followed by the removal of trace magnesium and calcium by the addition of soda ash. This is then followed by the precipitation of lithium carbonate with soda ash at elevated temperature followed by washing to achieve a technical grade product. To remove the trace impurities and achieve battery grade purity the technical grade lithium carbonate can be selectively dissolved with carbon dioxide to enable filtration removal of all remaining calcium and magnesium solids prior to reprecipitation. Scavenging of trace contaminants occurs by a sequence of ion exchange stages. A proprietary process using these techniques has been developed for the Olaroz project following rigorous test work.

20.2.2 Liming Process

The brine received from the wells is fed to the Magnesium Removal Plant where magnesium is precipitated with slaked lime ("liming"). A high grade lime (83% CaO) will be used for this process. The Olaroz brine contains sufficient sulphate to take up the calcium added as lime, and the addition of sodium sulphate is not required.

The magnesium is precipitated from the brine according to the following reaction:

$$Mg^{2+} + Ca(OH)_2 \rightarrow Mg(OH)_2 \text{ (solid)} + Ca^{2+}$$

The calcium will precipitate with the sulphate ions in the brine, forming gypsum:

$$Ca^{2+} + SO_4^{2-} \rightarrow CaSO_4.2H_20 \text{ (solid)}$$

The resultant magnesium hydroxide / calcium sulphate sludge is pumped to the first stage evaporation ponds.

Lime can be purchased from a lime plant in Jujuy as burnt lime and slaked to milk of lime or calcium hydroxide on site.

20.2.3 Evaporation Ponds

After the magnesium removal the brine is concentrated in solar evaporation ponds, where principally halite crystallizes together with some glauber salt [$Na_2SO_4.10H_20$] and gypsum [$CaSO_4.2H_20$]. The quantity of glauber salt crystallization depends on the ambient temperature. When further concentrated the brine saturates in glaserite ($Na_2SO_4.3K_2SO_4$) and finally the brine saturates in silvite (KCl). When the brine is concentrated to the optimal lithium concentration, it is ready for feeding to the lithium carbonate plant.

20.2.3 Boric Acid Plant

At some point in the concentration process boron can be recovered, and initial test work using solvent extraction techniques has been successful. There is potential for boric acid production with further process development. The Boric Acid plant was excluded from the Feasibility Study as the process definition is at a preliminary stage.

20.2.4 Potassium Chloride Plant

The salts from the more concentrated ponds can be harvested and fed to the Potassium Chloride Plant. The salts are milled in order to liberate the silvite, then a KCL concentrate is recovered by froth flotation, washed with water, filtered and dried.

This plant is a part of the Feasibility Study but as the production rate has not been optimised, the capital cost estimate was undertaken at a +/- 35% level of accuracy. As the KCl plant is not required until 2 years after first lithium carbonate production, there is adequate time to optimise the process flow sheet and plant scope.

20.2.5 Lithium Carbonate Plant

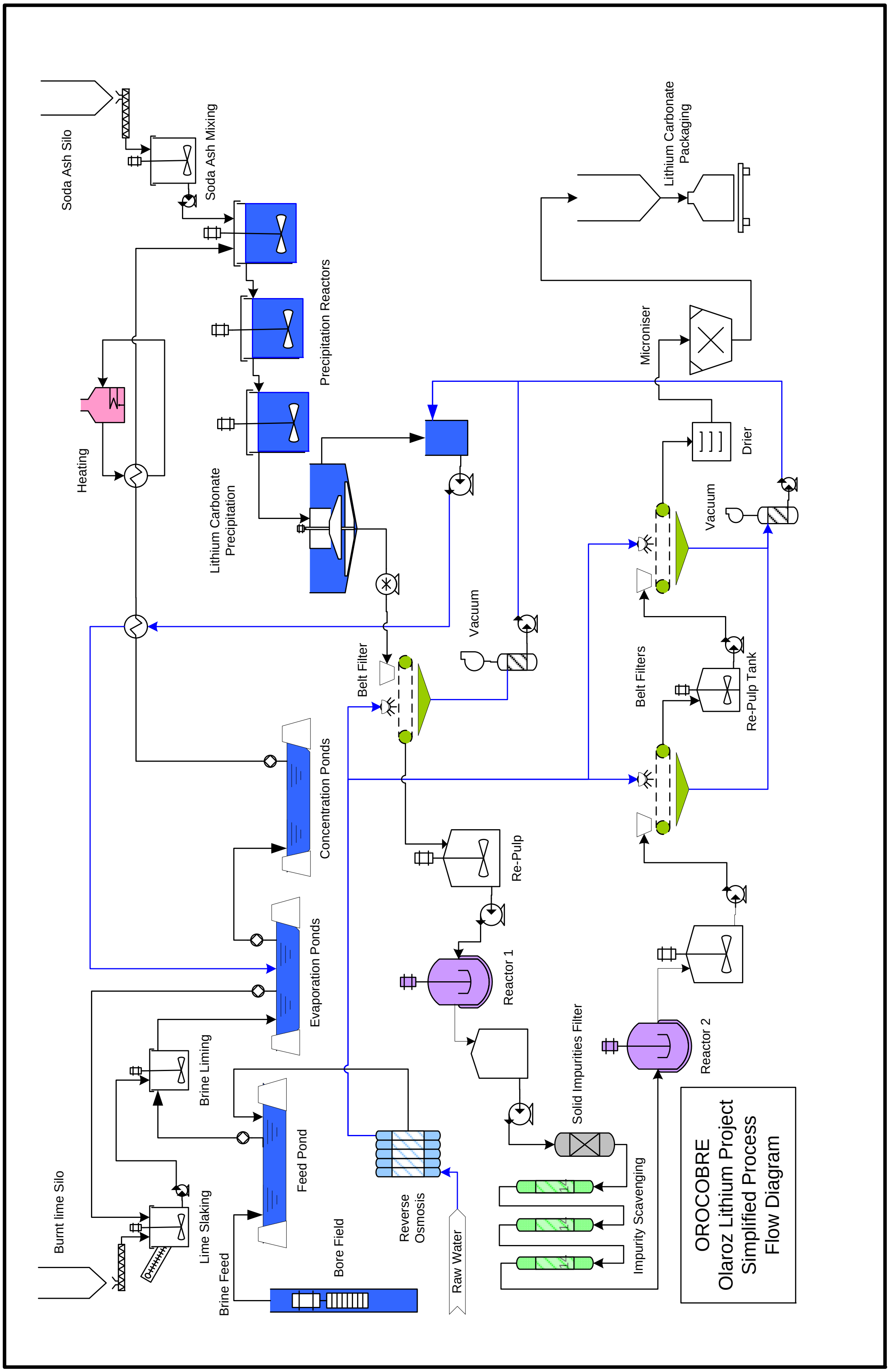
The lithium in the brine is concentrated up by solar evaporation to the selected level in the final evaporation ponds. The low solubility of lithium carbonate allows the precipitation of solid lithium carbonate from the lithium in plant brine feed. Lithium carbonate is precipitated with the addition of soda ash at elevated temperatures, and subsequently purified by a re-crystallization process.

Several purifications steps are required in order to remove the boron, calcium and magnesium remaining post the evaporation ponds in order to meet battery grade market specifications. The final lithium carbonate product of battery grade purity will be washed with purified water in a number of filtration stages, and the product is then dried in a gas fired kiln, micronized and packed for shipment.

The mother liquor or spent brine from the lithium carbonate recovery process contains a significant amount of lithium and therefore is recycled to the evaporation pond system.

Soda ash is a globally traded commodity, and pricing has been based on shipments landed in Antofagasta in Chile from Wyoming USA.

Figure 20.2 Detailed process flowsheet



20.3 Plant and Project Engineering

Sinclair Knight Merz undertook the engineering design based on the process flow sheet and mass balance provided by Consulting Processing Engineer, Peter Ehren. The engineering scope is defined in the following summary.

Brine Extraction Wells
The brine will be extracted with borehole pumps that discharge to the collector ponds from where the brine is pumped to the brine reservoir pond adjacent to the Liming Plant.

Liming Plant
This plant prepares slaked lime which is used to precipitate the magnesium from the extracted brine feeding the evaporation ponds. The slaked lime is prepared in a package slaking plant.

The slaked lime is contacted with the brine from the feed pond, precipitating gypsum and magnesium hydroxide. The resulting slurry is transferred to the solar evaporation ponds.

Solar Evaporation Ponds
The brine is concentrated in the solar evaporation ponds until the desired lithium concentration is obtained. During the evaporation process different salts are precipitated in the sequence of ponds. In the final ponds the brine will have a concentration of about 0.7% of lithium which is pumped to the Lithium Carbonate plant.

KCl Plant (option for 10,000 tpa production)
The purpose of this plant is to produce a potash product by flotation of a potash concentrate [KCl or silvite] from the mixed salts, mainly glaserite [$Na_2SO_4.3K_2SO_4$] obtained in the solar evaporation process. The potash process has four stages:

- KCl liberation (by milling)
- KCl concentration (by froth flotation)
- Solid – liquid separation (with centrifuges)
- Drying

This plant was designed by SKM but not included for the base case capital and operating cost estimates.

Lithium Carbonate Plant (16,400tpa production rate)
The purpose of this plant is to precipitate lithium carbonate from the lithium concentrated in the brine by the addition of concentrated sodium carbonate [soda ash Na_2CO_3] at elevated temperature. The process consists of the following stages:

- Lithium carbonate precipitation by soda ash prepared in a package mix plant
- Solid-liquid separation and washing (by thickener with underflow to a vacuum belt washing filter)
- Heat recovery from the mother liquor before recycling to the evaporation ponds

Final lithium carbonate purification is accomplished by:

- Re-dissolution of the lithium carbonate by carbon dioxide, and removal by filtration of insoluble residual solids [$MgCO_3$ and $CaSO_4$], followed by re-precipitation. Washing of the product on a vacuum filter, kiln drying, micronising and packaging

Removal of the remaining calcium, magnesium, boron and any traces of other deleterious elements occurs at various stages using a proprietary process route.

Utilities

The following utilities were incorporated into the project design:

- Power supply: by onsite gas fuelled generation
- Gas supply: Nntural gas is delivered by a 40 km pipe line from the existing Gas Atacama main line [by Orocobre].
- Water supply: includes water bores, pumping and water pipeline to water reservoir located near the process plant. Washing and dilution water for the lithium carbonate plant is purified by reverse osmosis.
- Fuel supply: the fuel supply system includes fuel tanks and a vehicle refuelling station.
- Compressed air: the process plant is provided with general utility and instrument quality compressed air.

Infrastructure

The following facilities were included in the SKM preliminary engineering and project design:

- Operation and administration offices, including s first aid room.
- Canteen
- Operation camp, including a change house.
- Operational and quality control laboratory, including a chemical warehouse and weather station.
- Maintenance workshops fitted out for mechanical, electrical and instrumentation requirements.
- Warehouse
- Internal roads for access to the process plant, maintenance facilities and general infrastructure.
- Site access checkpoint cabin and truck weigh station.
- Waste disposal
- Design of the operating plant considered areas for the disposal of domestic garbage, hazardous waste and material/equipment lay down areas.

20.4 Capital Costs

The capital cost estimate compiled by SKM has been built up from detailed definition of process plant civil works, mechanical, electrical and instrumentation equipment, materials supply for fit out and, within each of these line items, includes the costs for construction labour, equipment and materials requirements. The cost estimate is to an accuracy of +/- 15% except for the potash plant which is to an accuracy of +/- 35% as discussed in section 20.2.4

The major earthworks required for the evaporation ponds have been costed based on owner purchase and operating of the construction equipment fleet. The estimate in Table 20.1 is broken down into equipment and materials supply, construction and erection, and construction distributables. The latter category captures the costs that will be incurred within various contracts that are not covered by the contract quotations, and partly are corrections due to the work scope after the contract submissions.

Table 20.1 Capital cost estimate

DIRECT COSTS		US$million
PROCUREMENT		
Equipment Supply	3.4	
Materials Supply	3.7	7.1
CONSTRUCTION & ERECTION		
Labor	16.0	
Equipment	16.8	
Materials	6.9	39.7
CONSTRUCTION DISTRIBUTABLES		15.0
TOTAL DIRECT COSTS		125.7
DIRECT MAN HOURS	hours	1.2
INDIRECT COSTS		US$million
EPCM		22.6
Other indirect costs		6.1
Third party services		12.2
Owner's costs		17.9
TOTAL INDIRECT COST		58.8
CONTINGENCY		22.1
TOTAL INVESTMENT		206.7

The capital cost estimate has also been arranged on a Work Breakdown Structure with costs shown by project area in Table 20.2 below.

Indirect Costs are predominantly EPCM costs, consisting of engineering, procurement, commissioning and project management staff, IT and office services and travel. The EPCM estimate is 18% of the direct costs, which is regarded as conservative in the context of other projects of similar size. 'Other Indirect Costs' allow for items such as freight, customs duty and spares. A generous 'Third Party Services' allowance for facilities on site and general services for third parties has been developed and included in Indirect Costs.

Owner's costs are dominantly the working capital required to recruit and sustain staffing during design and construction, and for ongoing testwork and general overheads.

Table 20.2 Capital cost estimate for 16,400 tpa lithium carbonate production

Direct Costs		**US$million**
	Brine Production Wells and Pipelines	7.1
	Evaporation Ponds	38.0
	Processing Plant	26.5
	Utilities (Power Station, Gas, Water, Communication)	27.3
	Infrastructure	11.9
	Contrators Distributables	15.0
	Sub-Total Indirect Costs	**125.7**
Indirect Costs		**US$million**
	EPCM	22.6
	Third Party Services including freight, construction camp, catering etc	18.3
	Owners Costs to Production	17.9
	Sub-Total Direct Costs	**58.8**
Total Capital		**184.5**
Contingency		22.1
Total Capital including Contingency		**206.7**
Potash Plant Option		14.5

A further US$48m of capital expenditure, additional to that tabulated above, is allowed over the currently modelled project life. This allows for mobile equipment replacement, sustaining capital in the lithium carbonate plant and for new ponds.

The capital cost estimates are currently being reviewed by a major South American based construction company. Preliminary advice is that capital costs may be reduced by further optimisation in design, and through alternative implementation methodology. Reporting of this work is expected to be available during the current quarter, Q2 2011.

20.5 Operating Costs

Operating costs have been estimated by Sinclair Knight Merz taking into account local cost inputs from the Company's project personnel (Table 20.3).

Table 20.3 Operating cost estimate

		US$million per annum	US$ per tonne Lithium Carbonate
Fixed Costs			
	Personnel Charges	5.8	352
	Other	2.4	147
Variable Costs			
	Supplies and Reagents	15.8	964
	Energy	1.5	90
	Materials Handling	0.6	38
Total Operating Costs		**26.1**	**1,591**
Incremental cost for Potash Option		0.0	1
Incremental benefit from Potash Option		5.9	361
Total Net Operating Cost		**20.2**	**1,230**

At the forecast 16,400 tonnes per annum production rate, the operating cost is estimated at US$1,512 per tonne of battery grade lithium carbonate. This unit cost includes the additional costs associated with producing 100% battery grade production from the plant. Considering the option of production of 10,000 tonnes per annum of potash two years after initial lithium carbonate production and using the average forecast price of US$592 per tonne, the operating cost decreases to US$1230 per tonne of lithium carbonate.

Personnel charges include salaries US$5.2million, and $0.3m in associated costs such as personnel transport, work clothes, personnel protective equipments, training and medicals (Table 20.4).

Table 20.4 Personnel strength under operating conditions

Personnel per Area in the Olaroz Camp	
Production	49
Maintenance	15
Safety & Environment	8
Quality Assurance	18
Process & Engineering	5
Total	**95**
Personnel per Area in Jujuy city	
Administration	6
Logistics	4
Management	12
Total	**22**

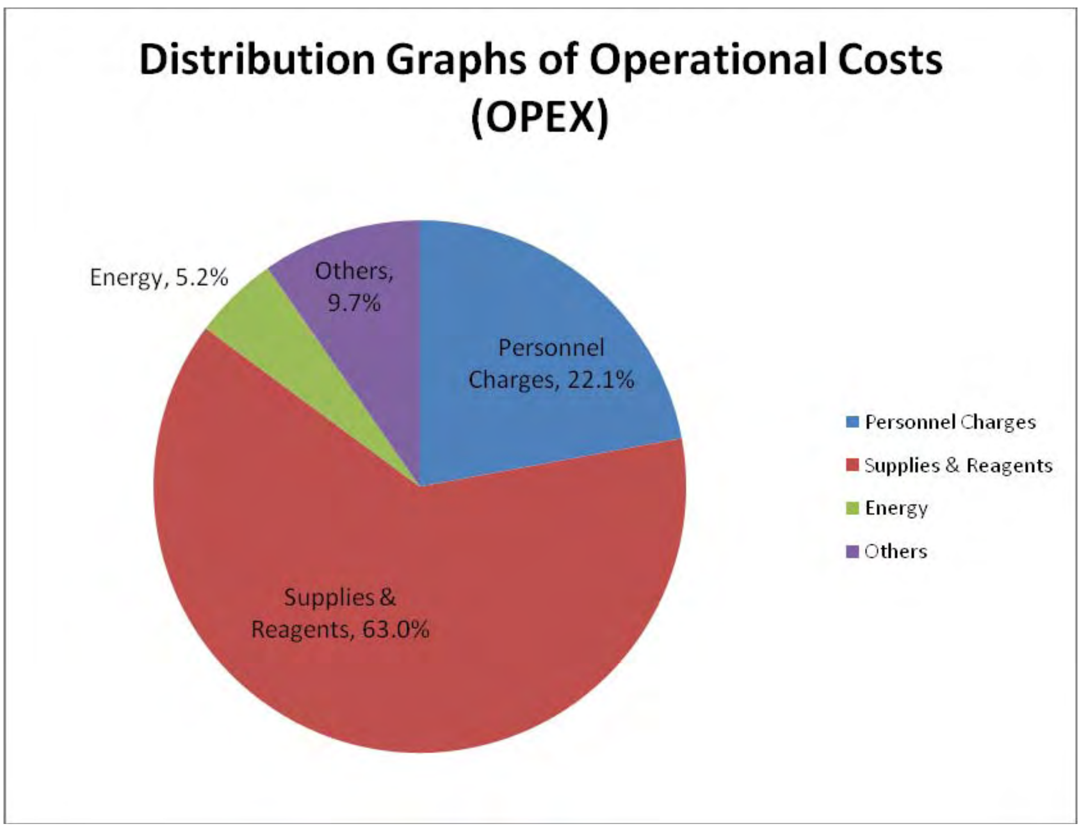
Supplies and reagents include raw and processed water, lime, sulphuric acid, treated water, soda ash, caustic soda [NaOH 50%], additives, propane and gas. These are included in the cost schedules in the financial analysis. Quantities of major consumables are shown in Tables 20.5 and Figure 20.3 below.

Table 20.5 Major consumables

Consumable	Tonnes per annum
Lime	39,138
Soda Ash	30,068
Purified Water	98,857
Water	308,964

Electrical energy consumption has been calculated from equipment operating requirements of 39.66 MW/day and for gas consumption of 10.997Nm3/day, resulting in a total energy cost of US$1,284,607 per year.

Figure 20.3 Distribution of operational costs



20.6 Lithium Carbonate and Potash Markets

As part of the Feasibility Study, Roskill Consulting Group Ltd ("Roskill") of London, United Kingdom was contracted to provide independent advice on the lithium and potash markets and future price forecasts. The Roskill future price forecast is a required economic input under the agreement with Toyota Tsusho Corporation.

Roskill advises that between 2000 and 2010 lithium demand increased at a 5.8% annual growth rate with demand associated with lithium ion batteries growing at 21.6%. Total demand in 2010 was 116,000 tonnes lithium carbonate equivalent (LCE) of which battery related demand was 25,100 tonnes.

Roskill has provided Orocobre with a forecast of annual high, low and average price forecasts for lithium carbonate and potash for years 2011 to 2025. The average price forecast for battery grade lithium carbonate is US$6160 per tonne and US$592 per tonne for Potash.

In its base case scenario, Roskill forecast overall demand for lithium to increase by 6.3% per annum from 2010 and to reach 215,150 tonnes LCE in 2020. The highest growth is forecast to come from lithium-ion batteries, a segment that is forecast to grow at 13.1% per annum.

In its best case scenario, where GDP growth and industrial output in both mature and emerging economies increases faster than is forecast and lithium-ion battery technology for automotive use and smart grid systems (largely renewable energy back-up storage) is adopted faster than expected, demand for lithium could increase by 8.0% per annum to reach 264,460 tonnes LCE in 2020.

In Roskill's worst case scenario, where global economic growth is slower than expected and electric vehicles do not penetrate the automotive market as fast as is forecast, demand for lithium might grow at only 4.3% per annum to reach 176,040 tonnes LCE in 2020.

Global potash consumption has been rising over the last decade from 42.3 million tonnes KCl in 2000 to 50 million tonnes KCl in 2010. Potash consumption is predicted by Roskill to continue to rise to 54 million tonnes KCl in 2011 which represents a strong rebound after the global economic downturn partly due to restocking of the supply chain. Potash consumption is strongly linked to food production.

20.7 Financial Analysis

20.7.1 Introduction

An economic analysis has been undertaken using a model jointly developed by the Company and a local Argentine consultant. The analysis does not consider cost inflation, and assumes a constant exchange rate of US$1 = ARG$4. The analysis is based on the measured and indicated resources of the Company described in this announcement.

Mineral resources that are not mineral reserves do not have demonstrated economic viability.

20.7.2 Inputs

The Feasibility Study considers a 40 year project life. This results in cumulative production of 650,000 tonnes of lithium carbonate. This production rate, allowing for process recovery, is less than 14% of the current measured and indicated resource.

Capital and Operating costs are as discussed in sections 20.4 and 20.5. Revenue forecast are based on Roskill's forecasts discussed in section 20.6

The economic analysis includes the various investment provisions as allowed under the Argentina Mining Code including accelerated depreciation. No allowance is made for capital already expended on exploration although the amount spent since the company was registered under the mining law may be depreciated. Similarly, no allowance is made to for the recovery of past VAT expensed or carrid forward losses.

The model includes the following royalties and applicable taxes.

- Corporate Tax – 35%
- Royalties payable to the province – 3%
- Export Duties (Retentions) – 5%
- Bank transaction tax – 1.2%
- Import duty – 1%

There is potential to recoup 50% of the Export Duty (Retention) and there are other allowances available for operating in the Puna region. No allowance is made for these in the current model.

20.7.2 Cashflows

Tables 20.6 and 20.7 present simplified cashflows for the lithium only option and with 10,000 tonnes per annum potash.

Table 20.6 Olaroz Project cashflow summarized for 16,400 tpa lithium carbonate production

	Year 0 US$million	Year 1 US$million	Year 2 US$million	Year 3 US$million	Year 4 US$million	Year 5 US$million	Year 6-10 US$million	Years 11-20 US$million	Year 21-40 US$million
Sales Revenues		61.4	94.3	92.3	96.4	98.0	104.6	116.1	116.9
Royalties, Export Duties, Transaction Tax		-5.0	-7.8	-7.6	-8.0	-8.1	-8.7	-9.8	-9.8
Operating Costs		-17.1	-24.7	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8
Corporate Tax		0.0	0.0	0.0	-0.8	-22.3	-24.0	-27.1	-28.1
Capital Costs	-165.3	-41.3	0.0	0.0	0.0	-0.3	-1.4	-3.3	-0.4
Cashflow (after tax)	-165.3	-2.1	61.8	59.9	62.8	42.5	45.6	51.1	53.8

Table 20.7 Olaroz project cashflow summarized for 16,400 tpa lithium carbonate production plus 10,000 tpa potash production

	0.00 US$million	Year 1 US$million	Year 2 US$million	Year 3 US$million	Year 4 US$million	Year 5 US$million	Year 6-10 US$million	Years 11-20 US$million	Year 21-40 US$million
Sales Revenues		61.4	94.3	97.7	101.9	103.7	110.9	123.4	124.2
Royalties, Export Duties, Transaction Tax		-5.0	-7.7	-8.0	-8.4	-8.6	-9.3	-10.4	-10.5
Operating Costs		-17.1	-26.0	-26.1	-26.1	-26.1	-26.1	-26.1	-26.1
Corporate Tax		0.0	0.0	0.0	0.0	-21.4	-25.6	-29.0	-29.9
Capital Costs	-165.3	-41.3	-14.5	0.0	0.0	-0.3	-1.4	-3.3	-0.4
Cashflow (after tax)	-165.3	-2.1	46.0	63.5	67.4	47.3	48.5	54.6	57.3

20.7.3 Discounted Cashflow Analysis

Under the base case, lithium carbonate only development, modelled with the annual average prices forecast by Roskill and the 2025 price thereafter, the internal rate of the return is 26% on an un-geared, after tax basis and 52% using the 60% debt to equity ratio contemplated in the agreement with Toyota Tsusho. Net Present Value (NPV) at a 7.5% discount rate is calculated at US$415 million un-geared and US$449 million geared (Table 20.8). Allowing for the option of potash production, the internal rate of return increases to 27% after tax, and un-geared, and 56% on a geared basis (Table 20.8).

Table 20.8 Economic model results

		Lithium Carbonate only	With Potash by product
Production Rate	TPA	16400	10000
Capital Cost	US$million	207	221
Payback	Years	3.4	3.4
Cash Opertating Cost	US$/t Li_2CO_3	1591	1230
After Tax Net Present value (7.5%) - un-geared	US$million	415	449
After Tax Internal Rate of Return ungeared	%	26	27
After Tax Net Present value (7.5%) 60% gearing	US$million	449	489
After Tax Internal Rate of Return 60% gearing	%	52	56
Modeled Project Life	Years	40	40

Table 20.9 shows the sensitivity of Net Present Value at differing discount rates.

Table 20.9 Analysis of NPV, after tax, at different discount rates

	Un-Geared (US$million)	Geared (US$million)
0.0%	1902	1903
5.0%	652	678
7.5%	415	449
10.0%	273	314
15.0%	121	172

The 0% NPV is equivalent to the cumulative after tax cash flow over the modelled 40 years.

20.7.4 Sensitivity Analyses

The sensitivities for both IRR% and NPV to a range of key inputs into the financial analysis are shown below in Figures 20.4 and 20.5. This is for the lithium carbonate only option.

Figure 20.4 Project IRR% Sensitivity

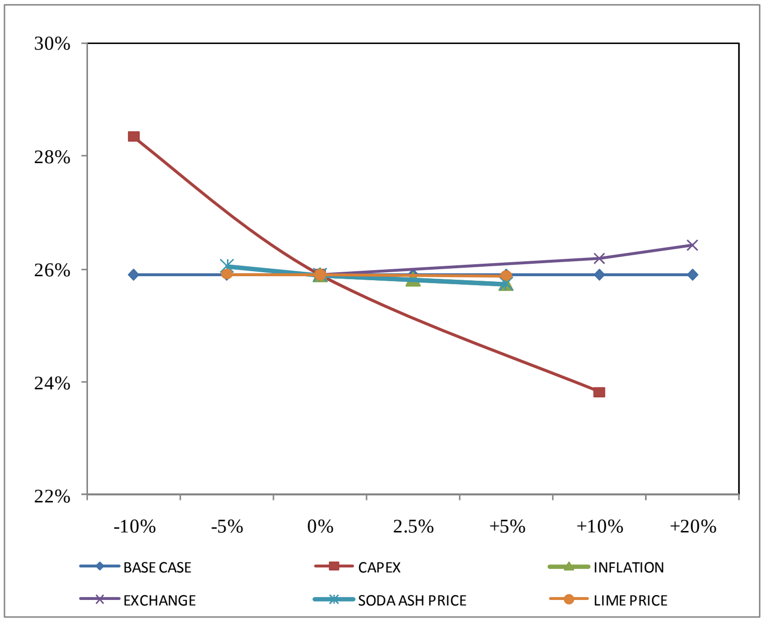
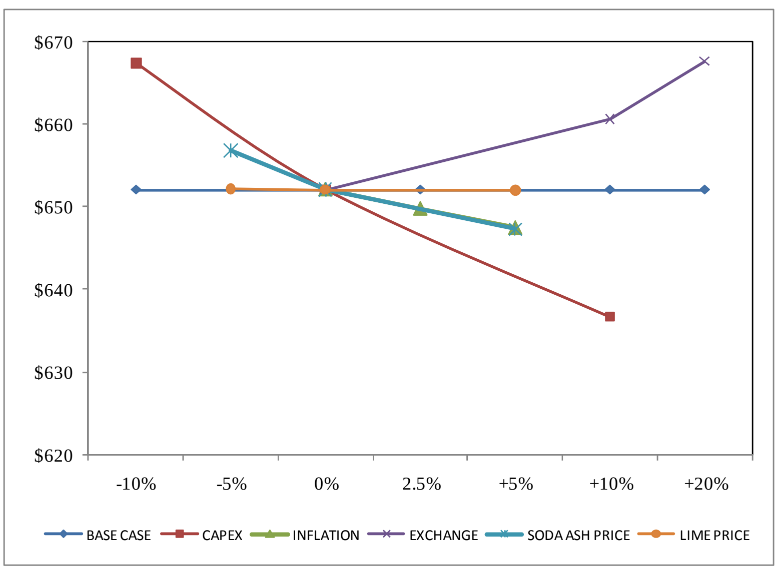


Figure 20.5 Project NPV Sensitivity



20.8 Environmental Impact Statement and Secondary Approvals Process

At the end of 2010, the Company received approval from the Jujuy provincial government of the Environmental Impact Statement for the development and exploitation of its Salar de Olaroz lithium-potash project.

The approval by the Provincial Director on Mines and Energy Resources was received following the recommendation by the Unit of Mining Environmental Management (UGAMP) in November, 2010. UGAMP is a body comprised of twelve members representing various government departments, stakeholder groups and local communities. As part of the approval, the Company is obliged to comply with various monitoring obligations, provide additional information on its planned construction works as the project design is finalised, and keep the local communities informed about its activities. The Company has recently provided the additional materials requested in compliance with the EIS approval as part of an addenda containing further information that was developed since the submission of the original EIS. The Company has entered into an access and compensation agreement with the local indigenous community also.

On 4 March 2011, the provincial government of Jujuy issued a decree that declared lithium a strategic mineral resource and introduced a secondary approvals process for lithium projects in Jujuy Province. In addition to an EIS approval, exploration and exploitation level projects now require assessment by a Committee of Experts and following a positive recommendation from this Committee, approval by the joint resolution of the Minister of Production and the Secretary General of the Provincial Government. Since the announcement was made, the relevant committee has been established but has yet to commence deliberations.

20.9 Toyota Tsusho Corporation Agreement and Timing

Under the terms of the agreement with Toyota Tsusho, in order to purchase its 25% equity interest in the Olaroz Project, Toyota Tsusho is obliged to arrange government guaranteed debt finance. The authors are advised that with the impending completion of the Feasibility, the Company has been working closely with Toyota Tsusho and the relevant Japanese banking and government departments regarding the financing and associated due diligence processes. Based on these discussions, the authors are advised that it is expected that the financing process will take approximately nine 9 months including final documentation. Joint venture agreement negotiations with Toyota Tsusho will be undertaken concurrently. Earlier conditional approvals are likely which will facilitate earlier project development subject to provincial government approvals.

Detailed engineering will be undertaken and engineering design and construction contractors will be selected during the same period together with order of long-lead time items. Bore field development will be undertaken once provincial government and conditional finance approvals have been received. The construction period for the project is estimated at 15 months.

21. INTERPRETATION AND CONCLUSIONS

The philosophy behind the investigation program has been to ensure that all samples were truly representative of in-situ conditions, and the results were repeatable. A great deal of attention has been applied to the field sampling program since very few, if any immature clastic salars have been previously investigated in the Altiplano-Puna, and they are rather different to the mature halite salars that are already under development in the region. Sonic drilling, whilst slow, was perceived as the best technique for acquiring the majority of undisturbed samples with a high recovery rate. Triple tube diamond drilling was used as the next best method for drilling at depths up to 200 m. Core samples retrieved at the surface must be effectively undisturbed for porosity measurement. Brine samples must be representative of the depth at which they were sampled and not contaminated with over or underlying formation fluids. Furthermore, laboratory analyses of porosity and brine chemistry must be reliable and repeatable. These objectives have been demonstrably met as shown by a number of experiments and tests described in this Technical Report.

A geological model of the basin and host aquifer has been developed that shows the Salar de Olaroz is underlain by a deep basin (gravity data suggests up to 1.2 km deep) bounded by a pair of N-S reverse faults that thrust Cretaceous and Ordovician basement rocks over the basin margins. The basin is infilled with Cenozoic sediments. Pliocene to Recent sediments form a multilayered aquifer that acts as a host to the brine that has probably taken many tens of thousands of years to develop. Drilling has demonstrated that the aquifer is present to depths of 200 m, and is probably significantly deeper. The brine contains elevated levels of dissolved elements in solution that are of economic interest: lithium, potassium and boron.

The aquifer may be subdivided into seven lithostratigraphic units that can be correlated throughout the basin. Within the nucleus the units are composed of coarse- to fine-grained sands, silts and clays, with varying amounts of evaporitic halite and ulexite, as well as calcite as calcrete or travertine. Evaporitic beds dominate the basal and upper units of the nucleus. To the north, these beds interdigitate with coarse sediments of the Rio Rosario fan-delta. To the south, they interdigitate with coarse sediments of the Archibarca alluvial fan, although this is a relatively recent feature of the basin, having been active only during the deposition of the upper four units of the nucleus. Internally, the basin has subsided on marginal growth faults that were largely active prior to the initiation of the Archibarca alluvial fan.

Recovery of undisturbed core has enabled the laboratory determination of total porosity, effective porosity and specific yield on all units. When coupled with continuous wire-line geophysical logs, a detailed database has been established. Determination of specific yields at the research laboratories of the British Geological Survey gave mean values ranging from 0.13 for sand dominated lithologies, to 0.02 for clay dominated lithologies, and with a full spectrum between. Halite dominant units gave mean specific yield values of 0.04, identical to those previously determined at the halite dominant salars of Atacama and Hombre Muerto.

The brine body is rather homogeneous, extending throughout the salar nucleus at the surface and expanding somewhat at depth, particularly to the north. Its chemistry suggests that it has been formed by the evaporation of inflowing dilute waters of only one type that initially saturate in and precipitate calcite, followed by gypsum. Halite saturation is only just reached at the highest brine concentrations, but lithium and potassium continue to concentrate demonstrating that these species remain in solution and do not precipitate as solid phase minerals. Within the nucleus, mean concentrations are 690 mg/L for Li, 5,730 mg/L for K, and 1,050 mg/L for B. Peak values exceed 1,000 mg/L, 8,000 mg/L and 1,200 mg/L for Li, K and B respectively. A production wellfield will be initially located and designed to extract these higher grades.

A summary of the Measured and Indicated Resource estimates is given below:

	Measured Resource million tonnes	Indicated Resource million tonnes	Total Measured+Indicated million tonnes
Li	0.27	0.94	1.21
K	2.08	8.02	10.10
B	0.39	1.46	1.85

The development of the process flowsheet for the Olaroz brine feed has been based on the outcome of high quality testwork at a scale that provides confidence in the data used to define plant design, production forecasts and product quality. This work has been undertaken by a team with demonstrated high level expertise in the specific technologies involved.

The feed stock brine used for the testwork is representative of the brine resource, and the analytical techniques and resulting data have been subjected to comprehensive referee based quality assessment. The primary process elements of magnesium removal and of concentration of the lithium content in the brine and rejection of extraneous salts by the process of evaporation have been conservatively interpreted and transferred into the design of the liming process and the evaporation ponds. The impact of climatic conditions on the evaporation process has been thoroughly analyzed, and the outcomes of a full annual cycle of pilot scale testing have been resolved against standard evaporation testing methods. This work has also been benchmarked against the actual performance of similar operations in the region and in similar climatic environments.

The development of the lithium carbonate purification process, using lithium carbonate feedstock precipitated by standard techniques from the pilot scale evaporation ponds, has utilized a sequence of established processes arranged to exploit the well established chemistry of the various impurity compounds involved. The close working relationship with Toyota Tsusho has demanded a high degree of technical rigor in the area of data integrity, cost estimates and external scrutiny in the context of product quality.

The cost structure of the project has been defined within a close working relationship between the Olaroz project team and their lead engineering consultant Sinclair Knight Merz [SKM]. SKM were selected on the basis of being able to apply a team of engineers experienced in brine processing projects in South America to the task of defining project capital and operating costs. The cost estimates are rigorous and have captured effectively the required spectrum of plant operations and services, with appropriate allowances for the costs of procurement, project management and construction, and the cost of sustaining the large team of people involved in the project over the duration of the construction and commissioning program.

The financial outcome of the Feasibility Study has been defined by:

- A well defined brine resource, with favourable chemistry and hydrogeological characteristics that provide for long term extraction at economic lithium grades,
- The income calculated in the study is generated from production forecasts that are based on long term process trials, proven product quality, and pricing projected by the Roskill,
- The operating and capital cost structure defined by recognized engineering consultants working with an owners team experienced in the lithium carbonate sector

The very positive financial projections for the project are supported by an established relationship with an offtake partner that has a long term view and involvement in the premium lithium carbonate market. This is further supported by Roskill's favorable projections of long term demand for battery grade lithium carbonate over a range of global economic conditions and changes in pattern of demand.

		Lithium Carbonate Only	With Potash By Product
Production Rate	TPA	16400	10000
Capital Cost	US$million	207	221
Payback	Years	3.4	3.4
Cash Opertating Cost	US$/t Li C	1591	1230
After Tax NPV (7.5%)	US$million	415	449
After Tax Internal Rate of Return	%	26%	27%
After Tax NPV (7.5%) with 60% debt	US$million	449	489
After Tax Internal Rate of Return with 60% debt	%	52%	56%
Modeled Project Life	Years	40	40

The project has substantial upside in terms of potash and boric acid production. Testwork in these areas is ongoing and this program is a component of the owners cost estimates.

22. RECOMMENDATIONS

The authors are of the opinion that the work done to date by the Company and reported herein is of a standard suitable to finance the project and that the economics of the project justify detailed engineering design and subsequent development.

As part of the detailed design phase, the following is recommended:

- The digital simulation model which is currently under construction and calibration should be finalized and used for the detailed design and optimization of the initial extraction wellfield, as well as to predict with more accuracy the production profile for the first 15 years of the project life. It should be noted that the model will require updating with groundwater modeling data during early production and this should enable the refinement of the production profile during the project life as well as allowing for any modifications to the extraction wellfield during the project life to be planned for. It is recommended that the model is reviewed on this basis at 6 months, and yearly from that point. This will also allow the final recoverable resource to be estimated with increasing levels of confidence as the model is calibrated and refined.
- The investigation and further definition of potash plant and production costs should be vigorously pursued to meet the year 3 projection of commencement of potash production
- The development of boric acid extraction should also continue, preferably post project commissioning such that the full scale operational deportment of boron in the various process stages is fully understood
- Options exist for reducing the project capital cost. The capital cost estimates are currently being reviewed by a major South American based construction company. Preliminary advice is that capital costs may be reduced by further optimisation in design, and through alternative implementation methodology, and it is recommended that these preliminary findings be vigorously pursued.

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24. DATE AND SIGNATURE PAGE

CERTIFICATE of AUTHOR

I, John Houston, MSc., C.Geol., do hereby certify that:

1. I am an independent consultant of:
   Stuart Lodge, 273 Wells Road,
   Malvern, WR14 4HH, UK.
2. I graduated with an Honours Bachelor of Science degree in Geology from Birkbeck College, London University, UK in 1970
3. I graduated with a Master of Science in Hydrogeology from University College, London University, UK in 1974.
4. I am a UK Chartered Geologist, a Fellow of the Geological Society of London, a Fellow of the Chartered Institute of Water and Environmental Management, a Member of the Geological Society of America and a Member of the American Geophysical Union.
5. I have published the following recent, relevant papers:

In press. The evaluation of brine prospects and the requirement for new filing standards. *Economic Geology.*

In review. Groundwater flow through the central Andean volcanic arc. *Geological Society of America Bulletin.*

2010. with Rech, Currie, Shullenberger, Dunagan, Jordan, Blanco, Tomlinson and Rowe: Evidence for the development of the Andean rain shadow from a Neogene isotopic record in the Atacama Desert, Chile. *Earth and Planetary Science Letters.*

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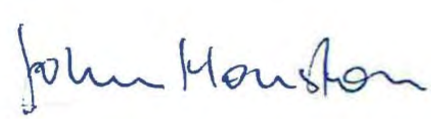
6. I have practiced my profession for forty five years.

7. I have read the definition of “qualified person” set out in National Instrument 43-101 (“NI 43-101”) and certify that by reason of my education and past relevant work experience, I fulfill the requirements to be a “qualified person” for the purposes of NI 43-101. This report is based on my personal review of information provided by the Issuer and on discussions with the Issuer’s representatives. My relevant experience for the purpose of this report is:
    - 1998-2008 Principal consultant to Nazca S.A.
    - 1990-1998 Group Chief Executive, Water Management Consultants
    - 1979-1988 Director, Hydrotechnica Ltd.
    - 1975-1979 Senior Hydrogeologist, Aspinwall and Company
    - 1970-1974 Hydrogeologist, Botswana Geological Survey
    - 1965-1970 Hydrogeologist, British Geological Survey

    And I have previously directed, managed, evaluated and participated in the following brine resource projects:
    - Salar de Hombre Muerto for FMC and Minera del Altiplano, Argentina (1991-1993)
    - Salar de Atacama for Amax and Minsal, Chile (1986-1997)
    - Sua Pan Brine Project, Botswana (1995-1996)
    - Lake Natron Resource evaluation, Tanzania (1991)
    - Um as Sammim brine development, Oman (1991).
8. I am responsible for the preparation of the Olaroz Project Technical Report dated May 13, 2011. I visited the property many times between April, 2009 and February 2011.
9. I have not had prior involvement with the properties that are the subject of the Technical Report.
10. As of the date of this certificate, to the best of my knowledge, information and belief, the technical report contains all scientific and technical information that is required to be disclosed to make the technical report not misleading.
11. I am independent of the issuer applying all of the tests in section 1.4 of National Instrument 43-101.
12. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
13. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Dated this 13th day of May, 2011



Signature of John Houston, C.Geol.

John Houston
Printed name of John Houston, C.Geol.

CERTIFICATE of AUTHOR

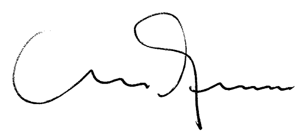
I, Michael Gunn, BSc., do hereby certify that:

1. I am an independent consultant of:
   58 Deerhurst Rd
   Brookfield, Qld 4069
   Australia.
2. I graduated with a Bachelor of Applied Science degree in Metallurgy from the University of New South Wales in 1974
3. I am a Member of the Australasian Institute of Mining and Metallurgy.
4. I have practiced my profession for thirty five years.
5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101. This report is based on my personal review of information provided by the Issuer and on discussions with the Issuer's representatives. My relevant experience for the purpose of this report is:

2004 - 2010	INDEPENDENT CONSULTING & CONTRACTS Non exec, Director Metals Finance Corp
2003 - 2004	METALLURGY ADVISOR Ok Tedi Mining Ltd, PNG
2002 – 2003	PROJECT CONSULTANT Ivanhoe Mines Mongolia
2000 - 2001	MANAGER METALLURGY Selwyn Operations Pty Ltd
1992 - 2000	INDEPENDENT CONSULTING Principal of Resource Engineers, AMPAC Pty Ltd Exec. Director, Majestic Resources NL 1995 - 98
1988 - 1992	PRINCIPAL METALLURGIST Minproc Engineers Pty Ltd, Brisbane
1985 - 1988	CHIEF METALLURGIST Renison Ltd, Tasmania
1982 - 1985	METALLURGICAL ENGINEER ARMCO Inc., USA and Australia
1978 - 1982	SENIOR METALLURGIST Bougainville Copper Ltd, PNG
1975 - 1978	METALLURGICAL ENGINEER Nchanga Consolidated Copper Mines, Zambia

6. I am responsible for the preparation of the technical report on the Olaroz project entitled "Technical Report for the Olaroz Project – Resource Upgrade and Feasibility Study" dated May 13, 2011. I visited the property in March 2011 for approximately 5 days.
7. I have not had prior involvement with the properties that are the subject of the Technical Report.
8. As of the date of this certificate, to the best of my knowledge, information and belief, the technical report contains all scientific and technical information that is required to be disclosed to make the technical report not misleading.
9. I am independent of the issuer applying all of the tests in section 1.4 of National Instrument 43-101.
10. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
11. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Dated this 13th day of May, 2011



Signature of Michael Gunn, B.Sc.

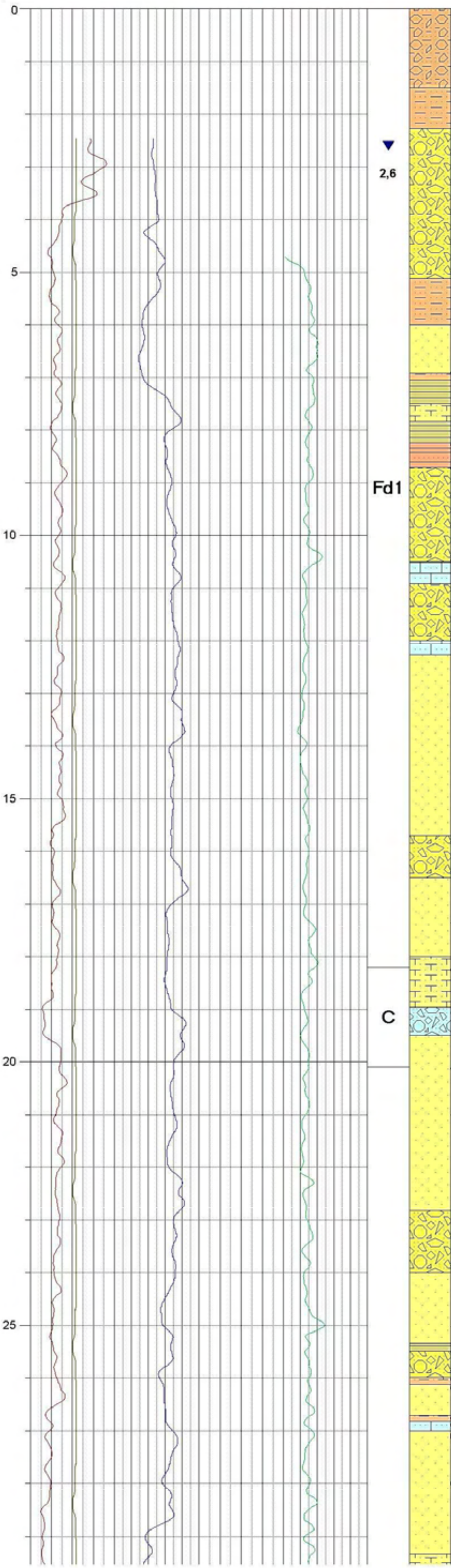
Michael Gunn
Printed name of John Gunn, B.Sc.

APPENDIX A

WELL LOGS

OROCOBRE — RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT						
CONTRACTOR:	BLY	START DATE:	23-07-10	COORDINATES (POSGAR 94 Zone 3) E:	3429999	WELL REFERENCE:	C-00
DRILL RIG:	SONIC	END DATE:	31-07-10	N:	7416498	Page 1 of 2	
METHOD:	SONIC	DEPTH:	54m	Elevn:	3940,308	LOGED BY:	Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SANDY GRAVEL with CLAY: Grava areno arcillosa matriz soportada (?10% de clastos). Clastos con abundantes hoquedades subangulosos de 2 a 7cm de arena media a fina cementada con carbonatos similar a matriz. Matriz de arena media a fina limo-arcillosa con abundante agua. Formada "in situ" y fracturada por perforación(?) o intraclastos(?). Color del conjunto marrón-claro (10YR 6/2). Micro: Cuarzo (?80%), Arenisca carbonática (?10%), Magnetita (?3%), Volcánicos? (?2%), Biotita (<1%) y Ap-Zr? (<<1%)

CLAYEY SAND: Arena media a fina con escasos y aislados fragmentos (1-2cm) angulosos de arena media a fina cementada con carbonato. Algunos niveles irregulares poseen baja proporción de arcilla. Color del conjunto marrón-claro (10YR 6/2).Fragmento anguloso, hoqueroso en sectores conformada por arena muy fina cemenada clastosoporte. Micro: Granos subredondeados de cuarzo (90-95%) magnetita (5%) carbonato cristalino? (5%), Biotita?(<<1%).

SANDY GRAVEL: Grava fina arenosa. Clastos subredondeados a subangulosos (2 a 10mm) conformados por pelitas y wakes gris-verdosas, líticos volcánicos rojizos a negros, fragmentos angulosos de cuarzo lechoso (Qzvein?) y Vuggy silica (cuarzo hoqueroso). En la zona del tope dos gruesos fragmentos angulosos de arena media a fina cementada con carbonatos y abundantes hoquedades (intraclastos?). Matriz de arena media a gruesa con escasos components de arena fina. Color del conjunto gris (N5). Micro: Matiz de arena gruesa a fina conformada por granos subredondeados de cuarzo (80%), líticos metamórficos (10%), magnetita (5%) y yeso? (5%)

SANDY GRAVEL: Arena media a fina con escaso limo y abundantes clastos de grava fina (3 a 10mm) dispersos. Micro: Arena media a fina (70%) conformada por cuarzo (?70%), lítico metamórficos (?20%), yeso? (?5%), líticos volcánicos (?3%), magnetita (?2%) y carbonatos masivos (?1%)

CLAYEY SAND: Arena fina a media con escasa arcilla de distribución irregular. Muy escasos clastos de grava fina y arena muy gruesa (?5mm).

SAND: Arena media a fina gris (N4) con escasos y aislados clastos subredondeados de 2 a 5mm. En el tope intercalan escasos niveles deformados de arena fina arcillosa marrón (3 a 4cm). Hacia la base niveles muy deformados de arcilla gris-clara (N7)y negra (1 a 3cm).

CLAYEY SAND: Arena fina a muy fina arcillosa marrón (10YR 5/4). Nivel (1-2cm) deformado de arcilla verde (10GY 5/2). Rastros irregulares de arcilla gris clara (N7) y negra.

CLAY : Intercalción rítmica (?0,5-2cm) entre arcilla negra y gris clara (N7).

SILTY SAND: Arena media a fina limosa gris-verdosa (5Y 5/2). En el tope nivel (9cm) de arena fina a muy fina limosa gris-oscura (N3) escasos rastros de materia orgánica.

CLAY : Arcilla rojiza-palida (10R 5/4) hacia la base grada a arena fina a muy fina limosa (últimos 3cm).

CLAY : Arcilla verde (10GY 6/2) intercala con dos finos niveles (?1cm) de arena muy fina limosa gris.

CLAY Interbeded SAND: Arcilla rojiza (10R 5/4) intercala rítmicamente (?3 a 5cm) con arena fina a muy fina gris ligeramente limosa.

SANDY GRAVEL: Arena gruesa a fina gris (N5) con clastos aislados (?10%) subredondeados a subangulosos de 2 a 5mm. Muy escasos individuos alcanzan 15mm. Conformados por pelitas y wakes gris-verdosas, líticos volcánicos rojizos y fragmentos de cuarzo lechoso. Intercala con nivel (?5cm) de arcilla marrón. Micro: Arena muy gruesa a fina (70%) conformada por cuarzo(?70%), líticos metamórficos (?20%), líticos volcánicos?(?3%), yeso?(?5%) y magnetita(?2%).

SAND cemented CARBONATE: Nivel fracturado masivo con abundantes fragmentos angulosos de arena media a fina con cemento carbonático. Muchos de estos fragmentos con abundantes hoquedades. Menor proporción de de arena media a fina friable. Micro: Arena gruesa a fina (55%) conformada por cuarzo (?70%), Lítico metamórficos (?25%), yeso? (?2%), líticos volcánicos (?1%) y magnetita (?1%).

SANDY GRAVEL: Arena gruesa a fina con clastos aislados principalmente subredondeados de 2 a 5mm, conformados por pelitas y wakes gris-verdosas, líticos volcánicos rojizos y fragmentos angulosos de cuarzo lechoso. El color varía muy iregularmente de gris (N6) a ligeramente marrón (10YR 6/2). Micro: Arena media a fina (90%) conformada así principalmente por cuarzo (?95% o más), magnetita (?3%) y líticos (1%).

SAND cemented CARBONATE: Estructura original del sedimento fuertemente alterada por split spoon. Abundantes fragmentos (2 a 8cm) angulosos de arena media cementada con carbonato con hoquedades. Arena media a fina con arcilla negra y nivel (?) de arcilla rojiza (10R 5/4).

SAND: Arena media a fina con escasos componentes de arena gruesa. Clastos escasos y aislados subredondeados de 3 a 5mm (escasos alcanzan 15mm). Conformados por wakes y pelitas gris-verdosas, líticos volcánicos rojizos(?) y fragmentos subangulosos de cuarzo lechoso. Color del conjunto marrón-claro (10YR 6/2). Micro: Arena media a fina (70%) conformada por cuarzo (?90%), líticos volcánicos?(?5%), magnetita(?4%) y yeso?(?1%).

SANDY GRAVEL: Grava muy fina (2 a 10mm) arenosa gris (N6). Arena gruesa a media (10-15%) conforma la matriz. Clastos subredondeados conformados por clastos subredodeados con líticos metamórficos(?60%), volcánicos(?25%), cuarzo(?10%) y yeso?(?5%) .

SAND: Arena media a fina con muy escasos clastos (pelitas, wakes, volcánicos y cuarzo) subredondeados (?5mm) aislados. Hacia la base nivel (4cm) de arena fina limosa. Color del conjunto gris (N6).

SAND: Arena media a fina marrón-clara (10YR 6/2). Muy escaso y aislados clastos subredondeados de 3 a 5mm conformados por wakes y pelitas gris-verdosas, líticos volcánicos rojizos y fragmentos de cuarzo lechoso. Micro: Arena media a fina (95%) conformada por cuarzo(?90%), magnetita(?6%), líticos volcánicos(?3%), líticos metamórficos(?1%), Zircón/Apatita?(<<1%).

SILTY SAND: Arena gruesa a fina limosa gris (N6) con clastos (2 a 10mm) subredondeados aislados (aumenta proporción hacia la base). Conformados por pelitas y wakes gris-verdosas y cuarzo lechoso. Finos y escaso niveles blanquecinos deformados (0,3 a 1cm) carbonáticos con textura de arcillosa. Micro: cuarzo(?70%), líticos metamórficos(?14%), líticos volcánicos(?10%), yeso?(?3%) , carbonatos masivos(?2%), magnetita(?1%) y biotita(<<1%).

GRAVEL cemented CARBONATE: Nivel carbonático. Grava muy fina (3 a 5mm) y abundante arena gruesa a media cementada con carbonato. Muy escasos y discontinuos niveles friables. Color del conjunto verde claro (10Y 8/2).

SAND: Arena gruesa a media gris (N6), con escasos componentes de arena fina. Micro: granos principalmente subredondeados conformados por cuarzo(?60%), líticos volcánicos(?20%), líticos metamórficos(?15%), yeso?(?3%) y magnetita(?2%). Escasos y aislados clastos subredondeados a subangulosos (2 a 15mm dominan 2 a 5mm). En tope (8cm) ligeramente limo-arcillosa. Y cercano a la base (9cm) de arena fina a muy fina verde-clara (10GY 6/2) friable con fragmentos (1cm) angulosos de carbonato. Nivel basal de arena fina con cemento carbonático.

SAND: Arena media a gruesa con escasa arena fina gris (N5). Clastos aislados subredondeados de 2 a 20mm, conformados por pelitas y wakes, cuarzo y líticos volcánicos. Micro: Arena fina compuesta por granos subangulosos (escasos subredondeados) de cuarzo(?85%), líticos(?10%) y magnetita(?5%). Dos niveles (21,13 y 21,22m) de 2cm cada uno, con arena gruesa a media cementada con carbonato. Muy escasos niveles (0,5cm) con arcilla blanquecina carbonática.

SANDY GRAVEL: Grava fina arenosa con escaso limo. Clastos de 2 a 20mm (dominan 3 a 10mm) subredondeados conformados por pelitas y wakes gris verdosas con escaso cuarzo y líticos volcánicos. Nivel (21,08m) de 5cm de grava fina cementada con carbonato. Color del conjunto gris (N5-N6). Micro: Arena media a gruesa conformada por cuarzo(?45%), líticos metamórficos(?30%) y volcánicos(?20%), yeso?(?5%) y magnetita(<<1%).

SAND: Arena gruesa a media con escasos clastos aislados subredondeados (de 2 a 15mm) conformados por pelitas gris-verdosas y menor wakes, cuarzo lechoso y líticos volcánicos? Rojizos. Micro: Arena media a gruesa (70%) conformada por cuarzo(?65%), líticos metamórficos(?20%) y volcánicos(?17%), yeso?(?3%) y magnetita(<<1%).

SAND: Arena fina gris (N5) con muy escasos clastos aislados (2-5mm).

CLAY : Arcilla gris verdosa (10GY 4/2).

SANDY GRAVEL: Grava fina arenosa. Clastos subredondeados (2 a 20mm) conformados por pelitas y wakes gris-verdosas, cuarzo lechoso subanguloso y líticos volcánicos rojizos (?). Matriz de arena gruesa a fina con escaso limo (N6). Micro: Matriz de arena gruesa a fina conformada por por cuarzo(?70%), líticos metamórficos(?15%) y volcánicos(11%), yeso?(?2%) y magnetita(<<1%).

CLAYEY SAND with SILT: Arena limo arcillosa gris (N6). Con clastos subredondeados (2 a 10mm) dispersos.

SAND: Arena gruesa a fina gris (N6) con muy escaso limo y clastos subredondeados dispersos (2 a 5mm).

CLAYEY SAND with SILT: Arena muy gruesa conformada por granos subredondeados (1 a 2mm) en matriz limo-arcillosa carbonática de color verde-claro (10GY 5/4).

SAND cemented CARBONATE: Nivel arcilloso gris-blanquecino (N7 a N8) con abundantes fragmentos de arena fina a muy fina cementada con carbonato (nivel fracturdo por avance de perforación?).

SAND: Arena muy gruesa a fina con escasos clastos dispersos (2 a 5mm). Escasos clastos subredondeados de arena fina con cemento carbonático (2 a 4cm). Color del conjunto gris (N6). Micro: conformada por litios metamórficos(?50%), cuarzo(?25%), líticos volcánicos(?15%) y arenisca muy fina carbonática(?10%).

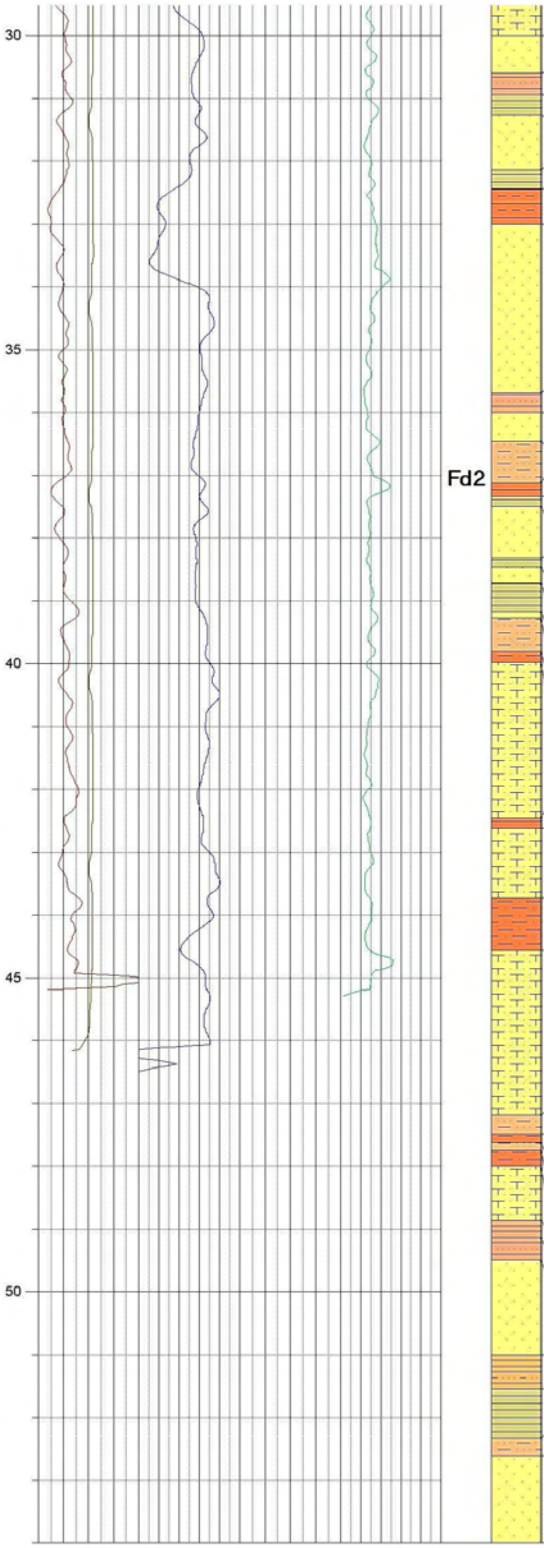
SAND: Arena media a fina gris (N5) con escasos clastos (2 a 5mm) dispersos y aumenta proporción hacia la base (últimos 10cm) alcanzando los 10mm. Micro: conformada por cuarzo(?70%), volcánicos(15%), magnetita(10%), líticos metamórficos(?5%) y yeso?(?1%).

SILTY SAND: Arena muy fina limosa gris (N6) intercala con nivel deformado (lente? 2cm) de arcilla marrón.

Depth (m)	Elevn. (m)
0	3940
5	3935
10	3930
15	3925
20	3920
25	3915

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 23-07-10	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 31-07-10	E: 3429999	C-00
	METHOD: SONIC	DEPTH: 54m	N: 7416498	Page 2 of 2
			Elevn: 3940,308	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SAND: Arena media a fina gris (N6) con muy escasa presencia de limo. Nivel (7cm), en la base, de arena gruesa. Micro: conformada por cuarzo(?35%), líticos volcánicos(30%), metamórficos(?20%), arenisa fina carbonática(?12%), yeso?(?3%) y magnetita(<<1%).

CLAY Interbeded SAND: Arcilla verde-oscura (5GY 3/2) intercala con dos niveles 1 y 7cm de arena muy fina limosa gris (N5).

CLAY : Arcilla rojiza-palida (10R 6/2) con muy escasas concreciones blanquecinas (2cm) carbonáticas y finos niveles (?2mm) con textura arcillosa.

SAND: Arena fina a muy fina gris (N5) con muy escasos clastos aislados (2 a 5mm) conformados por pelitas y wakes gris-verdosas, volcánicos rojizos y cuarzo lechoso.

CLAY : Arcilla marrón-clara (10YR 6/2) con fragmentos (2 a 4cm) carbonáticos blanquecinos (concreciones?).

SILTY CLAY: Nivel limo arcilloso carbonático gris-claro (N8). Fragmentos masivos carbonáticos muy compactos. Nivel intercalado (32,8m) de 7cm de arena fina a muy fina limosa gris-oscura (N3).

SAND: Arena fina a muy fina con escaso limo gris oscura (N3) y muy escasos clastos aislados (2 a 5mm). Micro: conformada por cuarzo(?70%), líticos volcánicos(?15%) y metamórficos(?7%), yeso?(?5%), magnetita(3%) y biotita(<<1%). Nivel limoso (2cm) con fragmentos carbonáticos angulosos (1 a 2cm). Hacia le tope (24cm) y base (29cm) arena gruesa a fina. Nivel (2cm) de arcilla gris-oscura (N2) en la base.

CLAY Interbeded SAND: Intercalación rítmica (0,5 a 1cm) de arena fina a muy fina con arcilla gris-oscura (N2).

SAND: Arena gruesa a fina gris (N5) con escasos y aislados clastos subredondeados a subangulosos de 2 a 10mm conformados por pelitas y wakes gris-verdosas, líticos volcánicos y menor cuarzo lechoso.

CLAYEY SAND: Arena fina a muy fina arcillosa gris (N5) con calstos subredondeados (1 a 2cm) conformados por arcilla-limosa gris-oscura a negra algo friable (intraclastos).

SILTY CLAY: Arcilla rojiza-oscura (10R 4/2) limosa.

CLAY : Arcilla verde-clara (5GY 7/2).

SAND: Arena fina a muy fina gris (N5). En tope (primeros 11cm) arena fina a muy fina arcillosa marrón-clara (10YR 6/2). Micro: cuarzo(?75%), magnetita(10%), yeso?(?5%), líticos volcánicos(?7%) y metamórficos(?3%) y biotita(<<1%).

CLAY : Arcilla rojiza (10R4/2) con nivel (2cm) lenticular con abundante FeOx(?).

SAND: Arena muy fina limosa gris (N6).

CLAY : Arcilla marrón-clara (10YR 6/2).

SAND: Arena gruesa a media con muy escasos clastos (?3mm) subredondeados conformados por pelitas y wakes gris-verdosas y líticos volcánicos rojizos (?).

CLAYEY SAND: Arena fina a muy fina arcillosa (N6).

SANDY CLAY: Arcilla arenosa (arena muy fina a fina) marrón (10YR 6/2).

SILTY SAND: Arena fina a muy fina limosa gris (N5) conformada por cuarzo(?85%), magnetita(10%), líticos(?2%) y yeso?(?3%). Muy escaso limo (lavado).

SILTY CLAY: Arcilla marrón-oscura (5YR 2/2) limosa.

SILTY SAND: Arena muy fina limosa gris (N5). Intecala con nivel (4cm) de arena muy fina limo-arcillosa marrón-oscura (5YR 2/2), nivel (3cm) de arena muy fina con matriz carbonática blanquecina (friable) conformada por cuarzo(90%), magnetita(9%) y líticos?(1%). Niveles (3cm)de arcilla marrón-oscura (5YR 2/2) y verde-oscura (5GY 3/2).

SANDY CLAY: Arcilla areno limosa (arena muy fina) marrón (10YR 4/2). Intercala con nivel (3 a 5cm) de arena fina limosa y dos niveles (?2cm) de arena fina con matriz carbonática (friable).

SILTY SAND: Arena fina a muy fina limosa marrón a gris (10YR 4/2) con muy escasa arcilla conformada por conformada por cuarzo(?80%), magnetita(15%), líticos(?3%) y yeso?(?2%). Intercala con tres niveles (2 a 3cm)de arena fina con matriz carbonática (friable). De 45,17 a 45,39m abundantes fragmentos angulosos (1 a 2cm) de arena fina con cemento carbonático.

CLAYEY SAND: Arena muy fina limo-arcillosa marrón-oscura (5YR 2/2) conformada por cuarzo(?85%), magnetita(10%), líticos(?2%) y yeso?(?3%).

SANDY CLAY: Arcilla limo-arenosa (arena muy fina) marrón-oscura (5YR 2/2) con nivel (3cm) de arcilla carbonática marrón-clara (10YR 6/2).

CLAYEY SAND: Arena limo-arcillosa marrón oscura (5YR 2/2) con nivel (3cm), en la base, de arcilla limosa carbonática.

SANDY CLAY: Arcilla limo-arenosa marrón-oscura (5YR 2/2).

SILTY SAND: Arena fina a muy fina limosa marrón a gris (10YR 4/2) conformada por cuarzo(?85%), magnetita(10%), biotita(?3%), yeso?(?2%) y líticos(<1%).

CLAY Interbeded SAND: Arcilla verde-oscura (5GY 3/2) intercala con niveles (2 a 3cm) de arena fina limosa gris (N5).

CLAY Interbeded SAND: Arcilla marrón (10YR 6/2) intercala con niveles (3 a 4cm) de arena fina limo-arcillosa gris (N4).

SAND: Arena fina gris (N5) con escaso limo conformada por cuarzo(?90%), biotita(7%), magnetita(3%) y yeso?(<1%). Nivel (2cm) de arcilla arenosa rojiza en la base.

CLAY Interbeded CLAYEY SAND: Intercalación de arcilla rojiza (10R 4/6) y niveles deformados (3 a 5cm) de arena fina arcillosa gris.

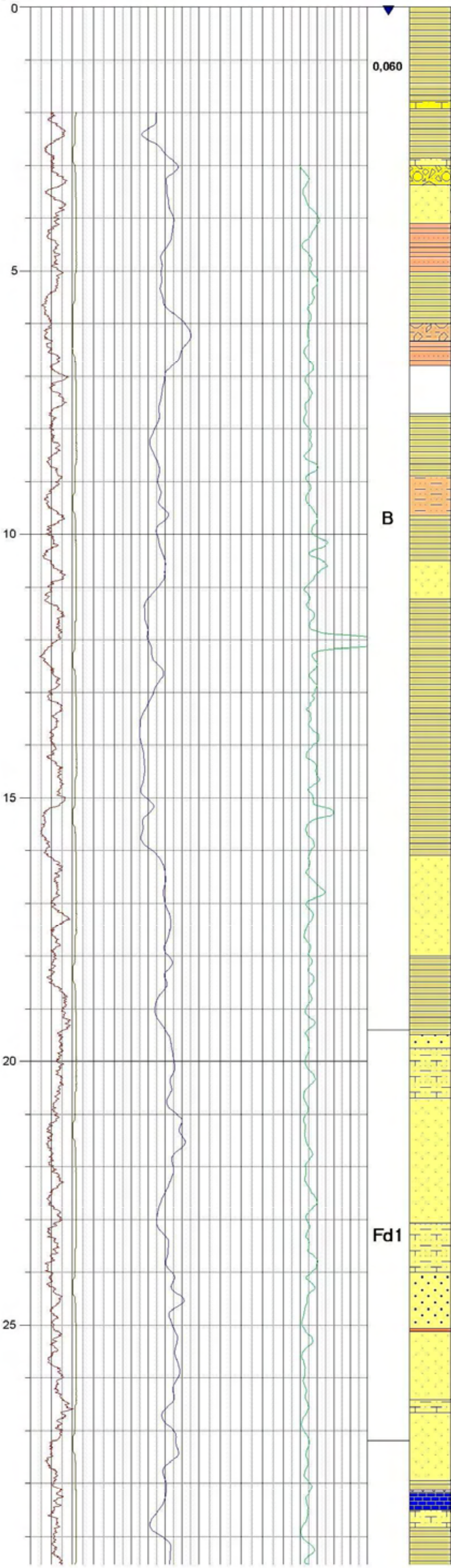
CLAY : Arcilla rojiza (10R 4/6) con muy escasos rastros de arcilla verde (10GY 5/2) de contacto irregular y niveles (2 a 3cm) de arena fina limosa gris.

CLAYEY SAND: Arena fina a muy fina arcillosa gris (N4).

SAND: Arcilla verde (10GY 5/2) intercala con finos niveles (0,2 a 3cm) de arena fina a muy fina limosa verde (5GY 5/2).

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 05-08-10	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-01
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC	END DATE: 13-08-10	E: 3428997	Page 1 of 2
		METHOD: SONIC	DEPTH: 54m	N: 7413941	
				Elevn: 3939,221	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY : Arcilla rojiza (10R 4/6). En el tope (primeros 30cm) abundantes papas de ulexita (2 a 4cm). Hacia la base (últimos 23cm) arcilla verde clara (10GY 5/2 a 5GY 8/1) y (2cm) de arena media a fina gris.

CLAY : Arcilla marrón (10YR 6/2) con niveles (1 a 2cm) de arcilla marrón-clara carbonática (reacciona con HCl) y escasos fragmentos (?0,5cm) carbonáticos angulosos masivos.

SILT: Nivel limoso gris (N6) (Ceniza volcánica?).

CLAY : Arcilla gris-verdosa (5Y 5/2) intercala con niveles (0,5 a 2cm) de arena fina a muy fina gris.

SILTY SAND: Arena fina a muy fina limosa color gris-oscuro (N4).

GRAVEL: Grava fina con escasa arena (<5%). Clastos subangulosos a subredondeados con tamaño aproximadamente uniforme (?3mm) conformados cuarzo(?35%), arenisca muy fina cementada con carbonatos(?35%), líticos volcánicos(?25%), magnetita(?4%) y líticos metamórficos(?1%).

SAND: Arena gruesa a fina muy compacta (friable) color gris (N6) con presencia de carbonatos en matriz.

SAND: Arena fina a muy fina negra con escaso limo, conformada por cuarzo(?85%), magnetita(?10%), líticos(?5%).Nivel (1cm) areno-acilloso verde.

SAND: Arena media a fina gris (N5) grada hacia la base (últimos 4cm) a arena muy gruesa a fina con clastos (2 a 4mm) planos finos orientados paralelamente aproximadamente horizontal. Conformada por cuarzo(?65%), líticos volcánicos(?25%), arensica muy fina cementada con carbonatos(?14%), yeso?(?3%) y magnetita(?3%).

CLAY Interbeded SAND: Arcilla gris-verdosa clara (N7 a 5GY 7/2) intercala con nivel (2cm) de arcilla negra y niveles muy deformados (2 a 4cm) de arena media a fina con escasos componentes de arena gruesa a muy gruesa. En tope nivel (11cm) de arena muy fina limo-arcillosa gris (N6).

CLAY : Arcilla con niveles en distintos tonos de verde. (dominan 10GY 6/4 y 10Y 8/2). Fino nivel (0,5cm) de arena muy fina limosa.

SANDY GRAVEL with CLAY: Grava fina areno-arcillosa. Clastos subangulosos a subredondeados (?3mm) conformada por arenisca fina con cemento carbonático(?50%), cuarzo(?35%), líticos volcánicos(?15%) y metamórficos(?10%), en matriz arcillo-arenosa gris (N6).

CLAY Interbeded SAND: Arcilla gris verdosa (5GY 5/2) intercala con niveles (2 a 5cm) de arena media gris y arena fina gris.

NO RECUPERADO

CLAY : Arcilla rojiza (10R 4/6) intercala con escasos niveles (1cm) de arcilla verde (10GY 5/2) y muy escasos niveles deformados (1cm) de arena muy fina limosa. Nivel intermedio (25cm) de arcilla marrón (5YR 5/2).

CLAYEY SAND: Arena fina a muy fina arcillosa gris (N5).

CLAY : Arcilla rojiza pálida (10R 5/4) con nivel (17cm) de arcilla verde clara (10Y 6/2). Arena gruesa a media en un borde (contaminación).

SAND: Arena gruesa a fina gris (N5) con muy escasos clastos aislados. Conformada por cuarzo(?85%), líticos volcánicos(?11%), yeso?(?3%), y magnetita(?1%).

CLAY : Arcilla verde (10GY 5/2) con escasos y finos niveles (?0,5cm) de arena media a fina y arena fina. Muy escasos rastros de materia orgánica. Nivel (49cm) con arcilla gris (N6) con materia orgánica.

BLACK CLAY : Arcilla negra intercala con escasos niveles (0,5 a 1cm) de arcilla verde (10GY 5/2). Manchas verdosas y blanquecinas en superficie (oxidación).

SAND: Arena gruesa a muy gruesa con escasa proporción de arena media conformada por cuarzo(?40%), líticos volcánicos(?30%), arenisca con cemento carbonático(?25%), calcita(?3%) y líticos metamórficos(?2%). Nivel (10cm) con muy escasa matriz limo-arcillosa negra (de 17,72 a 17,8m). En tope (primeros 23cm) con arena media a fina arcillosa gris (N4)

CLAY : Arcilla verde (10GY 5/2). Nivel (2cm) arena gruesa a fina con escasos clastos dispersos (muy deformado).

COARSE SAND: Arena gruesa a muy gruesa conformada por cuarzo(?40%), arenisca fina con cemento carbonático(?25%), líticos volcánicos(?15%), carbonatos masivos(?10%), yeso?(?8%), líticos metamórficos(?2%) y magnetita(<<1%). Clastos aislados subangulosos a subredondeados conformados por pelitas y wakes gris-verdosas y fragmentos de cuarzo lechoso. En la base (4cm) arcilla rojiza (10R 6/6)

SILTY SAND with CLAY: Arena fina a media limo-arcillosa marrón-clara (5YR 7/2) matriz limo arcillosa carbonática (friable con fuerte reacción al HCl). Intercalan 2 niveles (4 y 11cm) de arena fina a media marrón (10YR 4/2) con escaso limo (no carbonatico).

SAND: Arena media a fina marrón (10YR 4/2) con escaso limo pasa, en la base (últimos 49cm), a arena media a fina verde (10GY 5/2) con abundantes fragmentos angulosos (2 a 4cm) de arenisca fina cementada con carbonatos. Arena fina conformada por cuarzo(?85%), magnetita(?10%) y líticos?(?5%).

SILTY SAND with CLAY: Arena media a fina gris (N6) con escasa matriz limo-arcillosa. Lentes irregulares (1 a 2cm) con arena media a fina arcillosa verde oscura (10GY 4/4). Intercala en la base (últimos 20cm) con arcilla verde (10GY 5/2).

COARSE SAND: Arena gruesa a muy gruesa con clastos (?7mm) muy escasos y aislados subangulosos a subredondeados. Escasa matriz limo-arcillosa. Color del conjunto gris (N6). En la base (5cm), gruesos fragmentos carbonáticos angulosos con escasas hoquedades. Textura de arena fina a muy fina con cristales de cuarzo, magnetita y líticos?.

SAND: Arena media a fina gris (N6). Nivel en tope (5cm) de arcilla marrón (10YR 6/2) arenosa (arena fina a muy fina).

SILTY SAND with CLAY: Arena gruesa a fina limo-arcillosa marrón (10YR 6/2) dos gruesos niveles (?5cm) de carbonato masivo.

SAND: Arena media a fina marrón (10YR 6/2) con escaso limo. Intercala nivel (5cm a 27,21m) limoso blanquecino (N7) (ceniza volcánica?) (vitreo? ?50%) con arena muy fina conformada por cuarzo, Bt, Hr? Y magnetita.).

CLAY : Arcilla marrón-oscura (5YR 3/2) finos y escasos niveles de carbonatos (?5mm) fracturados.

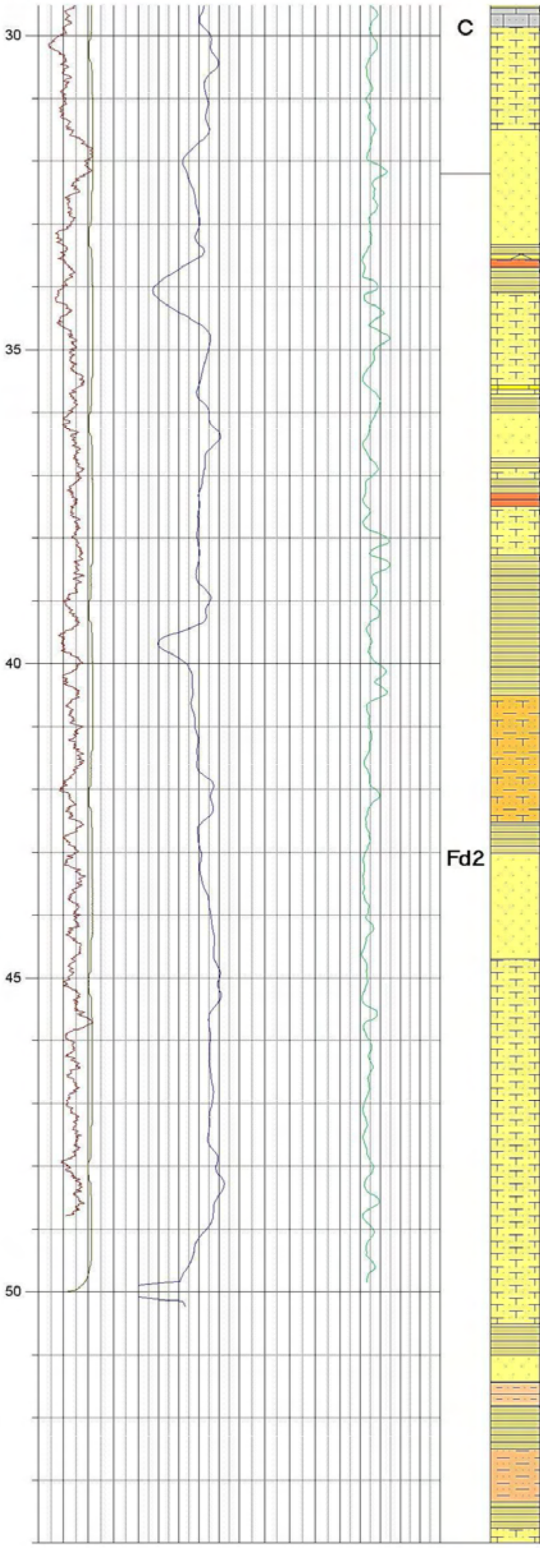
VOLCANIC ASH: Nivel limoso gris-blanquecino (N7) (ceniza volcánica?).

CARBONATE: Grueso nivel carbonático fracturado marrón-claro (10YR 6/2). Intercala con nivel de arcilla (7cm) marrón-oscura (5YR 3/2).

SILTY SAND: Arena fina a muy fina limosa marrón (10YR 6/2) conformada por cuarzo(?75%), líticos volcánicos(?10%) y metamórficos(?5%), yeso?(?5%), magnetita(4%) y arenisca fina con cemento carbonático(?1%).

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	05-08-10	COORDINATES (POSGAR 94 Zone 3) E:	3428997	WELL REFERENCE: C-01
		DRILL RIG:	SONIC	END DATE:	13-08-10	N:	7413941	Page 2 of 2
RESOURCE EVALUATION PROGRAM		METHOD:	SONIC	DEPTH:	54m	Elevn:	3939,221	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY : Arcilla rojiza (10R 4/6) intercala con escasos niveles (1 a 2mm) de arena muy fina arcillosa. Muy escasos fragemntos (?2cm) de arenisca muy fina con cemento carbonático.

SAND cemented CARBONATE: Nivel carbonático. Abundantes fragmentos de arenisca fina cementada con carbonatos (0,3 a 3cm) en matriz areno arcillosa gris-verdosa clara.

SILTY SAND: Arena media a muy fina limosa gris (N6) conformada por cuarzo(?75%), líticos volcánicos(?10%), magnetita(8%), metamórficos(5%), yeso?(?2%). Nivel de arcilla marrón (2cm). Transicional con nivel inferior.

SILTY SAND: Arena gruesa a fina limosa con escasa arcilla. Conformada por cuarzo(?70%), líticos volcánicos(?13%) y metamórficos(?5%), yeso?(?5%), magnetita(3%) y arenisca fina con cemento carbonático(?7%) y fragmentos carbonaticos masivos(?2%). Color del conjunto marrón (10YR 6/2). Muy escasos clastos dispersos subredondeados (hasta 4mm).

SAND: Arena fina a media gris (N6) transicional con el nivel (0,78) inferior: arena muy gruesa a fina con escaso limo y clastos (0,3 a 10mm) aislados subredondeados. Hacia la base arena media a fina arcillosa verde (5Y 6/4). Conformada por cuarzo(?80%), líticos volcánicos(?8%), magnetita(?7%), líticos metamórficos(?4%) y yeso?(?1%).

CLAY : Arcilla marrón (5YR 5/2).

SANDY GRAVEL: Nivel de grava fina arenosa. Clastos subredondeados (2 a 5mm) conformados por pelitas, wakes, volcánicos? y cuarzo lechoso. Matriz de arena gruesa a media con escasa arena fina.

SANDY CLAY: Arena fina arcillosa marrón (5YR 5/2).

CLAY : Arcilla verde (10GY 5/2) con escasos fragmentos carbonáticos (2cm). Últimos (15cm) arcilla areno-limosa (arena muy fina) roja-oscura (10R 3/4). En tope (9cm), arcilla rojiza (10R 4/6) con finos fragmentos carbonáticos (?3mm) concentrados en arcilla anaranjada (FeOx?).

SILTY SAND: Arena fina a muy fina limosa gris oscura (N4) pasa, en la base (últimos 52cm), a arena media a fina limosa con escasa arena gruesa marrón-pálida (10YR 6/2). Conformada por cuarzo(?80%), líticos volcánicos(?12%), yeso?(?5%), líticos metamórficos(?3%) y magnetita(<1%) .

SILT: Nivel limoso blanquecino (N7) (ceniza volcánica?).

SILTY SAND: Arena fina a muy fina limosa marrón-oscura (5YR 3/4).

CLAY : Arcilla marrón (10YR 6/2) con gruesoso fragmentos (2 a 4cm) carbonáticos.

SAND: Arena fina a media marrón-clara (10YR 6/2) conformada por cuarzo(?90%), magnetita(?5%), líticos(?4%), yeso?(?1%) y biotita(<1%).

CLAY : Arcilla marrón (5YR 5/2).

SILTY SAND: Arena fina a muy fina limosa gris (N5).

CLAY : Arcilla rojiza (10R 4/6) intercala con fino nivel (2mm) de arcilla limosa marrón.

SILTY CLAY: Arcilla limosa marrón-oscura (5YR 3/2).

SILTY SAND: Arena fina a muy fina limosa marrón (10YR 6/2) conformada por cuarzo(?92%), agnetita(?2%), líticos(?2%), biotita(?2%) y yeso?(<1%).

CLAY : Arcilla rojiza (10R 4/6) intercalan escasos niveles (2 a 4cm) de arcilla limosa marrón (10YR 4/2).

SANDY SILT with CLAY: Limo-arena muy fina arcillosa marrón (10YR 4/2). Intercala con niveles (0,5 a 20cm) de arcilla rojiza (10R 4/6).

CLAY : Arcilla rojiza-oscura (10R 3/4) intercala con niveles (0,5 a 1cm) limo arcilloso gris-oscuro.

SAND: Arena media a fina gris (N6) con escaso limo. Hacia el tope intercala con finos niveles (?0,5cm) de color negro (magnetita?). Escasos niveles intercalados, en todo el nivel, de arena fina arcillosa marrón (2 a 3cm). Conformada por cuarzo(?90%), magnetita(5%), líticos volcánicos(?2%) y metamórficos?(?1%) y yeso?(?1%).

SILTY SAND: Arena fina a muy fina limosa gris (N5) Pasa transicionalmente (últimos 2m) a arena media a fina gris (N5). Conformada por cuarzo(?93%), magnetita(?5%), líticos(?2%), yeso?(?1%) y biotita(<1%).

CLAY : Arcilla marrón-clara (5YR 7/2) con abundantes fragmentos (1 a 2cm) de arenisca cementada con carbonatos. Intercalan dos niveles (2 y 3cm) de arena media a fina con fragmentos de arenisa con cemento carbonático.

SAND: Arena media a fina gris (N6) con muy escasos granos de arena gruesa. Conformada por cuarzo(?90%), líticos volcánicos(?6%), magnetita(?2%), yeso?(?1%) Y líticos metamórficos?(?1%).

CLAYEY SAND Interbeded CLAY: Arena media arcillosa rojiza (10R 6/2) con abundantes fragmentos (0,5 a 1 cm) de arenisca fina cementada con carbonatos. Últimos 20 cm, intercala con arcilla rojiza.

CLAY : Arcilla rojiza (10R 6/2) con escasos rastros de arcilla verde. En la base (últimos 21cm) se torna marrón-oscura (10YR 4/2).

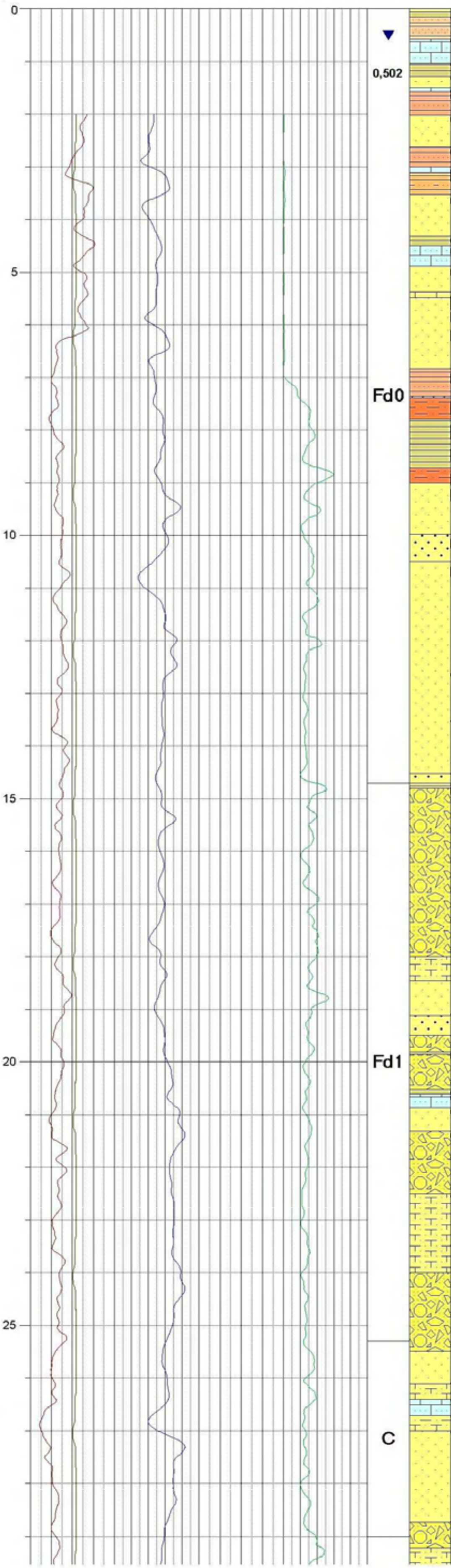
CLAYEY SAND: Arena media a fina arcillosa con abundantes fragmentos subangulosos a subredondeados de arena fina cementada con carbonatos (0,2 a 2cm).

CLAY : Arcilla marrón oscura (10YR 4/2) con rastros de arcilla verde.

SILTY SAND: Arena fina limosa gris oscura (N4).

OROCOBRE — RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 15-08-10	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-02
		DRILL RIG: SONIC	END DATE: 21-08-10	E: 3431002	Page 1 of 2
		METHOD: SONIC	DEPTH: 54m	N: 7413939	
				Elevn: 3939,301	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

CLAY: Arcilla marrón (5YR 4/4) con escasas y finas (1cm) papas de ulexita en el tope.

SAND interbeded CLAY: Arena media a fina gris (N5) con muy escaso limo. Hacia la base se torna marrón (5YR 5/4). Nivel deformado (?10cm) de arcilla marrón clara (10YR 6/2).

SAND cemented CARBONATE: Arena media a fina gris (N4) cementada con carbonatos. Nivel (8cm) de arcilla gris-verdosa (5Y 5/2).

CLAY: Arcilla gris-verdosa (5Y 5/2) intercala, en el tope, con finos niveles (2 a 4mm) de arcilla marrón.

SAND: Arena media a muy fina gris (N5), conformada por cuarzo(?80%), líticos volcánicos(?8%), arenisca muy fina con cemento carbonático(?3%), magnetita(?4%), fragmentos carbonáticos masivos(?2%), líticos metamórficos?(?2%) y yeso?(?1%).

SAND cemented CARBONATE: Nivel de arena media a fina cementada con carbonatos.

CLAY interbeded SAND: Arcilla gris-verdosa (5Y 5/2)con nivel (6cm) de arenisca media a fina gris cementada con carbonatos.

SAND: Arena media a fina limosa gris (N5) con muy escasa a nula arcilla de distribución muy irregular. Conformada por cuarzo(?85%), líticos volcánicos(?5%), magnetita(?5%), arenisca muy fina con cemento carbonático(?2%), líticos metamórficos?(?2%) y carbonatos masivos(?1%). Fragmentos aislados de arenisca media a fina gris (1cm) cementada con carbonatos.

CLAY interbeded SAND: Arcilla marrón (5YR 6/4) intercala con muy escasos niveles (1cm) de arena media a fina limosa gris.

SAND cemented CARBONATE: Nivele de arenisca media a fina cementada con carbonatos (N5). Alterado por SPT.

CLAY interbeded CLAYEY SAND: Fuerte alteración por SPT. Arcilla marrón (5YR 6/4) intercala con niveles (1 a 3cm) de arena fina limo-arcillosa gris (N5).

SAND: Arena media a fina limosa gris (N5) con escasos fragmentos (niveles de 2 a 3cm?) de arenisca media a fina gris cementada con carbonatos.

CLAY: Arcilla verde (10GY 5/2).

SAND cemented CARBONATE: Arenisca media a fina gris (N5) cementada con carbonatos. Hacia la base (17cm) gruesos fragmentos (5 a 7cm) de arenisca media a fina gris cementadas con carbonatos (intercala?) con arcilla marrón-palida (10YR 6/2).

SAND: Arena media a fina limosa con muy escasa arcilla y granos de arena gruesa color gris (N5), conformada por cuarzo(?80%), líticos volcánicos(?5%), yeso?(?6%), magnetita(?4%), arenisca fina con cemento carbonático(?2%) y líticos metamórficos?(?1%). Intercala nivel (0,5cm) de arena media con abundantes fragmentos carbonáticos banquecinos y nivel (3cm) de arcilla marrón (10YR 6/2) con fino lente (0,4mm) cementado con carbonato.

SILTY SAND with CLAY: Arena media a fina arcillosa marrón (5YR 6/4) con nivel fracturado (2cm) de arena media a fina cementada con carbonatos.

SAND: Arena media a fina con abundantes y gruesos fragmentos (1 a 5cm) de arena media a fina cementada con carbonatos. Nivel fracturado (Intraclastos?). El conjunto es de color gris (N5).

SAND: Arena media a fina gris (N5) con escaso limo y granos de arena gruesa, conformada por cuarzo(?45%), carbonatos masivos(?35%), magnetita(?10%), yesó?(?8%), líticos(?2%), biotita(<1%) y Apatita/Zircón?(<<1%).

SAND: Arena media a fina gris (N5) con fragmentos (?1cm) de arena cementada con carbonatos. Conformada por cuarzo(?90%), magnetita(?5%), yeso?(?3%), líticos(?2%), fragmentos carbonáticos(<<1%) y biotita(<<1%).

CLAY interbeded SAND: Arcilla marrón-pálida (5YR 5/2) intercala con escasos niveles (1 a 2cm) deformados de arena media a fina limosa gris.

VOLCANIC ASH: Nivel blanquecino limoso (Ceniza volcánica?-(vitreo?) con muy escasa presencia de cristales muy finos (<<1%).

SANDY CLAY: Arcilla marrón-oscura (10YR 4/2) arenosa (fina a muy fina). Fuerte deformación y contaminación por SPT.

SAND: Nivel de arena media a fina gris-oscura (N4) con escaso limo.

CLAY: Fuerte contaminación y alteración por SPT. Arcilla rojiza (10R 5/4).

CLAY: Arcilla verde (5G 5/2). En los primeros 13cm intercala rítmicamente (0,5 a 1cm) cona arcilla rojiza (10R 5/4) en transición con nivel superior.

SANDY CLAY: Arcilla con escasa arena fina marrón-pálida (10YR 6/2) y escasos fragmentos (?1cm) de arena cementada con carbonatos.

SAND: Arena media a fina gris (N5), conformada por cuarzo(?90%), magnetita(?5%), yeso?(?3%), líticos(?2%) y arenisca muy fina cementada con carbonatos(<<1%).

COARSE SAND: Arena gruesa a muy gruesa con clastos aislados (hasta 4mm) y escasa arena media a fina, conformada por arenisca muy fina con cemento carbonático(40%), fragmentos carbonáticos masivos(40%), cuarzo(?14%), líticos volcánicos(?3%) y metamórficos(?2%), magnetita(?1%). Color del conjunto gris (N5).

SAND: Arena fina a muy fina gris (N5) con muy escaso limo (moderada selección). Conformada por cuarzo(?85%), yeso?(?5%), carbonáticos masivos(?5%), magnetita(?3%), líticos(?2%) y biotita(<1%).

SAND: Arena gruesa a fina gris (N5), conformada por líticos volcánicos(?40%), cuarzo(?35%), arenisca muy fina cemento carbonático(?10%), agregados policristalinos de calcita(5%), líticos metamórficos(5%), yeso?(3%) y magnetita(2%).

SAND: Arena media a fina gris (N5) con escaso limo.

SAND: Arena gruesa a fina gris (N5).

COARSE SAND: Arena muy gruesa a gruesa gris (N5) con escasos granos medios a finos.

SAND: Arena fina a muy fina gris (N6).

CLAY: Nivel de arcilla gris verdosa (5Y 5/2).

SANDY GRAVEL: Grava fina (60%) conformada por clastos (2 a 5mm) subredondeados de líticos volcáicos(?55%), cuazo(?40%), líticos metamórficos(?3%), arenisca con cemento carbonático(?3%) y magnetita(?1%). Matriz de arena media a fina conformada por cuarzo(?75%), líticos volcánicos(?15%), yeso?(?8%), magnetita(?1%) y líticos metamórficos(?1%). Color del conjunto gris (N5).

SILTY SAND: Arena fina a muy fina gris limosa (N5).

SAND: Arena gruesa a fina gris (N5), conformada por cuarzo(?80%), magnetita(?8%), yeso?(?7%) Y líticos(?5%).

COARSE SAND: Grava (80%) fina (2 a 3mm) conformada por clastos subredondeados a subangulosos de líticos volcánicos(?60%), metamórficos(?24%), cuarzo(?15%), arenisca fina cementada con carbonatos(?1%). Arena fina conformada por cuarzo(?80%), líticos(?14%), yeso?(?5%) y magnetita(?1%). Color gris (N5) con muy escasa presencia de arcilla gris oscura a negra.

SANDY GRAVEL: Grava fina arenosa. Clastos subredondeados a subangulosos (2 a 3mm) conformados por pelitas y wakes(?) en distintos tonos de gris y gris-verdoso, líticos volcánicos rojizos (?) y cuarzo lechoso subangulosos.

CLAY: Arcilla marrón clara (10YR 6/2). Alteración y contaminación por SPT.

SANDY GRAVEL: Grava fina (>95%) conformada por clastos (2 a 12mm) de arenisca muy fina cementada con carbonatos(?55%), carbonatos masivos(?20%), cuarzo(?15%), líticos metamórficos(?8%) y volcánicos(?2%). Muy escasa (<%5) de arena fina.

CLAY: Arcilla marrón (5YR 4/4).

SAND cemented CARBONATE: Nive de arenisca media a fina cementada con carbonatos. Nivel fracturado por avance de perforación.

SAND: Arena fina a muy fina limosa con escaso clastos (2 a 3mm) dispersos. Color del conjunto marrón-claro (10YR 6/2).

SANDY GRAVEL: Grava (75%) fina (2 a 5mm) conformada por clastos subredondeados a subangulosos de líticos volcánicos(?50%) y metamórficos(?25%), arenisca fina cementada con carbonatos(?15%), cuarzo(?5%) y carbonatos masivos(?5%). En matriz de arena media a fina conformada por cuarzo (70%), líticos (15%), yeso? (9%), y magnetita (1%)

SILTY SAND: Arena fina a muy fina limosa marrón (10YR 6/2) hacia la base con muy escasos clastos (2 a 3mm) dispersos.

SILTY SAND: Arena fina limosa con clastos subredondeados de 0,2 a 1cm (dominan de 2 a 3mm). Conformada por cuarzo(?80%), líticos(?10%), yeso?(?8%), magnetita(?2%) y biotita(<<1%). Color del conjunto marrón (10YR 6/2).

SANDY GRAVEL: Grava fina (75%) conformada por líticos metamórficos(?65%), volcánicos(?20%), cuarzo(?10%), carbonáticos masivos(?5%). Muy escasos ejemplares alcanzan 1cm. Matriz de arena gruesa a fina conformada por cuarzo(?75%), líticos(?15%), yeso?(?7%), magnetita(?3%) y biotita(<<1%).

SAND: Arena media a fina gris (N6) conformada por cuarzo(?90%), magnetita(?5%), líticos(?4%), yeso?(?1%) y biotita(<<1%).

SILTY SAND: Arena muy gruesa a fina limosa.

SILTY SAND: Arena fina limosa con escasos clastos (?0,5cm) aislados y nivel deformado (1cm) de arcilla marrón.

SAND cemented CARBONATE: Nivel masivo de arenisca media a fina cementada con carbonatos. Nivel muy fracturado gris-claro a blanquecino (N7-N8).

SILTY SAND with CLAY: Arena fina a muy fina limosa con escasa arcilla gris clara (N7).

SAND: Arena media a fina marrón-pálida (10YR /2). Muy escasos componentes de arena gruesa y escasos clastos subredondeados (2 a 4mm). Conformada por cuarzo(?80%), líticos(?15%), yeso?(?4%), magnetita(?1%) y biotita(<1%).

SANDY GRAVEL: Grava (70%) fina (2 a 10mm) conformada por clastos subredondeados arenisca muy fina cementada con carbonatos(?85%), carbonatos masivos(5%), cuarzo(5%), líticos volcánico(3%) y metamórficos(2%), yeso?(<1%).

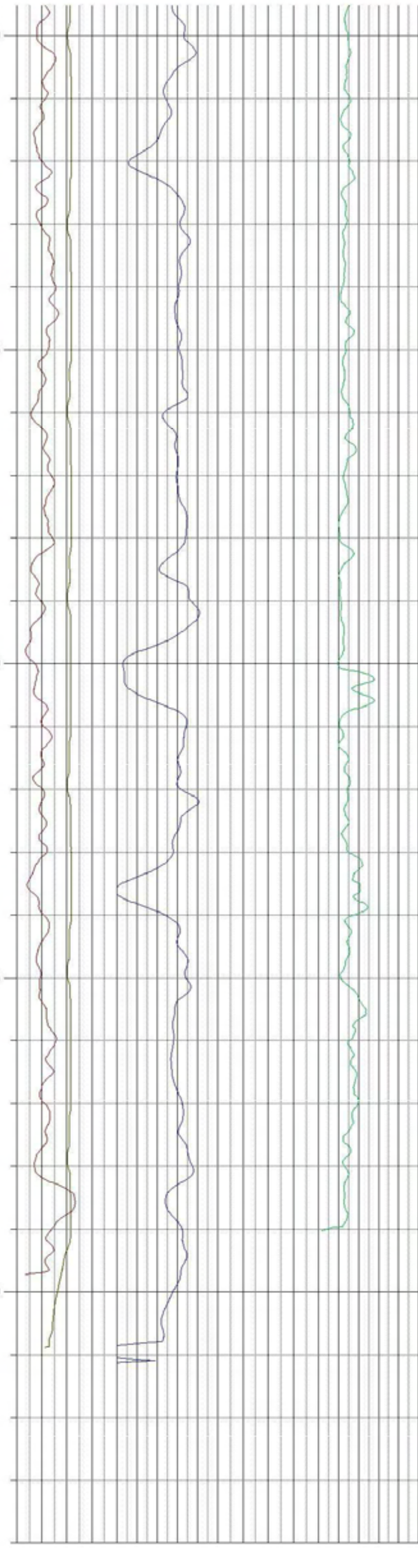
SILTY SAND: Arena fina a muy fina limosa gris (N5) con abundantes y gruesos fragmentos de arenisca media a fina cementada con carbonatos (3 a 6cm). Intercala niveles

Depth (m): 0, 5, 10, 15, 20, 25

Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910

OROCOBRE — RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 15-08-10	COORDINATES (POSGAR 94 Zone 3) E: 3431002	WELL REFERENCE: C-02
		DRILL RIG: SONIC	END DATE: 21-08-10	N: 7413939	Page 2 of 2
		METHOD: SONIC	DEPTH: 54m	Elevn: 3939,301	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Fd2

deformados (3cm) de arcilla arenosa marrón-clara (5YR 7/2) y arcilla rojiza (10R 4/6).

SAND: Arena media a fina gris (N6), conformada por cuarzo(?70%), liticos(?14%), magnetita(?10%), yeso?(?4%), carbonatos masivos(?2%) y biotita(<<1%).

SAND: Arena muy gruesa a fina con escasos clastos (2 a 3mm) subredondeados.

SILTY SAND with CLAY: Arena fina limo arcillosa marrón (5YR 5/2). Deformado y contaminado por avance de perforación.

SILTY SAND: Arena media a fina limosa con escasos clastos (2 a 3mm) aislados subredondeados.

SILTY SAND: Arena fina a muy fina limosa con fino nivel en la base (2cm) de arena media a fina.

CLAY: Arcilla verdosa-clara (5Y 7/2) deformada y contaminada por avance de perforación.

SAND: Nivel con abundantes fragmentos (0,2 a 4cm) de arenisca fina cementada con carbonatos en matriz de arena arcillosa. Color del conjunto gris-verdoso (10Y 6/2) a amarillento (5Y 7/6). Conformada por cuarzo, magnetita, Hr?, liticos y bioita? cementada con carbonatos de color marrón-amarillenta.

SAND: Arena gruesa a fina con muy escasos granos de arena muy gruesa, conformada por cuarzo(?75%), liticos(?10%), carbonáticos masivos(?5%), magnetita(?5%), yeso?(?4%) y arenisca muy fina cementada con carbonatos(?1%).. Color gris (N6).

SANDY GRAVEL: Grava muy fina (2 a 3mm) muy escasos clastos alcanzan 5mm. Matriz de arena muy gruesa a fina con escasa arcilla marrón de distribución muy irregular. Color del conjunto (10YR 6/2).

SILTY SAND: Arena limosa muy fina marrón (5YR 5/2) con nivel (3cm) arcilloso con fragmentos finos carbonáticos.

SAND cemented CARBONATE: Abundantes y gruesos fragmentos de arenisca gruesa a fina con cemento carbonático. Matriz muy escasa arena gruesa a fina arcillosa. (Nivel fracturado?).

SILTY SAND with CLAY: Arena muy fina limo-arcillosa marrón (5YR 4/4) intercala con dos niveles (4 y 2cm) carbonáticos arenosos y arcillosos respectivamente.

SAND: Arena media a fina con escasos granos de arena gruesa y muy gruesa, conformada por cuarzo(?80%), liticos(?15%), carbonatos masivos(?2%), yeso?(?2%) y magnetita(?1%). Color gris (N6).

SAND: Arena fina a media con muy escasos granos de arena gruesa. Color verde (5GY 3/2).

SILTY SAND: Arena muy fina limosa marrón (5YR 5/2) intercala con niveles de 2 a 3cm blanquecinos carbonáticos.

SAND: Fuerte alteración y contaminación por SPT. Abundantes y gruesos fragmentos de arenisca fina y arcilla cementadas con carbonatos en matri de arena arcillsoa marrón.

SAND cemented CARBONATE: Arena fina limosa blanquecina carbonática.

SILTY SAND: Arena fina a muy fina limosa marrón (5YR 5/2).

SAND cemented CARBONATE: Abundantes fragmentos de arenisca fina con cemento carbonático (nivel fracturado?) en escasa arcilla marrón.

CLAY: Arcilla rojiza (10R 4/6) con nodulo (4cm) cementado con carbonatos.

NO RECUPERADO.

SANDY CLAY: Arcilla arenosa rojiza (10R 5/4) intercala con dos niveles (4 y 7cm) de arena media a fina gris-verdosa (5Y 5/2).

SILTY SAND: Arena fina a muy fina limosa gris (N4) con nivel (1cm) de arcilla marrón. Fragmentos (2cm) de arena fina cementada con carbonatos.

SAND: Arena media a fina gris verdosa (5Y 5/2) con escasos granos de arena gruesa, conformada por cuarzo(?80%), liticos(?15%), carbonatos masivos(?2%), yeso?(?2%) y magnetita(?1%).

CLAYEY SAND: Arena fina limo-arcillosa marrón (5YR 5/2) intercala con dos niveles (6cm en tope y 10cm en base) de arcilla marrón con idem color.

SAND: Arena muy fina a fina arcillosa marrón (5YR 5/2) intercala con abundantes niveles de textura similar blanquecinos (N8) con carbonatos (fuerte reacción con HCl). Muy escasos niveles (2 a 3cm) fracturados con fragmentos de arenisca fina carbonática.

SILTY SAND: Arena fina a muy fina limosa marrón (5YR 5/2), conformada por cuarzo(?90%), magnetita(?5%), liticos?(?5%) y yeso?(?<1%).

SAND: Arena media a fina marrón con escaso limo, conformada por cuarzo(?85%), magnetita(?5%), liticos(?5%), yeso?(?3%), carbonatos masivos(?2%).

SAND cemented CARBONATE: Nivel con abundantes y finos fragmentos carbonáticos masivos (2 a 4mm) en matriz de arena fina a media limosa blanquecina (nivel fracturado).

CLAY interbeded SAND: Arcilla marrón-oscura (10YR 4/2) intercala con niveles (0,2 a 4cm) de arena fina limosa y arcilla verde-oscuro (10Y 4/2).

SAND: Arena media a fina gris (N5) intercala con nivel de arena fina limosa gris (11cm), dos niveles de arena fina limosa amarillentas (5Y 5/6) FeOx?, y nivel de arcilla verde (4cm). Conformada por cuarzo(?85%), magnetita(?5%), liticos(?5%), yeso?(?3%), carbonatos masivos(?2%).

SAND: Arena fina a media con escaso limo gris (N4) y muy escasos fragmentos angulosos aislados de arcilla marrón (intraclastos?). Conformada por cuarzo(?55%), magnetita(?15%), liticos metamórficos(?13%), arenisca muy fina carbonática(?5%), liticos volcánicos(?5%), yeso?(?5%) y biotita(?2%).

NO RECUPERADO.

SAND: Arena fina a muy fina gris (N4) con escaso limo, conformada por cuarzo(?75%), magnetita(?75%), biotita(?8%), yeso?(?5%) y liticos?(?2%).

CLAYEY SAND: Arena gruesa arcillosa verde-oscura (5GY 3/2) con fragmentos angulosos de arenisca fina cementada con carbonatos (1 a 2cm) y arcilla verde (5GY 3/2) de hasta 4cm (intraclastos?)

SILTY SAND: Arena fina limosa gris (N4), conformada por cuarzo(?80%), magnetita(?10%), biotita(?7%), yeso?(?2%) y liticos?(?1%). Dos gruesos fragmentos de arenisca media a fina (5cm) y grava fina arenosa (7cm) localizados de 48,60 a 48,70m. Escasos fragmentos de arcilla verde y arenisca fina cementada con carbonatos.

SILTY CLAY: Arcilla limosa marrón-clara (10YR 8/2).

VOLCANIC ASH: Nivel limoso blanquecino (N8) con muy escasa arena fina (ceniza volcánica?). Muy finos cristales (5-10%) con biotita y otros mafito (Hr?/Mt)

CLAYEY SAND: Arena limo arcillosa gris a gris-verdosa (N5 a 5Y 5/2) con distribución del color muy irregular. En tope, niveles deformados (3 a 5mm) de arena media a fina gris-verdosa y gris.

COARSE SAND: Arena muy gruesa a media verde(5GY 5/2) con escasos granos de arena fina, conformada por arenisca fina con cemento carbonático(?35%), fragmentos carbonáticos masivos(?30%), cuarzo(?25%), liticos volcánicos(?5%) y metamórficos?(?3%) y yeso?(?2%). Nivel basal (4cm) arena fina a muy fina limosa gris.

CLAY: Arcilla en distintos tonos de verde (10GY 5/2 a 10Gy 4/4). Intercala con dos niveles (2cm) de arcilla marrón-clara y escasos niveles (0.5 a 1cm) de arena fina limosa.

SAND: Arena media a fina gris (N5) con escasos granos de arena gruesa, conformada por cuarzo(?75%), magnetia(?10%), yeso?(?8%), carboantos masivos(?5%) y liticos(?2%). Hacia la base, dos niveles (?2cm) más oscuros (N3).

CLAY cemented CARBONATE: Abundantes fragmentos angulosos masivos carbonáticos en matriz de arcilla verde (10GY 5/2). Escasos rastros de arena media a fina en el tope (transición con nivel superior).

CLAY: Arcilla verde (10GY 5/2).

SAND: Arena media a fina gris (N4), conformada por cuarzo(?75%), magnetita(?15%), carbonatos masivos(?5%), yeso?(?3%), liticos(?2%) y biotita(<<1%). Escasos clastos en la base (?1cm) carbonáticos verdosos (intraclastos?).

CLAY: Arcilla verde (10GY 5/2).

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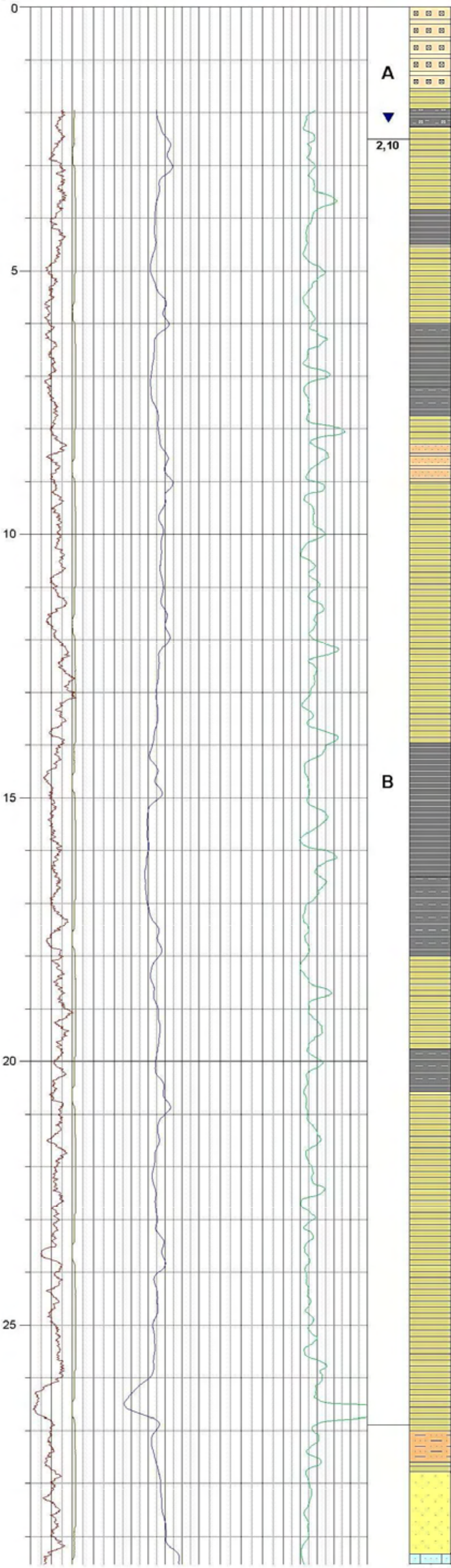
		METHOD: SONIC	DEPTH: 54m	N: 7410900	
				Elevn: 3938,785	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

HALITE with CLAY: Cristales de halita subhedros. En matriz de materia arcillosa negra y marron (10 YR 6/2). Abundantes rastros de ulexita. Cristales de halita (? 1 mm). Sedimento fuertemente disturbado.

CLAY: Arcilla marrón (5 YR 6/4). Fuerte alteración y contaminación de halita por SPT.

BLACK CLAY with HALITE: Intercalan arcilla marrón (5 YR 6/4) y negra con abundantes cristales de halita en cristales individuales (1- 2 mm) o agregados policristalinos (hasta 5 mm)

CLAY: Arcilla rojiza (10 R 5/4).

CLAY: Arcilla gris verdosa (5 Y 5/2). Rastros de arcilla marrón (5 YR 6/4) de contacto muy irregular.

BLACK CLAY: Arcilla negra intercalada con escasos y finos niveles (0,5 a 1 cm) de arcilla verde (5 y 5/2). Muy escazas y finas manchas anaranjadas pulvurulentas (Rejalgar oropimente?)

CLAY: Arcilla gris verdosa (5 Y 5/2). Con escazos rastros de materia organica y papas de ulexita (2 a 5 cm). Intercala varios niveles (0,5 cm) de arcilla gris verdosa con muy escasa arena.

CLAY: Intercalan arcilla marrón (10 YR 6/2) y gris verdosa (5 Y 5/2) de contactos irregulares. Escasos rastros de materia organica y niveles (0,2 a 0,3 cm) con muy finos cristales de (halita?)

CLAY interbeded ORGANICS: Arcilla gris verdosa (5 Y 5/2) con abundantes rastros de arcilla negra

BLACK CLAY: Arcilla negra con finos (0,5 cm) y escasos niveles intercalados de arcilla gris verdosa (5 Y 5/2).

CLAY interbeded ORGANICS: Intercalan ritmicamente con bancos (de ? 0,5 a 1 cm) arcilla negra y marrón (5 YR 6/4). Muy escasos y finos (? 1 mm) manchas anaranjadas pulverulentas.

CLAY: Arcilla marrón (5 YR 6/4).

SAND interbeded CLAY: Arena gruesa a media limo arcillosa gris (N 4), conformada por magnetita(?70%), selenita(?20%) y cuarzo(?10%). Intercala con escasos niveles (3 a 4 cm) de arcilla marrón (5 YR 6/4)

CLAY: Arcilla marrón (5 YR 6/4). Fuerte alteración y contaminación en los primeros 40 cm por SPT. Intercala nivel (2 cm) de arena fina limosa

CLAY: Arcilla rojiza (10 R 5/4). Muy escasos y aislados rastros de arcilla gris verdosa y escasos niveles (1 a 2 cm) de arcilla negra

BLACK CLAY: Arcilla negra. Muy escasos y finos niveles (0,5 a 1 cm) de arcilla rojiza en el tope.

CLAY interbeded ORGANICS: Sedimento fuertemente deformado por avance de perforación. Intercalación rítmica entre arcilla marrón (5YR 6/4) y negra. Hacia la base del nivel domina arcilla marrón.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros de arcilla negra.

CLAY interbeded ORGANICS: Arcilla marrón (5YR 6/4) con niveles (5 a 7cm?) muy deformados de arcilla negra con abundante agua.

CLAY: Arcilla marrón (5YR 6/4) con rastros de arcilla rojiza (10R 4/6) hacia los 21m. Intercala con escasos niveles deformados de arcilla marrón ligeramnete oscura (5YR 5/2).

CLAY: Arcilla marrón (5YR 6/4) con niveles deformados? (contactos muy irregulares) de arilla verde-clara (10Y 6/2).

CLAYEY SAND: Arena fina limo-arcillosa con abundante agua (N4), conformada por cuarzo(?80%), magnetita(?10%), yeso?(?5%), carbonáticos masivos(?3%), liticos?(?2%) y biotita(<1%).

CLAY: Arcilla verde oscura (10G 4/2) escasos rastros irregulares de arcilla marrón. Abundante agua.

SAND: Arena fina a muy fina limosa gris (N4), conformada por cuarzo(?85%), magnetita(?10%), yeso?(?3%), liticos volcánicos(?1%) y arenisca muy fina con cemento carbonático(?1%). Intercalan dos niveles fracturados (4 y 2cm) de arenisca fina cementada con carbonatos.

SAND cemented CARBONTAES: Arena fina a muy fina limosa gris-clara (N7) carbonática, conformada por cuarzo(?85%), magnetita(?5%), carbonatos masivos(?5%), liticos volcánicos(?3%) y yeso?(?2%).Escasos fragmentos (1 a 2mm) limosos carbonáticos (nodulos?). Nivel (12cm) de arena fina a muy fina limosa gris (N4).

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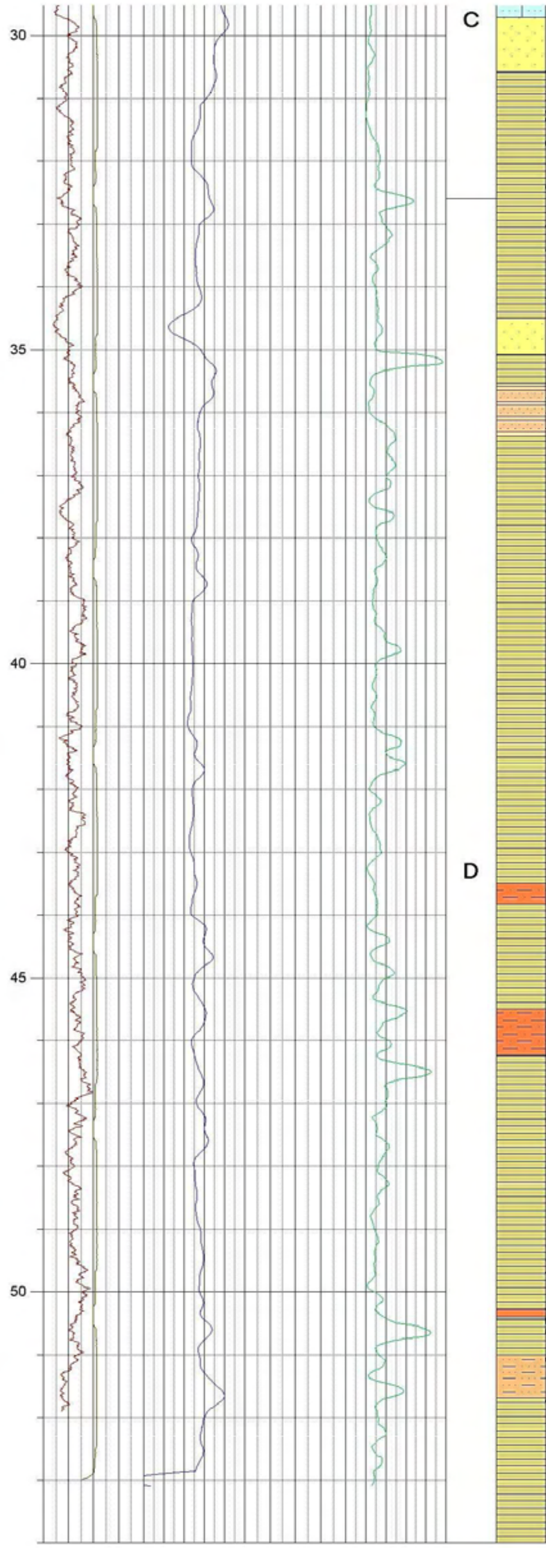
RESOURCE EVALUATION PROGRAM		METHOD: SONIC	DEPTH: 54m	N: 7410900		
				Elevn: 3938,785	LOGED BY: Geol. FERNANDO A. MARTÍN	

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



- SAND: Arena fina a muy fina limosa gris (N4). Nivel (2cm) con fragmentos subredondeados (2cm a 30mts) de arenisca fina cementada con carbonatos.
- CLAY: Arcilla gris-verdosa (10Y 4/2) con escasos niveles (5mm) carbonáticos arcillosos blanquecinos. Muy escasos y finos niveles (2mm) de arena muy fina limosa gris.
- CLAY: Abundantes fragmentos angulosos de arcilla con cemento carbonático en arcilla marrón clara (5YR 7/2).
- CLAY: Arcilla gris-verdosa (10Y 4/2) con abundantes fragmentos carbonáticos angulosos blanquecinos (3 a 4cm).
- CLAY: Arcilla marrón (5YR 5/2) hacia la base se torna gris-verdosa. Y remata con nivl (3cm) de arena fina a muy fina limosa gris-oscura (N3).
- CLAY: Arcilla gris-verdosa (10Y 4/2) con abundantes fragmentos carbonáticos angulosos blanquecinos (2 a 3cm). Nivel (3cm), en la base, de arcilla verde cementada con carbonatos.
- CLAY: Arcilla verde (10GY 5/2), con nivel (7cm) en el tope de arcilla marrón (5YR 5/2).
- CLAY: Arcilla verde (10GY 5/2). Abundantes fragmentos (?1mm) angulosos blanquecinos. Presencia de abunadnte agua. Nivel (7cm) en el tope de arcilla marrón (5YR 5/2).
- CLAY: Arcilla marrón (5YR 5/2). Fuerte contaminación en tope con arcilla verde del nivel superior por SPT.
- CLAY: Arcilla rojiza (10R 4/6). Escasos y aislados fragmentos carbonáticos (nodulos?) redondos (?1cm).
- CLAY: Arcilla verde (10GY 5/2) con escasos y aislados fragmentos carbonáticos (nodulos?) ?1cm.
- SAND: Arena media a fina gris (N4) con abundantes fragmentos blanquecinos carbonáticos angulosos (1 a 3mm).
- CLAY: Arcilla verde (10GY 5/2). Fino nivel (2cm) de arcilla marrón clara.
- SAND interbeded CLAY: Arena fina limosa gris (N4) intercala con niveles (2 a 4cm) de arcilla verde (10GY 5/2) deformados por avance de perforación.
- CLAY: Arcilla rojiza (10R 4/6).
- CLAY: Arcilla verde (10GY 5/2). Muy escasos rastros de arcilla negra.
- CLAY: Arcilla verde (10GY 5/2). Muy escasos y finos niveles deformados (2 a 4mm) de arcilla negra y dos nivel (9 y 2cm) deformado de arcilla rojiza.
- CLAY: Arcilla verde (10GY 5/2). Muy escasos rastros de arcilla negra.
- SANDY CLAY: Arcilla gris-verdosa (5G 6/1) con abundante agua. Escasos y aislados granos de arena media a fina y fragmentos de arcilla verde (10GY 5/2).
- CLAY: Arcilla verde (10GY 5/2) Muy escasos rastros de arcilla negra.
- SANDY CLAY: Arcilla gris-verdosa (5G 6/1) con abundante agua. Muy escasos y aislados granos de arena media a fina y fragmentos (?1mm) de arcilla verde (10GY 5/2).
- CLAY: Arcilla verde (10GY 5/2) con nivel (4cm) de arcilla gris-verdosa (5G 6/1) con abundante agua y escasa arena fina limosa.
- CLAY: Arcilla gris-verdosa (5G 6/1) con abundante agua y muy escasa arena fina limosa. Fragmentos (?1mm) de arcillagris-verdosa (idem color intraclastos?) y verde (10GY 5/2).
- CLAY: Arcilla verde (10GY 5/2) y verde clara (5GY 7/2) con nodulo de carbonato (4cm) blanquecino.
- CLAY: Arcilla gris-verdosa (5G 6/1) muy escasa presencia de arena muy fina limosa y abundante agua. Fragmentos de arcilla gris-verdosa (idem color) y verde (10GY 5/2) ?1mm (intraclastos?). Intercala nivel (8cm) de arcilla verde (5GY 5/2).
- CLAY: Arcilla verde (10GY 5/2). Escaso fragmentos (2 a 5cm) blanquecinos carbonáticos angulosos.
- CLAY: Arcilla rojiza (10R 4/6) con dos gruesos fragmentos (5 y 7cm) carbonáticos blanquecinos a verdosos.
- CLAY: Arcilla gris-verdosa (5G 6/1) abundante agua.
- CLAY: Arcilla rojiza (10R 4/6) pasa, en la base (últimos 11cm) a arcilla marrón-pálida (10YR 6/2).
- SILTY CLAY : Arcilla limosa gris-oscura (N4).
- SAND: Arena media a fina gris (N5).
- CLAY: Arcilla verde (10GY 5/2).
- CLAY: Arcilla rojiza (10R 4/6).
- CLAYEY SAND: Arena fina a muy fina arcillo-limosa marrón-pálida (10YR 6/2). Intercala nivel (10cm) en tope, con arcilla verde (10GY 5/2).
- CLAY: Arcilla rojiza (10R 4/6). Niveles (en 51,50 y 53,80m de 20cm) con fragmentos subredondeados (0,5 a 1cm) de arcilla rojiza cementada con carbonatos (nódulos?).

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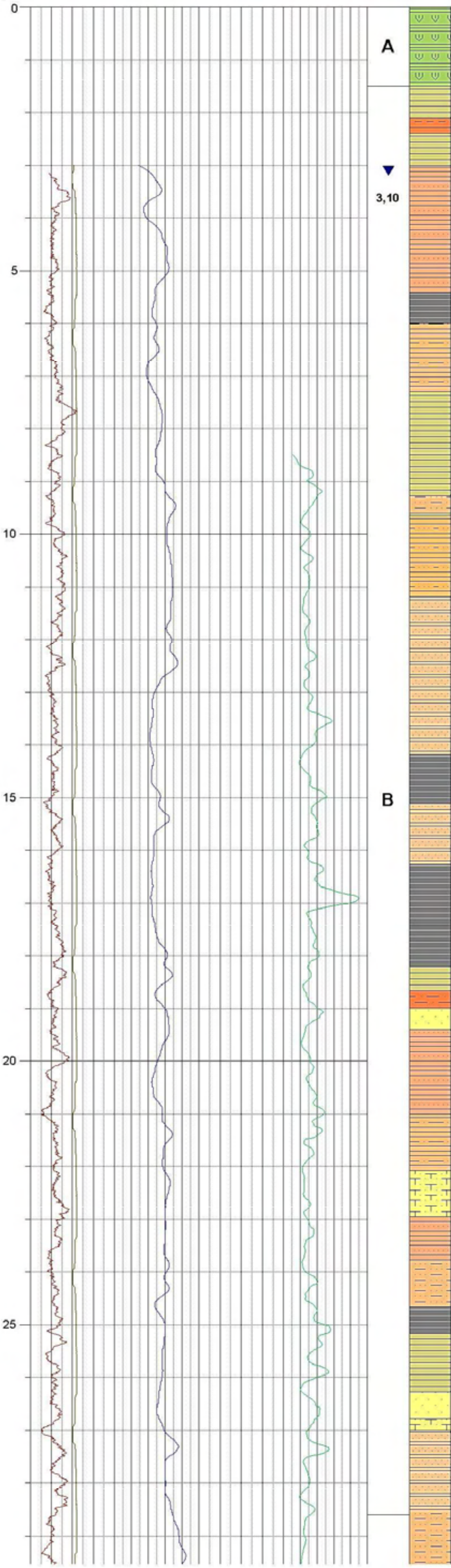
		METHOD: SONIC	DEPTH: 54m	N: 7411497	Page 1 of 2
				Elevn: 3938,916	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology:

CLAY with ULEXITE: Arcilla marrón (10YR 4/4) con muy escasa presencia de limo. Abundantes papas de ulexita (1 a 3cm) en todo el nivel. Nivel, en tope, de 3cm con abundantes cristales de halita (1 a 2mm) euhedros blanquecinos.

CLAY : Arcilla gris-verdosa (5Y 5/2).

SILTY CLAY: Arcilla limosa marrón-oscura (5YR 3/4) con muy finos a microcristales de halita. Abundantes niveles deformados (2 a 3cm) de ulexita.

CLAY : Arcilla marrón (10YR 4/4) con muy escasarastros de limo y papas de ulexita (2cm).

CLAY interbeded SAND: Arcilla marrón (5YR 5/2) a ligeramente rojiza (10R 5/4) intercalan con niveles (3 a 4cm) fuertemente deformados (por Split y avance de perforación), de arena muy fina limosa gris-verdosa (10Y 4/2). Escasas papas de ulexita (1 a 3cm).

BLACK CLAY : Arcilla negra con muy escasos y finos (?1cm) lentes de arena muy fina limosa y arcilla marrón. Escasas y finas papas (?1cm) de ulexita y manchas amarillentas pulverulentas (rejalgar/oropimente?).

CLAY interbeded SANDY CLAY: Arcilla marrón (10YR 4/2) intercala con niveles y papas de ulexita (1-2cm). Arcilla limo arenosa (arena muy fina) gris-verdosa (5Y 5/2) con menor presencia de arcilla rojiza (10R 5/4) y arcilla negra.

CLAY : Arcilla rojiza (10R 4/6). Abundantes rastros (en niveles muy deformados de ? 2 a 3cm) de arcilla negra. Muy escasa papas de ulexita (?1cm). Nivel (17m) de arcilla gris-verdosa (5GY 6/1)

CLAYEY SAND: Arena fina a muy fina limosa gris (N5). Hacia la base del nivel se torna ligeramente arcillosa.En la base, últimos 5cm, arcilla rojiza (10R 4/6) con escasas papas de ulexita (?1cm) y rastros irregulares de arcilla negra.

CLAY interbeded CLAYEY SAND: Intercalan, con contactos transicionales, arcilla gris-verdosa y arena fina limo arcillosa gris-verdosa (5Y 5/2) en niveles de aproximadamente 5cm.

SAND interbeded CLAY: Arena fina a muy fina limo arcillosa gris (N5) intercala con abundantes y niveles (0,5 a 20cm) de arcilla rojiza-clara (5R 6/2) con muy escasos rastros de arcilla negra.

BLACK CLAY : Arcilla negra intercala con escasos niveles (?1cm) de arena muy fina limo arcillosa gris (N5) y arcilla marrón.

SAND interbeded CLAY: Arena fina muy fina limosa (N5) intercala con escasos niveles deformados (?10cm) de arcilla verde (5GY 5/2) y negra. Conformada por cuarzo(?90%), líticos volcánicos?(?5%), magnetita(?3%), yeso?(?2%) y biotita(<<1%).

BLACK CLAY : Arcilla negra con muy escasos y finos (?1cm) niveles de arcilla marrón.

CLAY : Arcilla rojiza (10R 5/4) escasos rastros de arcilla negra.

SANDY CLAY: Arcilla arenosa (arena muy fina) gris-verdosa (5Y 5/2).

SAND: Arena media a fina con escasos clastos (hasta 2mm) muy escasa presencia de limo. Color gris-verdoso (10Y 4/2). Conformada por líticos volcánicos(?65%), cuarzo(?22%), carbonatos masivos(?5%), yeso?(?5%), líticos metamórficos?(?2%), magnetita(?1%) y biotita(<<1%).

CLAY interbeded SAND: Arcilla rojiza (10R 5/4) intercala en la base con tres niveles (?10cm) de arena fina a muy fina limosa gris-verdosa.

CLAY interbeded SANDY CLAY: Arcilla gris-verdosa (10Y 4/2) intercala con niveles (1 a 2cm) de arena muy fina arcillosa y arcilla arenosa (muy fina) limosa. Lente (3cm) de arena fina a muy fina gris.

SILTY SAND: Arena media a muy fina limosa gris (N5) conformada por cuarzo(?75%), líticos(?15%), magnetita(?5%), yeso?(?2%), fragmentos carbonáticos masivos(?2%), biotita(<1%) y Zircón/apatita?(<<1%).

CLAY interbeded SAND: Arcilla gris-verdosa (10Y 4/2) intercalacon niveles (0,5 a 1cm y uno de 20cm) de arena muy fina limosa. Últimos 6cm de arcilla rojiza-clara (10R 5/4).

CLAYEY SAND: Arena fina arcillosa gris (N5) a gris-oscura a negra en la base. La distribución de la arcilla es irregular.

BLACK CLAY : Arcilla negra intercala con finos niveles (2 a 3mm) de arcilla gris (N4).

CLAY : Arcilla verde (10GY 5/2) intercalan dos niveles (3 a 4cm) de arena media a fina gris.

SAND: Arena media a fina ligeramente limosa gris-oscura a negra. En el tope intercala con finos niveles (0,5 a 1cm) de arcilla negra y arena muy fina arcillosa. Conformada por magnetita(?75%), cuarzo(?15%) y líticos (?10%)(volvanico y metamórficos).

SILTY SAND: Arena fina a muy fina limosa con muy escasa arcilla gris-verdosa (5Y 5/2). Conformada por cuarzo(?75%), líticos(?14%), magnetita(?5%), carbonatos masivos(?5%) y yeso?(?1%).

SAND interbeded CLAY: Arena media a fina gris (N5) intercala con niveles de arcilla verde (10GY 5/2). Conformada por cuarzo(?85%), magnetita(?85%), líticos volcánicos(?5%), yeso?(?3%), líticos metamórficos?(?2%) y biotita(<1%).

CLAYEY SAND: Arena fina limo arcillosa gris-oscura a negra con abundante agua. Escasas y finas papas de ulexita (1 a 2cm). Fuerte alteración , en tope, por Split Spoon con nivel deformado (3cm) de arcilla gris verdosa (5Y 5/2). Hacia la base con numerosos fragmentos (intraclastos lenticulares?) con arena muy gruesa en matriz carbonática de 1 a 3cm, conformada por granos de cuarzo(?83%), líticos volcánicos(?12%), magnetita(?5%) y biotita(<1%).

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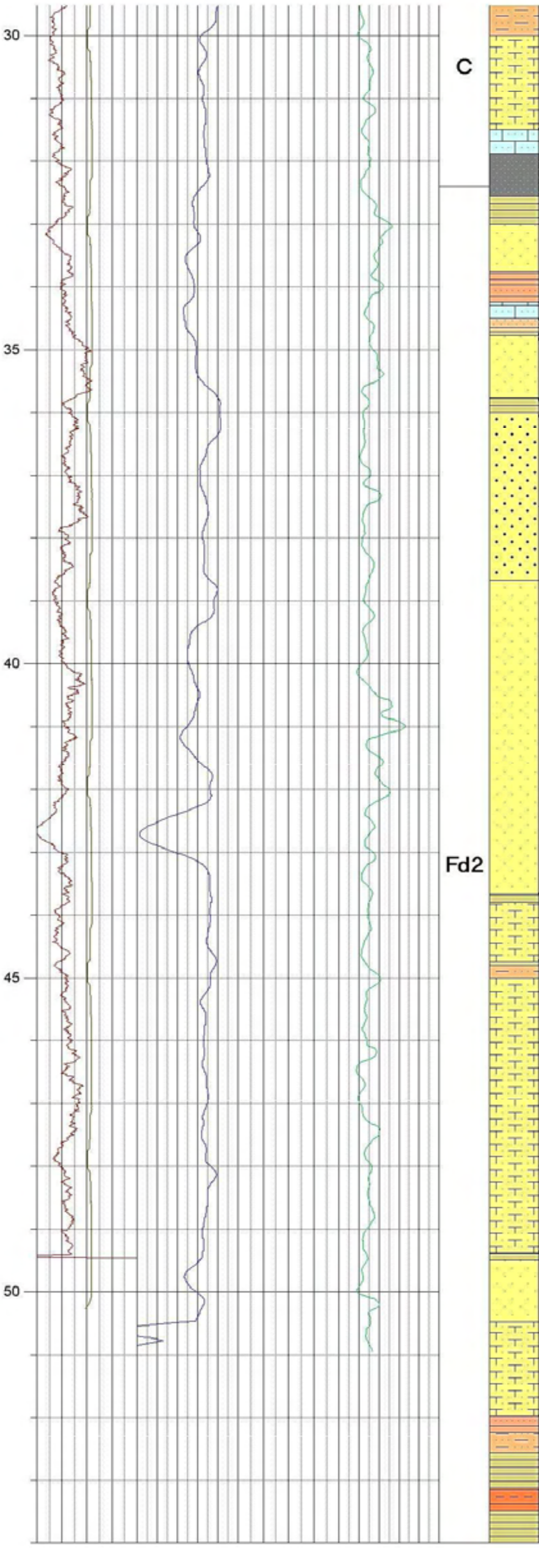
	METHOD: SONIC	DEPTH: 54m	N: 7411497	
			Elevn: 3938,916	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SILTY SAND: Arena fina limosa gris oscura a negra con abundante agua. Conformada por cuarzo(?85%), volcanicos(?8%), magnetita(?3%), yeso?(?3%) y carbonatos masivos(?1%).

SAND cemented CARBONATES: Fragmentos angulosos (0,3 a 3cm) de arena fina a muy fina cementada con carbonato, conformada principalmente por granos de cuarzo, magnetita y líticos. Escasa arena fina a muy fina suelta.

SAND with organics: Arena fina a muy fina limosa gris-oscura a negra. En algunos niveles (?10cm) con escasa presencia de arcilla. Hacia el tope, finos fragmentos (?1cm) de arena fina con cemento carbonático.

CLAY : Arcilla gris-verdosa (10GY 3/2).

SAND: Arena fina a media. Intercala en la base con nivel (1cm) de arcilla verde (10GY 5/2). En los últimos 5cm, abundantes fragmentos (2mm a 1cm) angulosos de arena fina cementada con carbonato. Abundante agua en todo el nivel. Conformada por granos de cuarzo(?75%), líticos volcánicos(?10%), magnetita(?7%), metamórficos(?3%), yeso?(?3%), carbonatos masivos(?2%) y biotita(<1%).

CLAY interbeded SAND: Arcilla verde (10GY 5/2) con niveles muy deformados (1 a 3cm) de arena muy fina limosa gris y arena arcillosa verde. Muy escasos fragmentos (1cm) de arenisca fina cementada con carbonatos.

SAND cemented CARBONATES: Nivel de Caliche (?). Nivel carbonático masivo intercala con finos niveles (3mm) de arena fina gris.

SAND interbeded CLAY: Arena fina a muy fina limosa gris-oscura. Intercala con finos niveles (1cm) de arcilla verde deformada por Split Spoon.

CLAY : Arcilla gris-clara (N8) y nivel de arcilla marrón con fragmentos (4cm) de arena fina a muy gruesa (hasta 2mm) cementada con carbonato.

SAND: Arena muy gruesa a fina. Muy escasos clastos alcanzan los 4mm (grava fina) conformada por clastos (2 a 3mm) subredondeados de líticos volcánicos(?50%), metamórficos(?25%), carbonatos masivos(?15%) y cuarzo(?10%). Arena conformada por cuarzo(?70%), líticos volcánicos(?15%), líticos metamórficos(?5%), yeso?(?5%), carbonatos masivos(?3%) y magnetita(?2%).

CLAY : Arcilla marrón-clara (5YR 7/2) con abundantes fragmentos de arenisca fina con cemento carbonático (3mm a 2cm).

COARSE SAND: Arena gruesa a media gris (N5) grada desde 36,9 a 37mts a arena muy gruesa con grava fina con granos y granulos subredondeados a subangulosos. Dominan los de 3mm. Conformada por cuarzo(?60%), líticos volcánicos(?15%), arenisca con cemento carbonático(?10%), metamórficos(?5%), yeso?(?5%), carbonatos masivos(?3%) y magnetita(?2%).

COARSE SAND: Arena gruesa a media gris (N5) con abundantes clastos dispersos de grava fina (2 a 5mm) subredondeados a subangulosos. Conformada por clastos (2 a 3mm) subredondeados a subangulosos de líticos metamórficos(?35%), volcánicos(?35%), cuarzo(?25%), carbonatos con muy finas inclusiones(?5%). Matriz de arena media a fina conformada por cuarzo, líticos, yeso?, carbonatos masivos, magnetita y biotita.

SAND: Arena fina a media gris-oscura (N3). Escasos y aislados clastos (2 a 3mm) y muy escaso limo. Conformada por cuarzo(?65%), líticos volcánicos(?10%), metamórficos(?10%), magnetita(?8%), yeso?(?5%) y carbonatos masivos(?2%).

CLAY : Arcilla verde (10GY 5/2).

SILTY SAND: Arena muy fina a fina limosa. Hacia la base grada a arena media a fina gris (N5) con escasos componentes de arena gruesa.

CLAYEY SAND: Arena muy fina limo arcillosa con abundante agua, conformada por cuarzo(?70%), magnetita(?13%), líticos(?10%), carbonatos masivos(?5%) y yeso?(?2%). Nivel inicial (5cm) de arcilla verde (10GY 5/2) con escasas manchas amarillas pulverulentas (rejalgar/oropimente?).

SILTY SAND: Arena media a fina limosa gris (N5) con muy escaso clastos de 2 a 3mm, conformada por cuarzo(?75%), carbonatos masivos(?10%), arenisca con cemento carbonático(?5%), magnetita(?5%), líticos(?5%) y biotita(<1%). Hacia 47,15m dos concreciones de carbonato (intraclastos?) de 3cm cada uno y nivel de arcilla verde (5cm). Por debajo de este nivel de arcilla muy escaso fragmentos (1cm) de arena fina con cemento carbonático.

SILTY SAND: Arena fina a muy fina limosa gris (N5) Hacia la base grada a arena muy gruesa a fina con muy escaso limo. Intercalan dos niveles (1cm) de arcilla marrón (5YR 4/4). Conformada por cuarzo(?75%), magnetita(?10%), líticos volcánicos(?10%), yeso?(?3%) y carbonatos masivos(?2%).

CLAY : Arcilla marrón (5YR 4/4).

SAND: Arena gruesa a fina gris con escaso limo. Escasos y finos niveles (0,5cm) de arena arcillosa marrón (arena gruesa a fina).

SILTY SAND: Arena fina a muy fina limosa gris (N4), En el tope intercala con escasos niveles (2 a 3cm) de arcilla marrón. Conformada por cuarzo(?75%), magnetita(?12%), líticos(?8%), carbonatos masivos(?4%) y yeso?(?1%).

CLAY interbeded SAND: Intercalación rítmica de niveles (?1cm) de arcilla marrón (5YR 4/4) y arena gruesa a fina limosa gris.

CLAYEY SAND: Arena media a fina limo arcillosa gris (N5). Últimos 6cm Nivel de caliche (?). Carbonato masivo gris-blanquecino

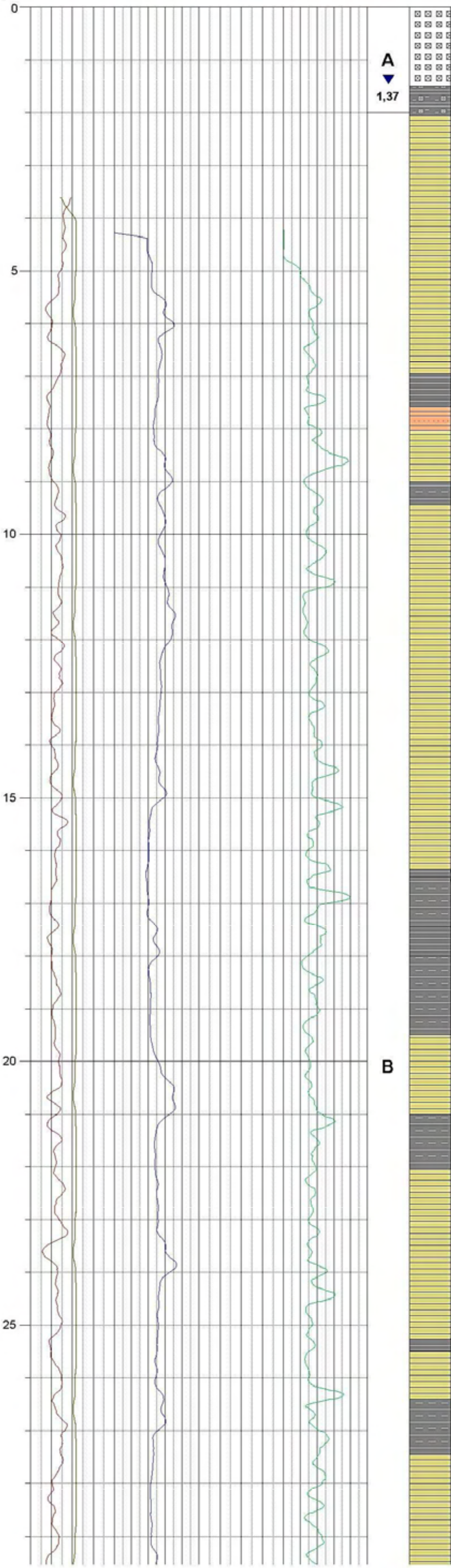
CLAY : Mix irregular de arcilla verde (10GY 5/2) y marrón (5YR 5/2).

SILTY CLAY: Arcilla limosa gris-blanquecina grada, hacia la base a gris clara (N6).

CLAY : Mix, de contacto muy irregular entre arcilla rojiza (10R 5/4), verde (5GY 5/2) y menro arcilla negra.

OROCOBRE — RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 05-09-10	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-05
		DRILL RIG: SONIC	END DATE: 09-09-10	E: 3424999	Page 1 of 2
		METHOD: SONIC	DEPTH: 54m	N: 7409002	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 3938,888	

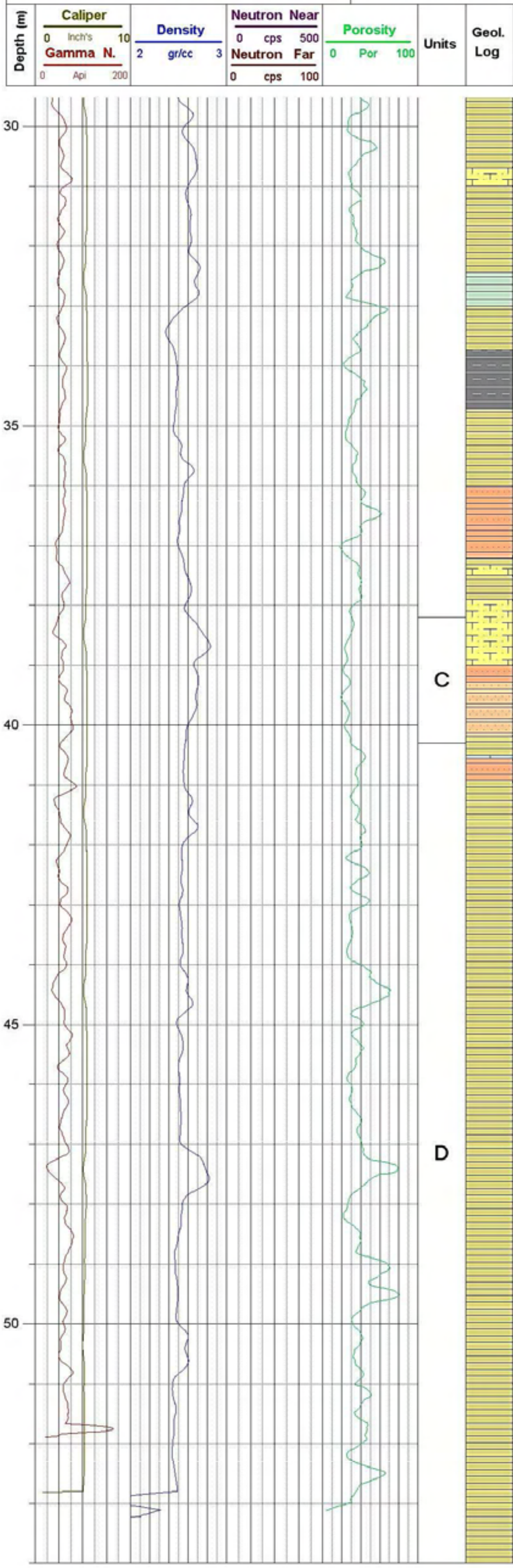
Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology
HALITE: Halita masiva compacta color del conjunto blanco. Cristales 1 a 2mm anhedros a subhedros muy escasos son translucidos. Nivel fracturado por avance de perforación.
HALITE: Halita masiva con poros, en algunos sectores fracturada. Cristales de 1 a 3mm. Presencia de escaso material clástico (limo-arcilla?) tiñe de rojizo parte del nivel.
HALITE: Halita con cristales subhedros a euhedros (<1 a 5mm) translucidos y blanquecinos. Posee nivel con mayor abundancia de material clástico marrón-rojizo y niveles deformados con presencia de arcilla negra.
BLACK CLAY with HALITE: Cristales de halita (1 a 5mm, dominan 2 a 3mm) en abundante arcilla negra (materia orgánica). Con abundante agua. Cristales euhedros a subhedros translucidos. Intercala nivel (6cm) de arcilla amrrón y negra (deformada SPT) con fina papas (2cm) de ulexita.
CLAY: Arcilla marrón-clara (5YR 6/4) contaminada y deformada por avance de perforación. Nivel en tope muy deformado de arcilla negra con papa (3cm) de ulexita.
CLAY: Arcilla marrón (10YR 6/2) fuertemente contaminada y deformada por avance de perforación y SPT.
CLAY: Arcilla rojiza-oscura (10R 4/2).
CLAY: Mix, de contacto irregular, de arcilla rojiza-oscura (10R 4/2) y arcilla gris-verdosa (5GY 6/1) con rastros de arcilla negra (lenticular?).
CLAY: Arcilla gris verdosa (5Y 5/2) con escasos rastros de arcilla negra. Ulxita en papas (3 a 5cm) Papa de 5cm con arena media a fina.
BLACK CLAY: Arcilla negra cona escasos niveles (0,5 a 1cm) de ulexita. Manchas amarillentas pulverulentas (rejalgar/oropimente?).
CLAY interbeded SAND: Intercala arcilla rojiza (10R 5/4) con niveles (3 a 5cm) de arena gruesa a media con abundantes rastros de arcilla negra y niveles de arcilla negra con fuerte deformación.
CLAY: Arcilla rojiza (10R 5/4) con escasos rastros irregulares de arcilla negra. En tope, nivel (3cm) de arena gruesa.
CLAY interbeded ORGANICS: Arcilla marrón (5YR 6/4) con abundantes rastros de arcilla negra. Fuerte alteración y contaminación por SPT.
CLAY: Arcilla marrón (5YR 6/4) intercala con escasos niveles deformados (2 a 3cm) de arena fina a muy fina limosa marrón. Gruesos agregados polcristalinos de selenita (rosa del desierto) hasta 1cm. Rastros irregulares de arcilla negra.
CLAY: Arcilla marrón (5YR 6/4) con escasos niveles muy deformados (3cm) de arena media a fina limo-arcillosa gris.
CLAY: Arcilla rojiza-pálida (10R 5/4). Escasos y aislados cristales de selenita de distinto tamaño (0,2 a 2cm) muy escasos forman rosas del desierto. De 12 a 12,44m y 1,5 13,92 Alteración y contaminación por SPT.
CLAY: Arcilla verde (10GY 5/2).
CLAY: Arcilla rojiza (10R 5/4) intercala con niveles (0,5 a 2cm) de arcilla negra. Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?). Transicional con el nivel inferior.
BLACK CLAY: Arcilla negra.
CLAY interbeded ORGANICS: Arcilla rojiza (10R 4/6) con niveles escasos muy deformados (1 a 2cm) de arcilla negra y nivel (2cm) de arcilla verde.
BLACK CLAY: Arcilla negra con nivel intercalado (9cm) de arcilla rojiza (10R 4/6) con rastros irregulares de arcilla negra.
CLAY interbeded ORGANICS: Intercalan rítmicamente arcilla rojiza (10R 5/4) con arcilla negra (0,5 a 1cm). Fuerte deformación en zona de tope por SPT.
CLAY: Arcilla rojiza-pálida (10R 5/4). Contacto irregular transicional con arcilla marrón (10YR 6/2). Nivel central de arena media (2cm) a fina gris (N5). En tope fuerte alteración y contaminación con arcilla negra por SPT.
CLAY interbeded ORGANICS: Arcilla rojiza-pálida (10R 5/4) con finos niveles (2 a 5mm) de arcilla negra.
CLAY: Arcilla rojiza-pálida (10R 6/2) con muy escasos rastros de arcilla negra (en lentes de 3mm aprox.).
CLAY: Arcilla gris-verdosa (5Y 5/2) con escasos y finos niveles (2mm) de arcilla negra.
BLACK CLAY: Arcilla negra con escasos y finos niveles (?1mm) limosos gris (N4).
CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasos rastros de arcilla negra, en finos niveles (1 a 2mm) en la base.
CLAY interbeded ORGANICS: Intercalan rítmicamente arcilla marrón pálida (10YR 6/2) y arcilla negra en niveles de 0,2 a 1cm.
CLAY: Arcilla gris-verdosa (5Y 5/2) con escasos rastros irregulares de arcilla negra.
CLAY: Arcilla verde (10GY 5/2).
CLAY: Arcilla marrón (10YR 6/2) a ligeramente verdosa (5Y 5/2) con escasos rastros de arcilla negra.
CLAY: Arcilla verde (10GY 5/2) con muy escasos rastros irregulares de arcilla negra.

Depth (m)	Elevn. (m)
0	
5	3935
10	3930
15	3925
20	3920
25	3915
	3910

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY DRILL RIG: SONIC METHOD: SONIC	START DATE: 05-09-10 END DATE: 09-09-10 DEPTH: 54m	COORDINATES (POSGAR 94 Zone 3) E: 3424999 N: 7409002 Elevn: 3938,888	WELL REFERENCE: C-05 Page 2 of 2 LOGED BY: Geol. FERNANDO A. MARTÍN

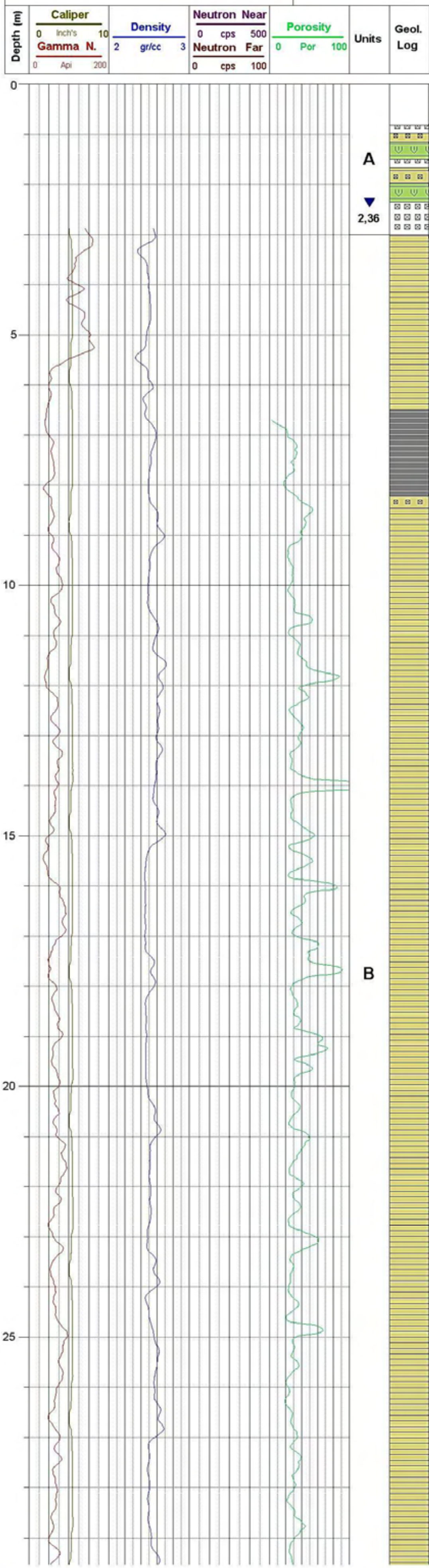


Lithology

- CLAY: Arcilla marrón-pálida (10YR 6/2) con muy escasos rastros irregulares de arcilla negra y lentes (1cm) de arena muy fina limosa gris.
- CLAY: Arcilla rojiza-oscura (10R 4/2) intercala con nivel (3cm) deformado de arena media a fina limo-arcillosa gris (N5).
- SILTY SAND: Arena fina a muy fina limosa gris (N5), conformada por cuarzo(?80%), magnetita(?14%), yeso?(?5%) Y liticos?(?1%). Interclala con nivel (2cm) de arcilla marrón-amarillenta (10Y 6/4).
- CLAY: Arcilla marrón-amarillenta (5Y 6/4) contaminada y alterada en zona de tope.
- CLAY with CARBONATES: Arcilla marrón-clara (10YR 6/2) pasa transicionalmente (zona central) a arcilla gris verdosa (5Y 5/2) en la base. Presencia de carbonatos (fuerte reacción con HCl en toda la arcilla).
- CLAY: Mix de contacto irregular entre arcilla marrón amarillenta (5Y 6/4) y rojiza-pálida (10R 6/2). Alterado por SPT.
- CLAY interbeded ORGANICS: Arcilla gris verdosa-oscura (10Y 4/2) con abundantes manchas, en formas de motas, de arcilla negra (?). Fuerte reacción de todo el conjunto con HCl. Nódulos(2cm) blanquecinos carbonáticos.
- CLAY: Sedimento fuertemente disturbado. Mix de arcilla marró-pálida (10YR 6/2) y arcilla gris-verdosa (5Y 5/2) con tres gruesos fragmentos (5x2cm=nivel fracturado?) carbonáticos marrón-pálidos (10YR 6/2). Escasos lentes? De arcilla marrón-amarillenta (5Y 6/4) en arcilla gris verdosa.
- CLAY interbeded SAND: Arcilla marrón-amarillenta (5Y 6/4) con abundante arcilla negra con escasos granos de arena fina a media. (intercalaldos?). Abundante agua.
- CLAY : Arcilla verde (10GY 5/2) con rastros de arcilla negra. Fragmento de 5x2cm carbonático (nivel fraturado?).
- SILTY SAND: Arena muy fina limosa negra.
- CLAY: Arcilla verde (10GY 5/2) contaminada y deformada por SPT.
- SILTY SAND: Arena media a fina limosa gris-oscura (N3) a negra, conformada por cuarzo(?65%), liticos volcánicos(?15%), yeso?(?13%), magnetita(?5%) y metamórficos?(?2%). Hacia el tope, intercala con niveles (2 a 3cm) deformados de arcilla verde (10GY 5/2).
- CLAY interbeded SAND: Intercalación rítmica (1cm) de arcilla rojiza (10R 4/6) y verdosa con arena fina limosa negra.
- SAND interbeded CLAY: Arena media a fina limosa gris (N4) intercala con dos niveles (4 y 9cm) de arena arcillosa rojiza y arcilla rojiza (10R 4/6) con rastros de arcilla negra, respectivamente. Conformada por cuarzo(?75%), magnetita(?10%), liticos volcánicos(?10%), yeso?(?4%) y metamórficos?(?1%). Hacia la base nivel (4cm) de arenisca gris cementada con carbonatos (nivel fracturado).
- CLAY: Arcilla verde (10GY 5/2) deformado y contaminado (en zona central) por avane de perforación.
- SAND cemented CABONATE: Arenisca fina cementada con carbonatos.
- CLAY interbeded SAND: Arcilla gris-verdosa (5Y 5/2) intercala? Con arena media a fina limosa gris (N4). Estructura original fuertemente deformada por avance y SPT.
- CLAY: Arcilla rojiza (10R 4/6).
- CLAY: Arcilla verde (10GY 5/2). Muy escasos rastros de arcilla negra. Nivel (4cm) de arena fina limo-arcillosa gris (N6) a los 44,70m con abundnate agua.
- CLAY: Arcilla rojiza (10R 4/6) con nivel (9cm) en el tope carbonático fracturado por SPT. Carbonato masivo blanquecino a marrón-claro (arcilla cementada?).
- CLAY: Arcilla verde (10GY 5/2) con niveles de arcilla rojiza (1cm) y arcilla limosa gris (N6) con abundnate agua y muy escasa arena fina.
- CLAY: Arcilla verde (10GY 5/2) con fragmentos? De arcilla marrón-pálida (10YR 6/2) con poco agua (friable) Intraclastos? Hasta 10cm. En la base intercala con nivel deformado (3cm) de arcilla rojiza (10R 4/6).
- CLAY: Arcilla rojiza (10R 4/6) intercala con dos niveles deformados (8 y 12cm) de arcilla verde (10GY 5/2).
- CLAY: Arcilla marrón-pálida (10YR 6/2) hacia la base intercala con escasos y finos niveles (0,2 a 0,5cm) de arcilla negra y rojiza (10R 4/6).
- CLAY: Arcilla rojiza (10R 4/6) ligeramente oscura intercala con niveles aislados (0,2 a 0,7cm) de arcilla negra. Fuerte deformación de la estructura origial or avance de perforación.
- CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasos niveles (1 a 2mm) de arcilla negra.
- CLAY: Arcilla verde (10GY 5/2) con muy escasos rastros de arcilla negra. Hacia la base abundantes manchas anaranjadas pulverulentas (rejalgar/oropimente?).

Depth (m): 30, 35, 40, 45, 50 — Elevn. (m): 3905, 3900, 3895, 3890, 3885

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY	START DATE: 16-09-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-06
	DRILL RIG: SONIC	END DATE: 20-09-2010	E: 3429002	Page 1 of 2
	METHOD: SONIC	DEPTH: 54m	N: 7408995	
			Elevn: 3939,013	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

NO RECUPERADO

HALITE: Halita en cristales euhedros a subhedros (?1 a 3mm) blanquecinos lechosos. Muy escasa presencia de material clástico arcillo-limoso rojizo. Alta porosidad.

CLAY with HALITE: Arcilla negra con abundantes microcristales de halita y finas papas de ulexita (0,5 a 1cm).

CLAY with ULEXITE: Arcilla rojiza (10R 5/4) con escasas papas de ulexita (2 a 3cm).

HALITE WITH CLAY: Halita en cristales sueltos subhedros (1 a 3mm) translucidos y blanquecinos en arcilla negra. Papas de ulexita (1 a 3cm).

CLAY with HALITE: Arcilla marrón (10YR 6/2) con abundantes y muy finos cristales de halita. Abundantes niveles deformados (0,5 a 1cm) de ulexita.

CLAY with ULEXITE: Arcilla rojiza (10R 5/4) con papas de ulexita (1 a 3cm). Cristales individuales de selenita o como agregados policristalinos (rosas del desierto). Finos lentes (?2cm) de halita (<1mm) en matriz arcillosa gris-oscura (N3).

HALITE: Sedimento fuertemente alterado por avance de perforación. Halita en gruesos cristales (2 a 5mm) blanquecinos subhedros con escasa presencia de material clásticos. En los bordes de lexan arcilla rojiza con selenita (1 a 2cm).

CLAY : Arcilla gris-verdosa (5Y 5/2), en escasos sectores, con presencia de microcristales de halita (tamaño arena fina). Intercalan niveles de arcilla negra con ulexita (2 a 5cm). Muy escasos y aislados cristales de selenita (0,5cm).

CLAY : Arcilla marrón (10YR 4/2) con muy escasas papas de ulexita (1cm) y cristales de selenita (0,5cm).

CLAY : Arcilla gris-verdosa (5Y 5/2) con niveles (?3cm) muy deformados de arcilla negra con ulexita.

CLAY : Arcilla marrón (10YR 4/2) con muy escasos rastros (?2cm un solo nivel) de arcilla negra y ulexita.

CLAY : Arcilla gris-verdosa (5Y 5/2) con muy escasas papas (1cm) de ulexita.

BLACK CLAY: Arcilla negra con escasas papas (1 a 2cm) y nivel (3cm) de ulexita. Hacia el tope con abundantes microcristales de halita.

CLAY with HALITE: Arcilla rojiza-pálida (10R 5/4) intercala con dos niveles (?4cm) con abundantes cristales de halita en matriz de arcilla negra (<1mm). Escasas papas de ulexita y cristales de selenita (0,5cm).

CLAY: Arcilla verde (10GY 5/2) cristales aislados de selenita (hasta 1cm). De 9 a 9,58m fuerte alteración de la estructura original por avance y SPT.

CLAY: Arcilla marrón-pálida (10YR 6/2) intercala con nivel de arcilla negra (3cm) deformado con papa de ulexita. Grueso cristal de selenita (3cm) y escasas manchas irregualres de acilla negra.

BLACK CLAY: Arcilla negra, hacia la base intercala con finos y escasos niveles de arcilla marrón (0,5 a 1cm).

CLAY: Arcilla rojiza (10R 5/4) con nivel intercalado en tope con abundantes microcristales de halita en matriz arcillosa gris (contaminación?).

CLAY: Arcilla marrón-pálida (10YR 6/2) con papas de ulexita (1 a 2cm). Nivel (4cm) con abundantes microcristales de halita. Cristales de selenita (0,5cm) escasos forman agregados de varios individuos intercrecidos. Nivel (7cm) de arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) 'papas de ulexita (5cm). Fuerte alteración y contaminación por SPT.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) hacia la base escasas papas de ulexita (1 a 2cm).

CLAY: Arcilla verde (10GY 5/2).

BLACK CLAY: Arcilla negra intercala con escasos bancos de arcilla marrón (10YR 6/2) y rojiza (10R 4/6). Sedimento muy plástico deformado por avance de perforación.

CLAY: Arcilla rojiza (10R 4/6) con escasos niveles (2 a 5mm) de arcilla negra fuertemente deformados por avance (alta plasticidad). Contaminación por SPT.

CLAY: Arcilla gris-verdosa (5Y 5/2) con nivel deformado de color blanquecino (arcilloso de alta plasticidad) carbonático (fuerte reacción con HCl).

CLAY: Arcilla marrón-pálida (10YR 6/2) intercala con niveles (2 a 5mm) de arcilla negra.

CLAY: Arcilla marrón-páida deformada y contaminada por SPT.

CLAY: Arcilla verde (10GY 5/2) con fino nivel (1cm) de arena muy fina limosa gris (N6).

CLAY: Arcilla marrón-pálida (10YR 6/2) intercla con muy escaso niveles (0,5cm) de arcilla rojiza-pálida y finos niveles deformados (?2mm) de arena fina limosa gris. Escasos rastros irregulares de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) muy escasos rastros irregulares de arcilla negra y niveles (<1cm) de arena muy fina limosa gris.

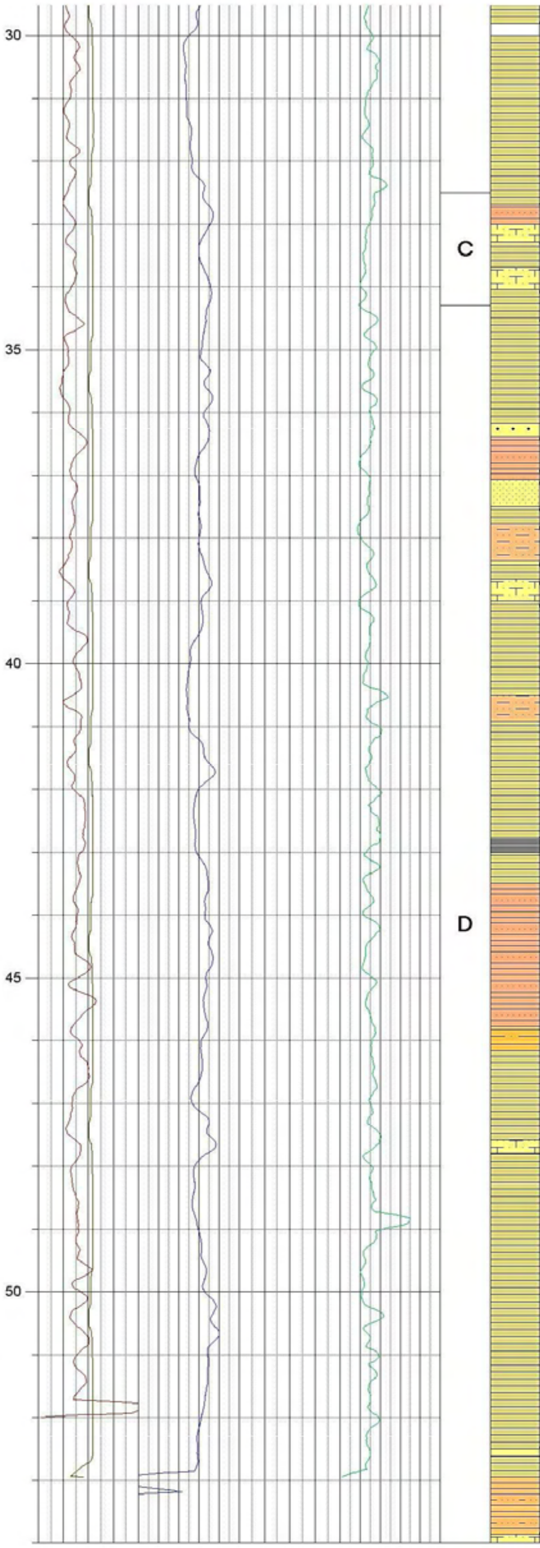
CLAY: Arcilla marrón-pálida (10YR 6/2) intercala con niveles (2 a 4mm) de arcilla negra.

CLAY: Fuerte contaminación y altercación por avance de perforación. Arcilla marrón-pálida (10YR 6/2) con escaso rastros de arcilla negra. En la base, últimos 35cm, mix con arcilla verde (10GY 5/2), muy deformado con alta plasticidad.

Depth (m)	Elevn. (m)
0	
	3935
5	
	3930
10	
	3925
15	
	3920
20	
	3915
25	
	3910

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 16-09-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-06
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 20-09-2010	E: 3429002 / N: 7408995	Page 2 of 2
	METHOD: SONIC	DEPTH: 54m	Elevn: 3939,013	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) intercala con escasos niveles de arcilla negra y muy finos niveles (?1mm) de arena fina gris limosa. Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY interbeded SAND: Arcilla marrón (10YR 6/2) con rastros irregulares de arcilla negra intercala con niveles (3 a 4cm) de arena fina limosa.

SILTY SAND: Arena media a fina limosa gris (N6), conformada por cuarzo(?70%), líticos volcánicos(?15%), yeso?(?10%), magnetita(?3%) y carbonaos masivos(?2%). Intercala con escasos niveles deformados (1 a 2cm) de arcilla verde con rastros de arcilla negra.

CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente rojiza.

SILTY SAND: Arena fina muy fina limosa gris (N6), conformada por cuarzo(?85%), magnetia(?5%), líticos volcánicos?(?5%), yeso?(?2%), carbonaos masivos(?2%) y biotita(?1%).

CLAY : Arcilla limosa gris-verdosa (5Y 5/2). Fragmento carbonáico masivo blanquecino. En tope, nivel de arcilla marrón clara (2cm).

CLAY: Fuerte contaminación y altercación por avance y SPT. Arcilla marrón-pálida (10YR 6/2) y clara (5Y 6/4) intecala con escasos niveles de arena fina limosa con abundantes rastros de materia orgánica (arcilla negra).

CLAY: Arcilla limosa marrón-oscura (10YR 4/2) con nivel deformado (1cm) de arcilla marrón-clara.

CLAY: Arcilla gris verdosa (5Y 5/2) intercala con nivel (3cm) de arena fina limosa. Fragmentos subredondeados en arcilla (5cm) carbonáticos blanquecinos (nodulos?).

COARSE SAND: Arena gruesa a fina (60%) conformada por cuarzo(?80%), líticos volcánicos(?10%), magnetita(?7%), yeso?(?2%), carbonatos masivos(?1%) y biotita(<1%). Grava fina (2 a 4mm) conformada por líticos volcánicos(?70%), cuarzo(?17%), litios metamórficos(?10%), carbonatos masivos(?3%).

CLAY interbeded SAND: Arcilla rojiza (10R 4/6) intercala, en tope, con nivel (9cm) de arena muy gruesa gris con clastos dispersos y niveles (2 a 3cm) de arena media a fina gris y arena fina limosa. Fuerte alteración de la estructura original por SPT.

CLAY interbeded SAND: Arcilla marrón (5YR 5/2) intercala con tres niveles (0,5 a 2cm) de arena muy fina limosa gris.

V. FINE SAND: Arena muy fina limosa marrón (10R 4/2) con nivel (1cm) de arcilla marrón (5YR 5/2).

CLAY: Arcilla rojiza (10R 5/4). Fuerte alteración y contaminación por SPT.

CLAYEY SAND: Arena media a fina arcillosa(60%) conformada por cuarzo(?85%), magnetita(?10%), yeso?(?4%), líticos?(?1%), gris (N5). Grava fina (hasta 3mm) conformada por líticos volcánicos(?70%), cuarzo(?17%), líticos metamórficos(?10%), carbonáticos masivos(?3%).

CLAY: Arcilla rojiza (10R 5/4).

SILTY SAND: Arena muy fina limosa marrón (10R 4/2).

CLAY: Arcilla rojiza (10R 5/4) intercala con muy escasos niveles de arcilla gris-verdosa (2 a 3cm). Muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla marrón-oscura (10YR 4/2) intercala con escasos y finos niveles (2 a 3mm) de arena fina limosa gris muy deformados.

CLAYEY SAND: Fuerte alteración y contaminación por SPT. Arena gruesa a fina arcillosa marrón (5YR 5/2) intercala (?) con niveles de arcilla rojiza (10R 5/4).

CLAY: Arcilla rojiza (10R 5/4).

CLAY: Arcilla rojiza (10R 4/6) hacia la base mix, de contacto muy irregular, con arcilla verde (10GY 5/2) en los últimos 30cm.

CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente rojiza. Intercalan nivel de arena fina limosa gris (3cm), nivel (1cm) con abundantes fragmentos blanquecinos carbonáticos masivos, nivel (2cm) de arcilla negra y manchas irregulares de arcilla negra.

BLACK CLAY: Arcilla negra con escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY: Arcilla marrón-pálida (10YR 6/2) con rastros de arcilla negra, de contacto muy irregular. Escasos y finos niveles (2 a 5mm) de arcilla rojiza.

CLAY interbeded SAND: Arcilla rojiza (10R 4/6) con tres niveles (2 a 3cm) intercalados y aislados de arena muy fina limosa gris.

CLAYEY SILT: Limo-arcilla rojiza oscura (10R 3/4) con nivel (5cm) de arcilla rojiza (10R 4/6).

CLAY: Arcilla rojiza (10R 4/6) con nivel deformado (3cm) de arena fina muy fina.

SILTY SAND: Nivel de arena fina a muy fina limosa gris (N5).

CLAY: Arcilla rojiza (10R 4/6). Muy escasos rastros de arcilla negra. Niveles deformados (1cm) de arcilla arenosa fina.

CLAY: Arcilla gris-verdosa (10Y 4/2) a ligeramente marrón.

CLAY: Arcilla rojiza (10R 4/6). Muy escasos rastros de arcilla negra y nivel (3cm) deformado de arena fina limosa.

CLAY: Arcilla gris-verdosa (5Y 5/2) intercala con aislados niveles (2 a 5cm) de arcilla rojiza (10R 4/6) deformada.

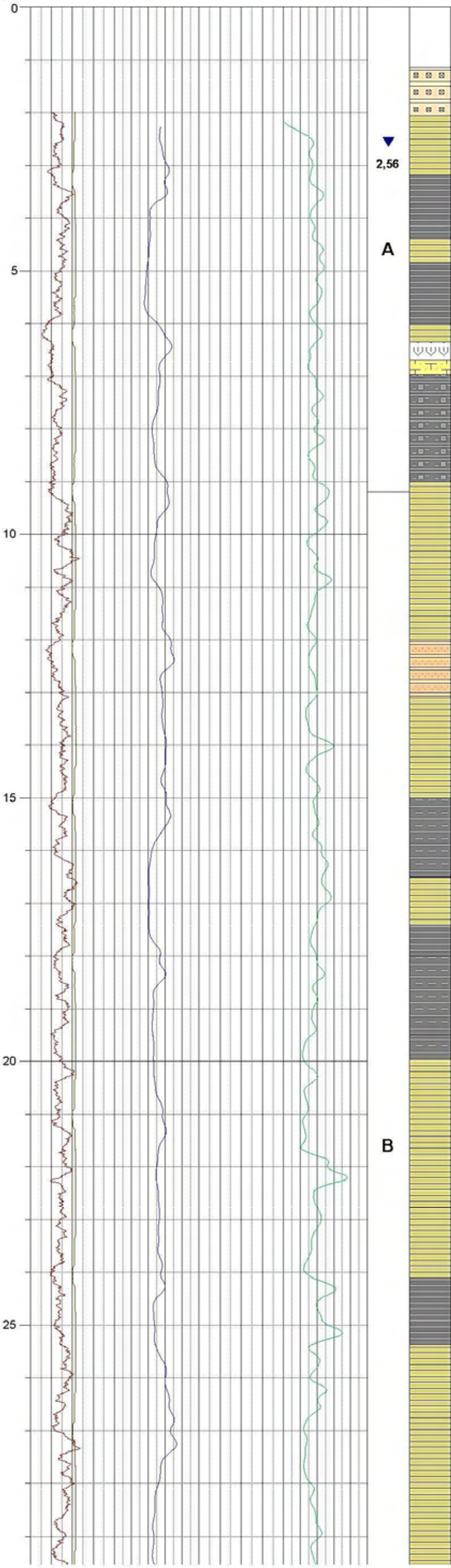
SAND: Arena media a fina gris (N6) con escaso limo.

CLAY: Arcilla rojiza (10R 4/6). Fuerte alteración y contaminación (con arena del nivel superior) por SPT.

CLAY interbeded CLAYEY SAND: Arcilla gris-verdosa (5Y 5/2) con escasos y finos niveles deformados (2 a 4cm) de arena arcillosa y arcilla rojiza.

SILTY SAND: Arena fina limosa gris.

ORDCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	28-10-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-07
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	31-10-2010	E: 3431000 N: 7408998	Page 1 of 2
		METHOD:	SONIC	DEPTH:	54m	Elevn: 3939,101	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

NO RECOVERY: NO RECUPERADO

HALITE: Nivel de halita masiva porosa blanquecina. Cristales subhedros blanquecinos (1 a 2mm) muy escasos rastros de material clástico marrón-rojizo (arcilla limosa).

HALITE with CLAY: Arcilla gris-marrón y menor rojiza. Abundantes microcristales de halita y niveles deformados (1 a 2 cm) de ulexita.

NO RECUPERADO

CLAY: Arcilla marrón (5YR 5/2) y rojiza (10R 4/6) con nivel (1cm) y papas (3cm) de ulexita. Escasa presencia de microcristales de halita.

CLAY: Arcilla rojiza (10R 4/6) con niveles lenticulares? (muy deformados) de arcilla marrón con abundantes microcristales de halita. Muy escasos niveles y papas de ulexita (1 a 2cm) y menor cantidad de cristales (1cm) de selenita aislados. En la base (últimos 6cm) grada a arcilla gris-verdosa (5Y 5/2) con papa (2cm) de ulexita. Rastros de arcilla negra y escasas manchas anarnjadas pulverulentas (rejalgar/oropimente?).

BLACK CLAY: Arcilla negra muy escasas y finas manchas anaranjadas (rejalgar/oropimente?). Y escasa arcilla gris-verdosa en rastros irregulares.

CLAY: Arcilla marrón-oscura (5YR 3/4) con abundnates papas (2cm) de ulexita.

NO RECUPERADO

BLACK CLAY: Arcilla negra con escasa arcilla marrón-clara (5YR 6/4) y menor gris-verdosa (fuertemente deformada y contaminada por avance).

BLACK CLAY: Arcilla negra con muy escasoa rastros de arcilla gris-verdosa y marrón.

CLAY: Arcilla gris-verdosa (5Y 5/2) a marrón con papas (?2cm) de ulexita. Sedimento alterado por SPT.

ULEXITE: Grueso nivel de ulexita con escaso material clástico (arcilla-arenosa) gris-verdosa. Deformación por avance y SPT.

SILTY SAND: Arena fina a muy fina limosa con abundantes microcristales de selenita y menor halita. Muy escasa e irregular presencia de arcilla en matriz. Abundnates niveles (2 a 7cm) de ulexita. Color del conjunto gris (N5).

BLACK CLAY with HALITE: Arcilla negra con abundantes microcristales de halita. Y escasas papas y niveles (0,5 a 1cm) de ulexita.

CLAY: Arcilla marrón-pálida (10YR 6/2). Fuerte alteración y contaminación por SPT.

CLAY: Arcilla verde (10GY 5/2). Muy escasos cristales de selenita (1cm). Fuerte alteración y contaminación (zona central) por SPT.

CLAY: Arcilla marrón-palida (10YR 6/2) a ligeramente rojiza con escasos niveles de arcilla negra (1 a 2cm), arena fina limosa gris (1 a 5mm) y menor ulexita (1 a 2cm). Fuerte deformación de la estructura original por avance e perforación.

SAND Interbeded CLAY: Arena fina a media limosa gris (N5) conformada por cuarzo(?35%), yeso?(?25%), selenita(?20%), magnetita(?17%), líticos volcánicos?(?2%) y biotita(?1%). Intercala? Con niveles (1 a 4cm) de arcilla marrón (10YR 4/2) con finas papas de ulexita (0,5cm).

CLAY: Arcilla marrón (10YR 4/2) con muy escasos rastros de arcilla negra y muy escasas papas de ulexita (0,5cm). Sediemnto fuertemente alterado por avance de perforación.

CLAY: Arcilla rojiza-pálida (10R 5/4) escasos agregados policristalinos (1cm) de selenita (rosa del desierto). Parte superior del nivel alterada y contaminada por SPT.

CLAY interbeded ORGANICS: Sedimento fuertemente alterado (arcilla muy plástica). Arcilla marrón oscura (5YR 3/2) intercala con niveles muy deformados de arcilla negra (1 a 3cm?).

CLAY: Arcilla marrón-pálida (10YR 6/2).

CLAY: Arcilla verde (10GY 5/2) con fino nivel (0,5cm) muy deformado de arcilla negra.

BLACK CLAY: Arcilla negra.

CLAY interbeded ORGANICS: Arcilla negra intercla con niveles (2 a 4cm) de arcilla marrón-oscura (5YR 3/4) y muy escasos de arcilla marrón-clara (10YR 6/2). Fuerte deformación por avance (arcilla muy plástica).

CLAY interbeded ORGANICS: Arcilla marrón-pálida (10YR 6/2) intercala rítmicamente con niveles (0,5cm) de arcilla negra. Fuerte deformación por avance (arcilla muy plástica).

CLAY: Arcilla rojiza-pálida (10R 5/4) intercala con niveles aislados (0,5cm) de arcilla negra. Muy deformados por avance de perforación (arcilla plástica).

CLAY: Arcilla gris-verdosa (5Y 5/2) con escasos ratsros muy irregulares de arcilla rojiza-pálida (10R 5/4) y menor arcilla negra. Nivel (3cm) de arcilla verde (10GY 5/2) cercano a la base. Transicional con nivel inferior.

CLAY: Arcilla verde (10GY 5/2) con nivel (2cm) muy deformados de arcilla marrón-pálda (10YR 6/2). Alta plasticidad.

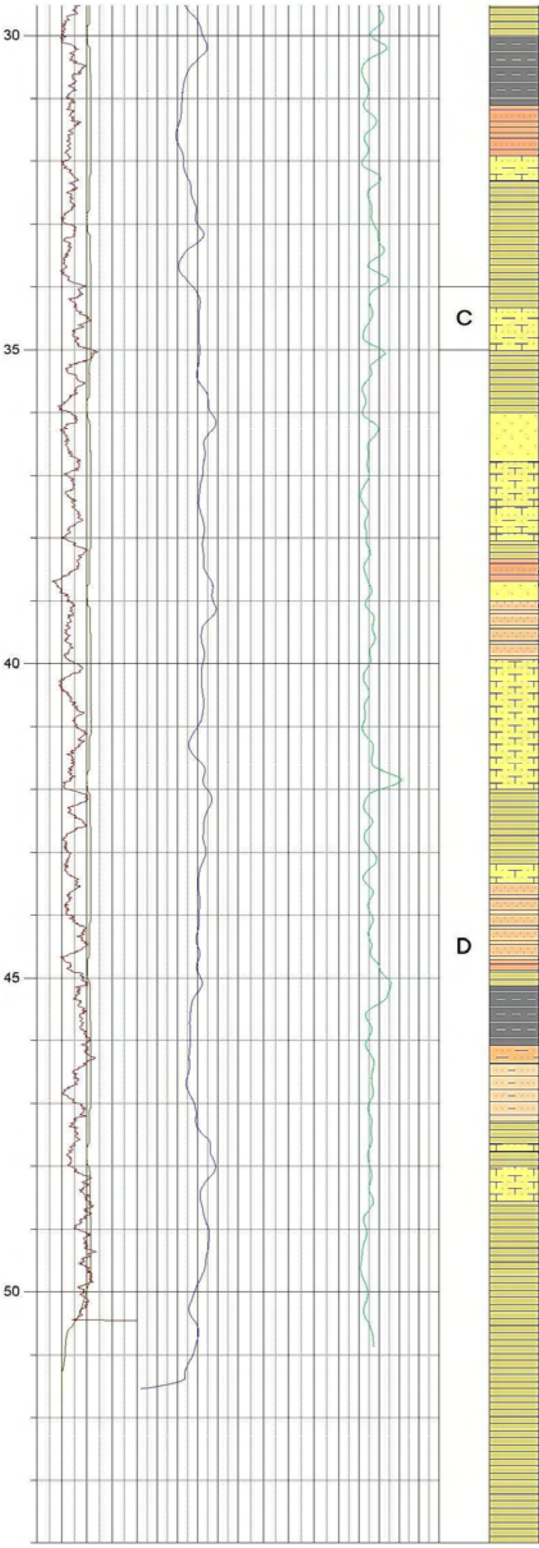
BLACK CLAY: Arcilla negra con nivel, cercano a la base, de 7cm de arcilla marrón-pálida (10YR 6/2) muy deformada. Alta plasticidad.

CLAY: Arcilla marrón-pálida (10YR 6/2) muy escasos lentes muy deformados (por avance) de ?1cm de arena muy fina limo arcillosa. Nivel (3cm) en tope, de arena media a fina limosa gris.

CLAY: Arcilla marrón-pálida (10YR 6/2) con niveles (0,5 a 1cm) escasos de arcilla negra y muy escasos niveles gris-verdosos. Alta plasticidad. Muy escasas manchas anarnajadas pulverulentas (rejalgar/oropimente?).

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	28-10-2010	COORDINATES (POSGAR 94 Zone 3) E: 3431000	WELL REFERENCE: C-07
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	31-10-2010	N: 7408998	Page 2 of 2
		METHOD:	SONIC	DEPTH:	54m	Elevn: 3939,101	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY interbeded ORGANICS: Arcilla gris-verdosa (5Y 5/2) intercala con finos niveles (0,5cm) de arcilla negra y dos niveles (2 y 3cm) de arcilla marrón (10YR 6/2). Muy deformado por avance y alta plasticidad.

CLAY Interbeded SAND: Intercalación de arcilla negra con niveles de arena fina limosa gris-oscura a negra (3 a 5cm) cada uno. Muy fuerte deformación por avance y alta plasticidad.

SILTY SAND with CLAY: Arena media a fina limo-arcillosa marrón (10YR 6/2), conformada por cuarzo(?70%), líticos volcánicos(?12%), carbonatos masivos(?10%), magnetita(?8%) y biotita(?1%).

CLAY: Arcilla rojiza-pálida (10R 5/4) con rastros muy irregulares de arcilla gris-verdosa (5Y 5/2) y nivel (2cm) de arena fina a muy fina limosa cercana al tope.

SILTY SAND with CLAY: Arena fina a muy fina limo-acillosa gris (N5), conformada por granos de cuarzo(?70%), líticos volcánicos(?12%), magnetita(?8%), carbonatos masivos(?7%), selenita?(?2%), yeso?(?1%) y biotita(<1%). Proporción de arcilla variable y distribución muy irregular.

CLAY: Arcilla rojiza-pálida (10R 5/4) con escasos y aislados niveles (0,2 a 4cm) de arena fina a muy fina limosa gris.

SAND: Arena media a fina gris (N5) escasos componentes gruesos, conformada por cuarzo(?65%), líticos volcánicos?(?15%), carbonatos masivos(?12%), magnetita(?6%) y yeso?(?2%). Nivel en la base, muy deformado, (3 a 4cm) de arcilla rojiza (10R4/6).

SILTY SAND: Arena fina a muy fina limosa gris (N5) con nivel (3cm) de arena fina arcillosa rojiza y muy escasos rastros de arcilla gris-verdosa. Conformada por cuarzo(?80%), magnetita(?10%), carbonatos masivos(?7%), líticos volcánicos(?2%), biotita(<1%) y Ap/Zr?(<<1%).

SILTY SAND with CLAY: Arena gruesa limo-arcillosa marrón (5YR 5/2), conformada por cuarzo(?60%), líticos volcánicos(?15%), carbonatos masivos(?10%), yeso?(?8%), magnetita(?5%), líticos metamórficos?(?2%) y biotita(<1%).

SILTY SAND: Arena fina a media limosa gris (N5).

CLAY: Arcilla rojiza (10R 4/6).

CLAY Interbeded SAND: Arcilla gris-verdosa intercala? (Muy deformado). Con arena media a fina gris.

NO RECUPERADO.

SAND: Arena fina a media gris (N4) con escaso limo.

SAND Interbeded CLAY: Conglomerado intracuencal (?). Abundantes frgamentos muy labiles (plásticos) de arcilla rojiza (10R 4/6), gris-verdosa (5Y 5/2) y fragmentos de arena fina cementada con carbonatos en matriz de arena fina a media gris (60%) y arena arcillosa en tope. Los clastos? varian de 0,5 a 2cm.

SILTY SAND: Arena fina a muy fina gris (N5) limosa, conformada por muy finos cristales de cuarzo(?75%), magnetita(?15%), liticos(?5%), carbonastos masivos(?3%), yeso?(?2%) Y biotita(<1%). Intercalan escasos niveles (2 a 3cm) de arcilla marrón. Escasos intraclastos? De arcilla rojiza (0,5 1cm). Nivel (8cm) cercano a la base de arena media a fina.

CLAY: Arcilla gris verdosa (10Y 4/2) con dos niveles (3 y 7cm) de arcilla marrón-oscura (5YR 3/4). Escasa presencia de limo.

SILTY SAND: Arena muy fina limosa gris (N4). Pasa transicionalmente a arena fina limosa gris oscura a negra.

SAND Interbeded CLAY: Arena fina a muy fina gris-oscura (N3) conformada por muy finos cristales de cuarzo(?55%), magnetita(?35%), líticos volcánicos(?5%), carbonatos masivos(?3%), yeso?(?2%) Y biotita(<1%). Dos niveles intercalados (3 y 6cm) muy deformados de arcilla marrón-pálida (10YR 6/2).

CLAY Interbeded SAND: Arcilla marrón-pálida (10YR 6/2) con niveles muy deformados de arena fina a muy fina limosa.

CLAY: Arcilla rojiza-pálida (10R 5/4) pasa (últimos 9cm) a arcilla negra.

CLAY interbeded ORGANICS: Arcilla gris-verdosa (5Y 5/2) con abundantes rastros (niveles muy deformados?) de arcilla negra.

CLAY interbeded ORGANICS: Arcilla marrón (5YR 5/2) con abundantes rastros de arcilla negra.

CLAYEY SAND: Arena arcillosa marrón a gris muy deformada. Intercala? Con finos niveles de arena limosa.

SANDY CLAY Interbeded SAND: Arena fina a muy fina limosa gris (N3) con abundantes y gruesos niveles (?10cm) arcillosos muy deformados. Nivel basal (5cm) de arcilla marrón y fragmento (nodulo?) de arena fina cementada con carbonatos (5cm).

CLAY: Arcilla marrón-pálida (10YR 6/2) a rojiza-pálida (10R 5/4) con nivel (4cm) de arena muy fina limosa gris y muy escasos lentes (1cm). Fino nivel (5cm) limo-arcilloso carbonático.

SILTY SAND: Arena fina limosa gris-oscura (N2 a 3).

CLAY: Arcilla rojiza-oscura (5R 4/2).

SILTY SAND: Arcilla arenosa gris-oscura (N3) con escasos niveles de arena fina limosa gris y arcilla marrón pálida. Alta deformación y plasticidad.

CLAY: Arcilla marrón-pálida (10YR 6/2) pasa a arcilla rojiza-pálida (10R 5/4). Fuerte contaminación con arena del nivel superior.

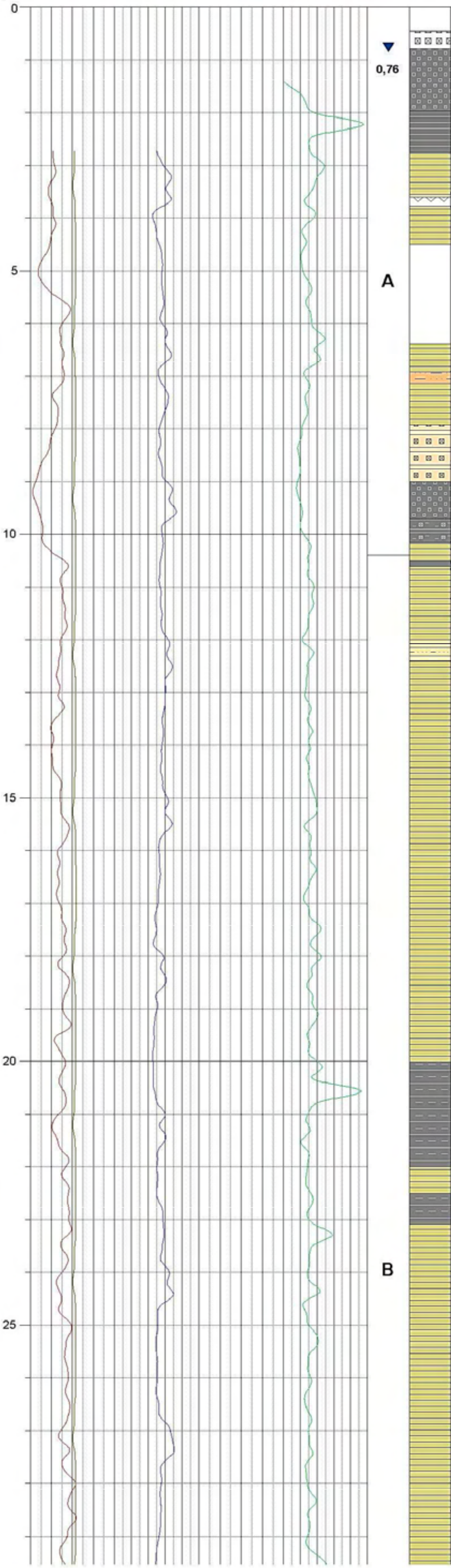
CLAY: Intercalación? (fuerte deformación) en bancos de 0,5 a 1cm, entre arcilla verde (10GY 4/4 a 10GY 5/2) y rojiza (10R 6/2) a marrón-pálida (10YR 6/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) intercala con niveles areno limo-arcillosos con abundante agua (?3cm).

CLAY: Intercalación? (fuerte deformación) en bancos de 0,5 a 1cm, de arcilla verde (10GY 5/2) y rojiza (10R 6/2) a marrón-pálida (10YR 6/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) muy escasos niveles muy deformados de arcilla gris-verdosa, arena fina a muy fina limosa y arcilla negra (1 a 5mm).

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	20-09-2010	COORDINATES (POSGAR 94 Zone 3)		WELL REFERENCE:	C-08
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	21-10-2010	E:	3425999	Page 1 of 2	
						N:	7406495		
		METHOD:	SONIC	DEPTH:	54m	Elevn:	3939,066	LOGED BY:	Geol. FERNANDO A. MARTÍN



Lithology

NO RECOVERY: NO RECUPERADO

HALITE: Halita blanquecina porosa. Cristales subhedros (2 a 5mm) muy escasos rastros de material arcillo-limoso rojizo.

BLACK HALITE: Halita negra en cristales euhedros a subhedros (3 a 10mm) traslucidos. Abundante presencia de arcilla negra (?10%). Intercalan, en tope, escasos niveles (1 a 6cm) de cristales blanquecinos sin arcilla negra.

BLACK CLAY: Arcilla negra con abundantes cristales de halita (1 a 5mm) diseminados.

CLAY: Arcilla marrón-pálida (10YR 6/2) con niveles (2 a 10cm) y papas (?2cm) de ulexita. Alteración por SPT.

HALITE with CLAY: Abudantes cristales de halita anhedros (1 a 3mm) en matriz de arcilla gris-verdosa con abundantes agua.

ULEXITE: Nivel de ulexita con escasa presencia de arcilla gris-verdosa (5Y 5/2) intersticial.

CLAY: Arcilla gris-verdosa (5Y 5/2) con escaso limo. Abundantes niveles y papas (2 a 5cm) de ulexita y escasos y muy deformados niveles (?1cm) de arena fina limosa (lentes?) con halita microcristalina.

NO RECOVERY: NO RECUPERADO

CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente rojiza. Muy escasas papas de ulexita (1cm) contaminada con halita y arcilla negra (por SPT?).

CLAYEY SAND: Arena fina arcillosa gris con papas (1 a 2cm) de ulexita.

CLAY: Arcilla marrón pálida (10YR 6/2) con escasos niveles (?2cm lentes?) de arena arcillosa (idem color).

NO RECUPERADO

HALITE with CLAY: Nivel con abundantes cristales de halita (1 a 5mm) subhedros en matriz de arcilla negra. Escasas y aisladas papas (?2cm) de ulexita. Nivel muy friable.

SIN MUESTRA (BGS?).

BLACK HALITE: Halita en cristales euhedros traslucidos (1 a 5mm) con matriz de arcilla negra. Nivel friable.

BLACK CLAY with HALITE: Arcilla negra con cristales euhedros (<1 a 2mm) diseminados. Dos niveles (2 y 3cm) de ulexita.

CLAY: Arcilla marrón-pálida (10YR 6/2) con papas (2cm) de ulexita.

CLAY: Arcilla verde (10GY 5/2).

BLACK CLAY: Cristales de halita (2 a 5mm) con abundante matriz de arcilla negra.

CLAY: Arcilla marrón-pálida (10YR 6/2) pasa transicionalmente (últimos 3cm) a rojiza pálida.

CLAY: Arcilla rojiza-pálida (10R 5/4).

SILTY SAND Interbeded CLAY: Fuerte alteración por SPT. Intercalción? De arena fina limosa gris y arcilla marrón pálida (10YR 6/2). Niveles (5 a 7cm?) Muy deformados.

CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente rojiza y muy escasos niveles irregulares (1 a 2cm) de arcilla verde. Escasos niveles de ulexita (2 a 5cm) y abundantes y gruesos agregados policristalinos de selenita (2 a 3cm) diseminados (rosas del desierto).

CLAY: Arcilla rojiza (10R 4/6) con agregados policristalinos de selenita (3cm) aislados.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza (10R 4/6) con gruesos y aislados cristales de selnita (3cm).

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) con muy escasos rastros irregulares de arcilla verde y menor negra.

BLACK CLAY: Arcilla negra con muy escasos niveles (0,5 a 1cm) aislados de arcilla marrón-clara (10R 6/2).

CLAY: Arcilla marrón-pálida (5YR 5/2) a rojiza con finos (2 a 5mm) y escasos niveles intercalados de arcilla negra.

CLAY Interbeded ORGANICS: Sedimeno con fuerte alteración por SPT y elevada plasticidad. Intercalan? Arcilla marrón-pálida a rojiza (5YR 5/2) con niveles muy deformados de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) a rojiza con escasos rastros irregulares de arcilla negra y menor arcilla verde.

CLAY: Arcilla rojiza-pálida (10R 5/4) contaminada y deformada por SPT.

CLAY: Arcilla verde (10GY 5/2) con aislados y escasos cristales de selenita (?1cm). Fuerte alteración y contaminación SPT.

CLAY: Arcilla rojiza-pálida (10YR 5/4) a ligeramente marrón. Intercalan niveles muy deformados de arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza-pálida (10YR 5/4).

CLAY: Arcilla marrón (10YR 4/2). En la base, manchas anaranjadas pulverulentas (rejalgar/oropimente?) y manchas de arcilla nerga.

CLAY: Arcilla rojiza (5R 4/2) pasa transicionalmente a arcilla marrón-clara (10YR 6/2).

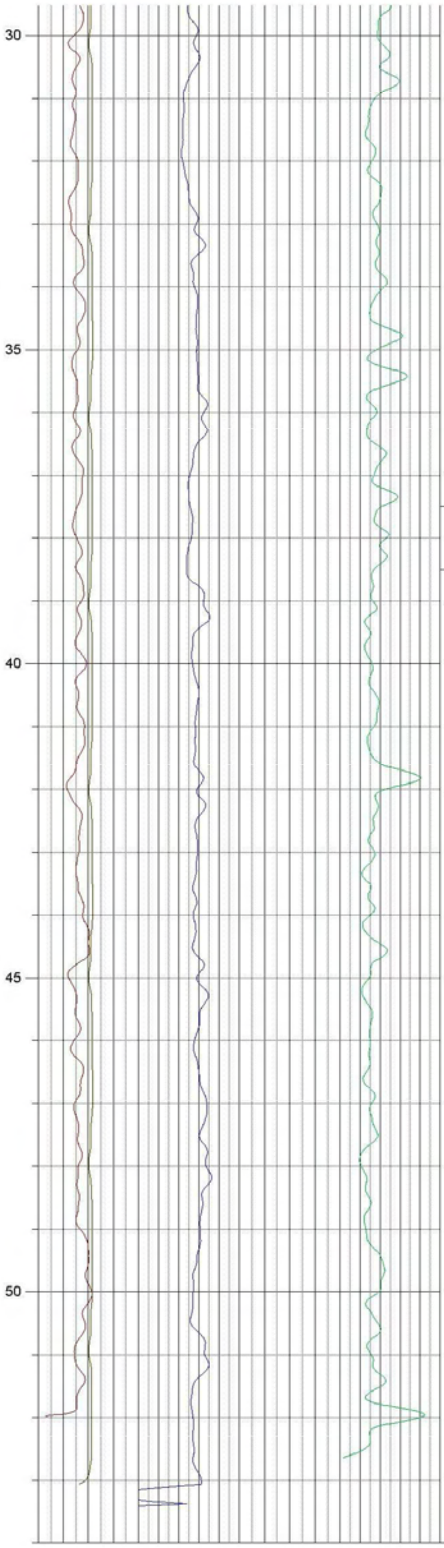
CLAY: Arcilla gris-verdosa (5Y 5/2).

CLAY: Arcilla marrón (10YR 4/2) muy escasos rastros de arcilla negra y en todo el nivel con finas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

Depth (m)	Elevn. (m)
0	
5	3935
10	3930
15	3925
20	3920
25	3915
	3910

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 20-09-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 21-10-2010	E: 3425999	C-08
	METHOD: SONIC	DEPTH: 54m	N: 7406495	Page 2 of 2
			Elevn: 3939,066	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



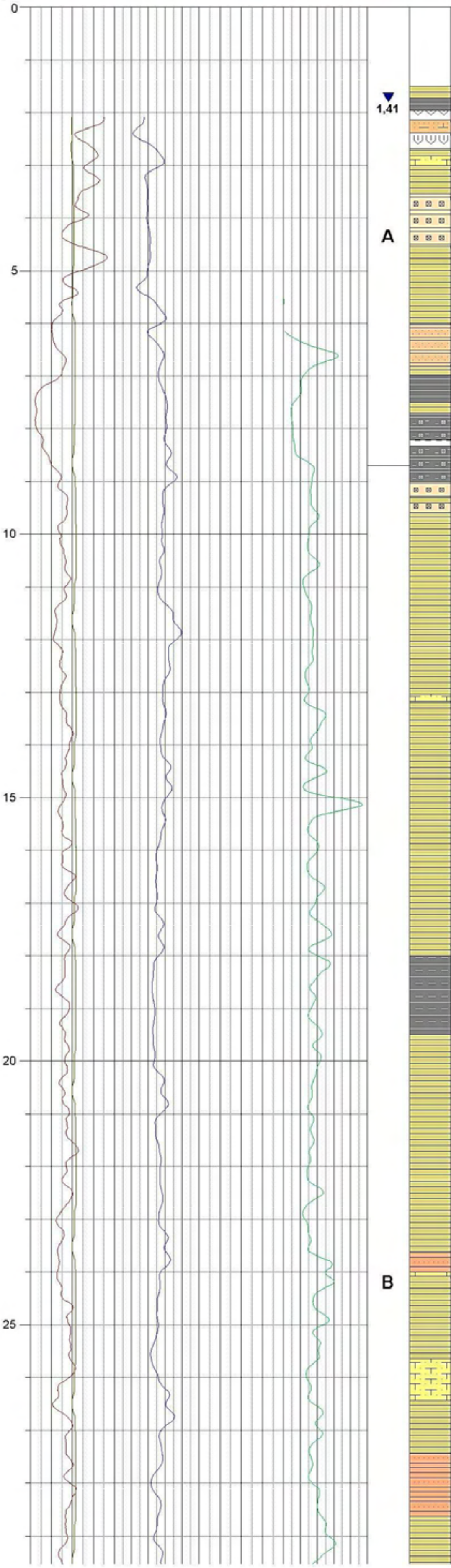
Units	Lithology
	CLAY: Arcilla rojiza (10R 4/2) con manchas anaranjadas pulverulentas (rejalgar/oropimente?).
	CLAY: Arcilla verde (10GY 5/2) con nivel intercalado (28cm) de arcilla rojiza mix con verde, cercano al tope.
	CLAY: Arcilla verde a gris-verdosa (5Y 5/2), nivel transicional entre el superior e inferior. (Arcilla verde a rojiza).
	CLAY: Arcilla rojiza-pálida (10R 5/4).
	CLAY: Mix de contacto muy irregular entre arcilla verde (10GY 5/2) y rojiza-pálida (10R 5/4).
	CLAY: Arcilla rojiza-pálida (10R 5/4).
	CLAY: Arcilla verde (10GY 5/2) a ligeramente gris.
	CLAY: Mix de arcilla rojiza (10R 5/4) y verde (10GY 5/2) alterada con abundante agua.
	CLAY: Arcilla rojiza-pálida (10R 5/4) hacia la base transicional con nivel inferior (arcilla marrón).
	CLAY: Arcilla marrón-pálida (10YR 6/2). Muy ecasos niveles deformados (?1cm) lenticulares? De arena fina arcillosa.
C	SAND: Arena media a fina gris (N4) con muy escaso limo, conformada por cuarzo(?75%), magnetita(?10%), yeso?(?10%), líticos(?5%), y biotita(<1%). Nivel (4cm) cercano al tope, de arcilla marrón con arcilla negra de contacto irregular y papas (1cm) de ulexita.
C	CLAY Interbeded ORGANICS: Arcilla marrón (5YR 5/2) con abundantes rastros muy irregulares de arcilla negra. Papas de ulexita (2 a 4cm) con manchas anaranjadas pulverulentas (rejalgar/oropimente?).
D	CLAY: Arcilla rojiza (10R 4/6) muy escasas papas y niveles (0,2 a 1cm) de ulexita. Nivel (19cm) de arcilla marrón (10YR 4/2) con abundantes rastros de arcilla rojiza. Contaminación y alteración en zona central por SPT.
D	CLAY: Arcilla rojiza-pálida (5R 6/2) con muy escasos rastros de arcilla negra y gris-verdosa pálida.
D	CLAY: Arcilla marrón-oscura (10YR 4/2) muy escasos rastros de arcilla gris-verdosa y dos papas (4 y 2cm) de ulexita.
D	CLAY: Arcilla gris-verdosa (5Y 5/2) alterada y contaminada por SPT. Transicional en los últimos 4cm con nivel inferior.
D	CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramnete rojiza. Escasas manchas anaranjadas (FeOx/rejalgar?). Papa (1cm) de ulexita.
D	CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramnete rojiza con escasos niveles muy deformados (?1cm) de arena fina limosa (6 niveles). Muy escasos ratsros irregulares de arcilla negra. Alteración y contaminación por avance de perforación y SPT.
D	SAND Interbeded CLAY: Arena gruesa a media gris (N4) conformada por granos subredondeados de cuarzo(?35%), líticos volcánicos(?25%), yeso?(20%), líticos metamórficos?(?15%) y magnetita(?5%). Niveles (10cm y dos de 1cm) de arcilla rojiza-pálida (5R 6/2) muy deformada. Escasos fragmentos (1cm) de arcilla gris oscura (intraclastos?).
D	CLAY: Arcilla rojiza-pálida (5R 6/2) con muy escasas papas (1cm) de ulexita. Fuerte alteración y contaminación por SPT.
D	CLAY: Arcilla marrón-pálida (10YR 6/2) en la base (14cm) se torna ligeramente rojiza.
D	SAND: Arena media a fina gris (N5) con muy escaso a nulo limo, conformada por cuazo(?75%), líticos volcánicos(?15%), metamórficos?(?5%), magnetita(?3%) y yeso?(?2%). Tres niveles (2cm y dos de 1cm), en la base, de arcilla rojiza.
D	CLAY: Arcilla rojiza (10R 4/6) escasos rastros de arcilla gris-verdosa. En tope intercala con niveles aproximadamente regulares de arcilla nerga (1 a 3cm) y ulexita (2 a 5mm).
D	CLAY: Arcilla gris-verdosa (5Y 5/2). Rastros muy escasos y muy irregulares de arcilla rojiza-pálida. Contaminaión y alteración, en tope, por SPT.

Depth (m): 30, 35, 40, 45, 50

Elevn. (m): 3905, 3900, 3895, 3890

OROCOBRE RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT	CONTRACTOR: BLY DRILL RIG: SONIC METHOD: SONIC	START DATE: 21-10-2010 END DATE: 24-10-2010 DEPTH: 54m	COORDINATES (POSGAR 94 Zone 3) E: 3428000 N: 7406498 Elevn: 3938,755	WELL REFERENCE: C-09 Page 1 of 2 LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



NO RECUPERADO

CLAY: Arcilla marrón (5YR 4/4) muy escasos rastros de arcilla negra y papas de ulexita (0,5cm).

CLAY Interbeded ORGANICS: Arcilla gris-verdosa (5Y 5/2) con abundantes rastros irregulares de arcilla nerga y escasas papas de ulexita (1cm).

ULEXITE: Nivel de ulexita con escasos rastros de arcilla gris-verdosa intersticial.

CLAYEY SAND with SILT: Arena fina limosa gris-oscura (N3) con rastros irregulares de arcilla. Papas (1 a 2cm) de ulexita.

ULEXITE: Nivel de ulexita con nivel (4cm) de arcilla marrón-oscura (5YR 3/2). Escasos y aislados cristales de selenita (hasta 1cm).

CLAY: Arcilla marrón-oscura (5YR 3/2) con nivel (3cm) de ulexita.

SILTY SAND: Arena fina limosa gris (N3) con muy escasos rastros de arcilla.

CLAY: Arcilla gris-verdosa (5Y 5/2) limosa y escasa presencia irregular de arcilla marrón. Abunadantes niveles de ulexita (3 a 5cm) y papas. Fuerte deformación de la estructura original. Muy escasos rastros irregulares de arcilla negra.

HALITE with CLAY: Halita en finos cristales (<0,5 a 2mm) blanquecinos traslucidos principalmente anhedros con abundante presencia de material clástico (arcilloso) gris-verdoso (5Y 5/2) y escasa marrón y muy escasa arcilla negra de distribución muy irregular.

CLAY: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra y gris-verdosa y muy escasas papas de ulexita (0,5 a 2cm). Fuerte alteración y contaminación por SPT y avance de perforación.

CLAY: Arcilla limosa gris-verdosa oscura (5Y 3/2) con abaundantes papas (2 a 4cm) deformadas de ulexita.

SAND Interbeded CLAY: Mix muy deformado y alterado de arena fina limosa y arcilla gris-verdosa (aprox. 50%) (5Y 5/2) con abundantes papas (1 a 3cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con escasas papas de ulexita (1 a 2cm).

BLACK CLAY: Arcilla negra con muy escasa papas de ulexita (1cm) y finos niveles (1 a 3mm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) escasos rastros de arcilla negra y gruesa papa (8cm) de ulexita terrosa amarillenta.

BLACK CLAY with HALITE: Arcilla negra con niveles (1 a 2cm) con abundantes microcristales de halita. Escasos y aislados cristales gruesos (5mm) traslucidos de halita.

HALITE: Halita masiva muy compacta microsristalina (?) escasos ejemplares alacanzan 2mm. Muy escasos rastros de arcilla negra.

BLACK CLAY with HALITE: Arcilla negra con abundantes cristales de halita (1 a 3mm) diseminados. Niveles (1 a 2cm) de halita blanquecina masiva muy compacta.

HALITE with CLAY: Abundantes cristales de halita (1 a 2mm) traslucidos subhedros a anhedros en matriz (?15%) de arcilla negra. Muy escasos agregados policristalinos de halita hasta 3cm. Intercala nivel (13cm) de arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasas papas de ulexita (2cm).

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza. Fuerte deformacion y contaminación por SPT. Muy escasos niveles (1cm) de arena arcillosa y niveles (1cm) de ulexita muy deformados. Nivel (24cm) de arcilla verde (10GY 5/2) con cristales (lcm) aislados de selenita.

CLAY: Arcilla marrón-oscura (5YR 3/2) con escasa arena fina (arcilla arenosa). Escasos niveles de ulexita.

CLAY: Arcilla marrón (5YR 5/2) muy escasas papas (0,5 a 1cm) de ulexita y cristales aislados (0,5 a 2cm) de selenita. Niveles (0,5 a 1cm) arcillo-arenosos muy aislados y escasos (lentes?) muy deformados.

CLAY: Nivel de arcilla gris-verdosa oscura (5Y 3/2) con abudnantes papas de ulexita (1 a 2cm).

SILTY SAND: Arena muy fina limosa gris (N4), hacia el tope ligeramente arcillosa.

CLAY: Arcilla marrón-oscura (5YR 3/4) cristales aislados de selenita (5mm) escasos forman agregados policristalinos (rosasas del desierto). Escasos rastros de arcilla negra.

CLAY: Fuerte alteración y contaminación por SPT. Arcilla marrón-pálida (10YR 6/2) con muy escasos rastros de arcilla negra y papas de ulexita (0,5cm).

CLAY: Arcilla rojiza-pálida (10YR 5/4) a ligeramente marrón-clara. Muy escasos rastros de arcilla negra y niveles y papas (1 a 2cm) de ulexita.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con escasos niveles deformados (1cm) de ulexita. Alterada y contaminada por SPT.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasos rastros irregulares de arcilla negra.

CLAY Interbeded ORGANICS: Intercalación rítmica con niveles de aproximadamente 1cm entre arcilla marrón (5YR 5/2) y negra.

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza intercala con escasos niveles (?1cm) aislados de arcilla negra y muy escasos y finos niveles (?1mm) de arena fina. En la base muy finas y escasa manchas anaranjadas pulverulentas (rejalgar/oropimente?). Deformación por muy alta plasticidad.

CLAY: Intercalan, con contactos transicionales, Arcilla girs-verdosa (5Y 5/2) y rojiza-pálida (10R 5/4) a marrón-clara. Muy escasos niveles deformados de arcilla negra de contactos muy difusos. Fuerte alteración y contaminación por SPT.

CLAY Interbeded SAND: Arcilla gris-verdosa (5Y 5/2) con niveles intercalados (1 a 2cm) muy deformados de arena media a fina limosa gris-verdosa.

SILTY SAND: Arena fina a media limosa gris (N5).

CLAY: Arcilla verde (10GY 5/2) Nivel (18cm) y muy escasos rastros muy irregulares de arcilla rojiza-pálida (10R 5/4).

CLAY: Arcilla rojiza-pálida (10R 5/4) con dos niveles (2 y 1cm) de arena media a fina gris con muy escaso limo y rastros de arcilla verde.

SILTY SAND: Arena media a fina limosa gris (N4) escasa arcilla de ditribución muy irregular y abundante agua. Conformada por cuarzo(?80%), líticos volcánicos(?10%), carbonatos masivos(?5%), magnetita(?3%), yeso?(?2%) y biotita(<1%).

CLAY: Arcila verde (10GY 5/2) con nivel intercalado? (2cm) muy deformado de arcilla rojiza-pálida (10R 5/4).

CLAY: Arcilla rojiza-pálida (10YR 5/4).

CLAY: Arcilla marrón-oscura (10YR 4/3) abundantes niveles y papas (2 a 3cm) de ulexita.

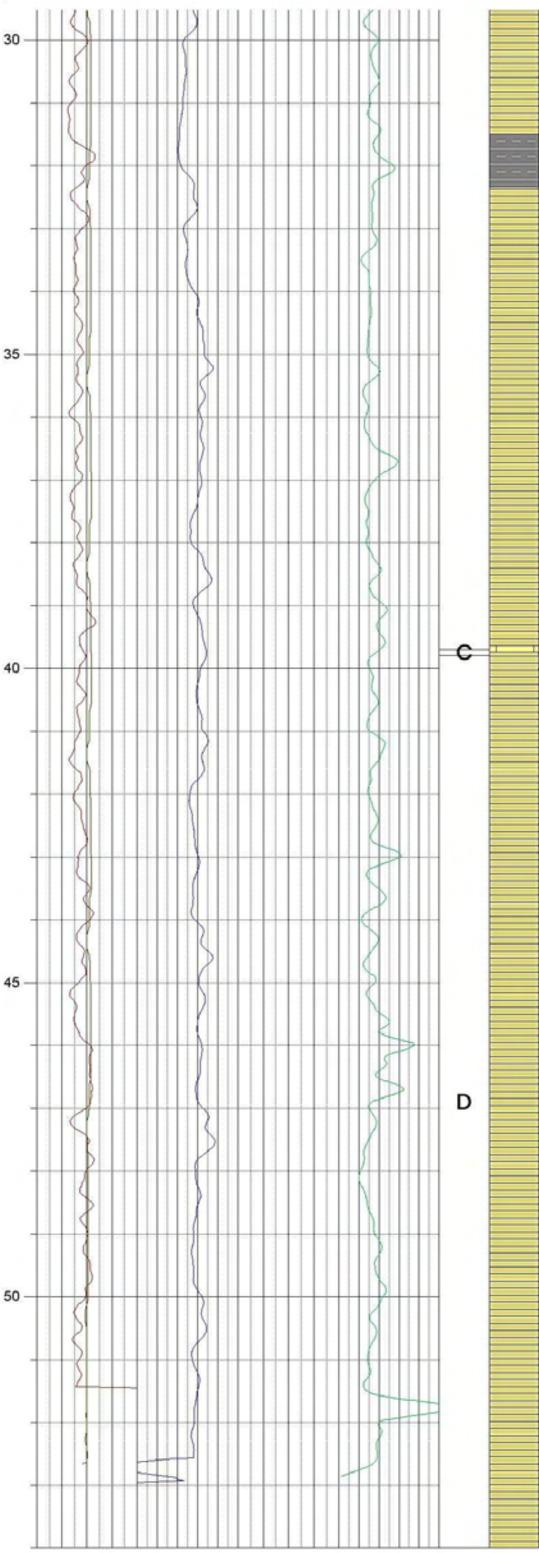
CLAY Interbeded SAND: Arcilla gris-verdosa (5Y 5/2) con niveles (2 y 10cm) de arena muy fina limosa gris-oscura a negra. Muy escasos rastros irregulares de arilla marrón-rojiza y negra. En tope, papas de ulexita (2cm).

CLAY: Arcilla rojiza-pálida (10R 5/4) con muy escasos rastros irregulares de arcilla negra. Nivel muy deformado (3cm) de arena limosa gris-oscura (N2).

CLAY: Arcilla marrón-pálida (10YR 6/2) con muy escasas manchas irregulares de arcilla negra. Muy escasos y finos niveles (1 a 2mm) de arena fina gris.

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 21-10-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-09
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 24-10-2010	E: 3428000	Page 2 of 2
	METHOD: SONIC	DEPTH: 54m	N: 7406498	
			Elevn: 3938,755	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m) | Caliper 0 Inch's 10 / Gamma N. 0 Api 200 | Density 2 gr/cc 3 | Neutron Near 0 cps 500 / Neutron Far 0 cps 100 | Porosity 0 Por 100 | Units | Geol. Log | Lithology | Depth (m) | Elevn. (m)



Lithology

CLAY: Arcilla verde (10GY 5/2) con muy escasos y finos (?1mm) niveles de arena muy fina limosa y niveles de arcilla blanquecina (1mm). Muy escasos niveles (0,5cm) de arcilla negra.

CLAY Interbeded ORGANICS: Arcilla negra intercala con niveles (2 a 3cm) de arcilla verde (10GY 5/2). Muy escasas manchas amarillentas (rejalgar/FeOx?).

CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente rojiza. Rastos irregulares de arcilla gris-verdosa (5Y 5/2).

CLAY: Arcilla rojiza-pálida (5R 6/2) a ligeramente marrón-clara. Muy escasos y finos niveles (1 a 2mm) de arena fina gris.

CLAY: Arcilla rojiza-pálida (5R 6/2) con papas de ulexita (1 a 3cm) a lo largo del nivel. Muy escasos rastros de arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropimente?). Contaminación(?) con arena por SPT.

CLAY: Arcilla marrón-oscura (10YR 4/2) con escasas papas (2 a 3cm) de ulexita y muy escasos rastros irregulares de arcilla negra y nivel (2cm) de arena fina gris.

CLAY: Arcilla rojiza (10R 4/6).

SILTY SAND: Nivel de arena muy fina limosa gris-oscura (N3).

CLAY: Arcilla marrón-pálida (10YR 6/2).

CLAY: Arcilla rojiza (10R 4/6) Alterada y contaminada por SPT.

CLAY: Arcilla marrón-pálida (10YR 6/2) deformación y contamianción por SPT y avance de perforación.

CLAY: Arcilla rojiza-pálida (10R 5/4) intercala con nivel (7cm) de arcilla verde (10GY 5/2) y escasos niveles (1 a 2cm) de arcilla gris verdosa (5Y 5/2).

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) con nivel (7cm) de arcilla arenosa gris-verdosa (10Y 4/2) con papas (?1cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con papas y niveles (3 a 4cm) de ulexita concentrados en el tope. Nivel (17cm) con abundantes rastros de arcilla gris verdosa.

CLAY: Arcilla rojiza (10R 4/6) muy escasas papas de ulexita (2 a 3cm).

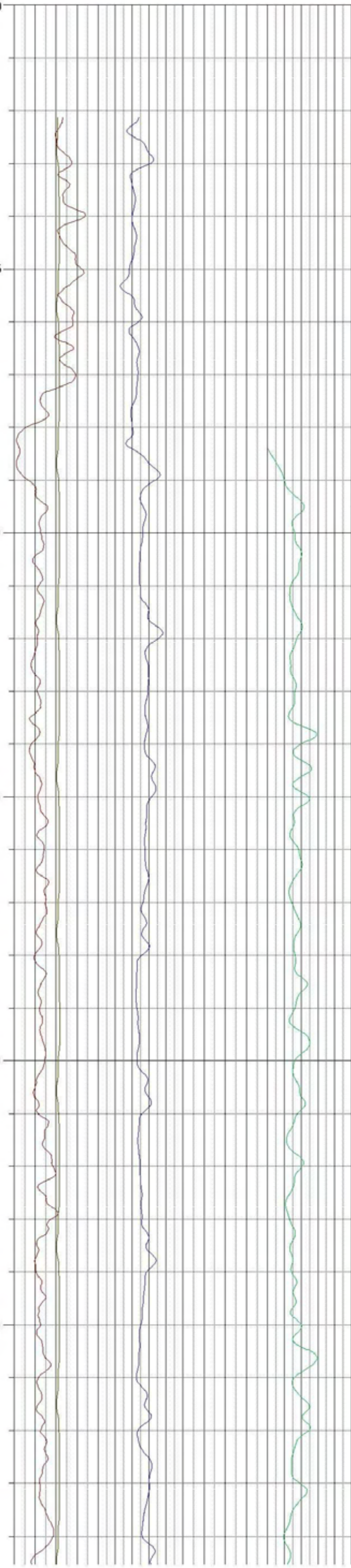
CLAY: Arcilla gris-verdosa (5Y 5/2) con abundnates rastros, contacto muy irregular, de arcilla negra.

Depth (m): 30, 35, 40, 45, 50

Elevn. (m): 3905, 3900, 3895, 3890, 3885

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 24-10-2010	COORDINATES (POSGAR 94 Zone 3) E: 3430000	WELL REFERENCE: C-10
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC	END DATE: 28-10-2010	N: 7406498	Page 1 of 2
		METHOD: SONIC	DEPTH: 54m	Elevn: 3938,907	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Units: A (water level ▼ 1,83); B

NO RECUPERADO.

CLAY: Arcilla marrón-clara (5YR 5/6). Ulexita en papas y niveles (0,5 a 3cm) y aislados cristales de selenita (hasta 1cm). En el tope (4cm) abundantes microcristales de halita y selenita?.

CLAY with HALITE: Arcilla arenosa (arena fina) con microcristales de halita y de selenita, color girs-verdosa. Niveles deformados (2 a 3cm) de arcilla gris-verdosa (5Y 5/2), dos niveles (1 y 6cm) de halita masiva blanquecina. Cristales aislados de selenita (0,5cm).

SANDY CLAY: Arcilla arenosa marrón-pálida (10YR 6/2) con abundantes papas de ulexita (2 a 3cm). Intercalan niveles (3 y 4cm) de arena media a fina gris limo-arcillosa. Escasos niveles (3 a 4cm) muy deformados de arcilla marrón-pálida (10YR 6/2) y gris-verdosa (5Y 5/2). Muy escasos y gruesos (hasta 2cm) cristales de selenita.

CLAY: Arcilla gris-verdosa (5Y 5/2) en la base niveles muy deformados de arcilla negra (1 a 2cm).

BLACK CLAY: Arcilla negra.

CLAY: Arcilla gris-verdosa (5Y 5/2) con nivel (1cm) de arcilla negra y muy escasas papas (0,5 a 2cm) de ulexita.

CLAYEY SAND Interbeded CLAY: Arena muy fina a fina arcillosa gris a gris-verdosa (10Y 4/2), conformada por selenita(?45%), cuarzo(?37%), magnetita(?10%), liticos(?7%), yeso?(?1%) y biotita(<1%). Intercalan dos niveles muy deformados (?10cm) apenas diferenciables de arcilla marrón-pálida. Abundantes papas (1 a 2cm) y menor niveles (1 a 3cm) de ulexita.

BLACK CLAY: Arcilla negra con muy escasos y difusos niveles (1 a 2cm) de ulexita.

BLACK HALITE: Abundantes cristales (1 a 2mm) subhedros traslucidos de halita en matriz de arcilla negran (10 al 15%). Nivel (7cm) de arcilla negra con abundantes cristales de halita.

BLACK CLAY: Arcilla negra.

BLACK HALITE with CLAY: Abudantes cristales de halita (1 a 3mm) subhedros a euhedros traslucidos en matriz de arcilla negra (?20%) con niveles y papas de ulexita (1 a 2cm).

CLAY: Arcilla verde (10GY 5/2) con nivel (12cm), en tope, de arcilla marrón-pálida (10YR 6/2).

CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramnete rojiza. En la base muy escasos rastros irregulares de arcilla gris-verdosa.

CLAY Interbeded SAND: Arcilla marrón-rojiza (5YR 5/2). Abundantes niveles y lentes? (1 a 2cm) muy deformados areno fino arcillosos con abundantes microcristales de halita. Escasos niveles y papas (1 a 2cm) de ulexita. Fuerte deformación y ontaminación por SPT.

CLAY: Arcilla marrón-oscura (10YR 4/2) con papas y niveles (1 a 3cm) de ulexita. Muy escasos rastros irregulares de arcilla rojiza (10R 4/6) y negra. Escasos cristales aislados (1cm) de selenita. En tope, primeros 36cm, intercala con arcilla pálida (10YR 6/2) en niveles de 3 a 5cm.

CLAY: Arcilla rojiza (10R 4/6) con muy escasas y aisladas papas (1 a 2cm) de ulexita. Hacia la base (últimos 20cm) se torna ligeramente gris-verdosa, transicional con nivel inferior.

CLAY: Arcilla verde (10GY 4/4). Con ratsros irregulares y escasos niveles (0,1 a 2cm) de arcilla negra.

CLAY Interbeded ORGANICS: Arcilla marrón-rojiza (5YR 5/2) intercala ritmicamente, con abundantes niveles (1 a 7cm) de arcilla negra. Muy escasas y muy finas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY: Arcilla marrón-pálida (10YR 6/2) muy escasos rastros irregulares difusos de arcilla gris-verdosa y finos niveles (2mm) de arena muy fina limo arcillosa gris-oscura.

CLAY: Arcilla rojiza (10R 4/6) con niveles escasos muy deformados (0,2 a 2cm) de arcilla negra. Alta plasticidad.

CLAY: Arcilla marrón-pálida (10YR 6/2) con muy escasos rastros irregulares de arcilla negra y papas (?1cm) de ulexita. Hacia la base, últimos 24cm, arcilla verde (10GY 5/2) con nivel (1cm) de arcilla marrón-rojiza.

CLAY: Mix de arcilla marrón-pálida (10YR 6/2) y gris-verdosa (5Y 5/2) de contacto difuso.

CLAY: Arcilla gris-verdosa (5Y 5/2) transicional en el último centimetro con nivel inferior. Grueso agregado policristalino de selenita (4cm). Muy escasos cristales aislados de selenita y papas (1cm) de ulexita.

CLAY: Arcilla verde (10GY 5/2) muy escasos rastros irregulares de arcilla rojiza. Muy escasos cristales aislados de selenita (hasta 2cm).

BLACK CLAY: Arcilla negra.

CLAY: Arcilla marrón-oscura (10YR 4/2) muy escasos niveles y lentes (1cm) de arena fina a muy fina limosa con abundantes microcristales de selenita?. Escasas papas de ulexita (1 a 3cm) y escasos cristales aislados (?1cm) de selenita. En tope (17cm) arcilla marrón-pálida (10YR 6/2) con niveles (0,3 a 1cm) muy deformados de arcilla negra.

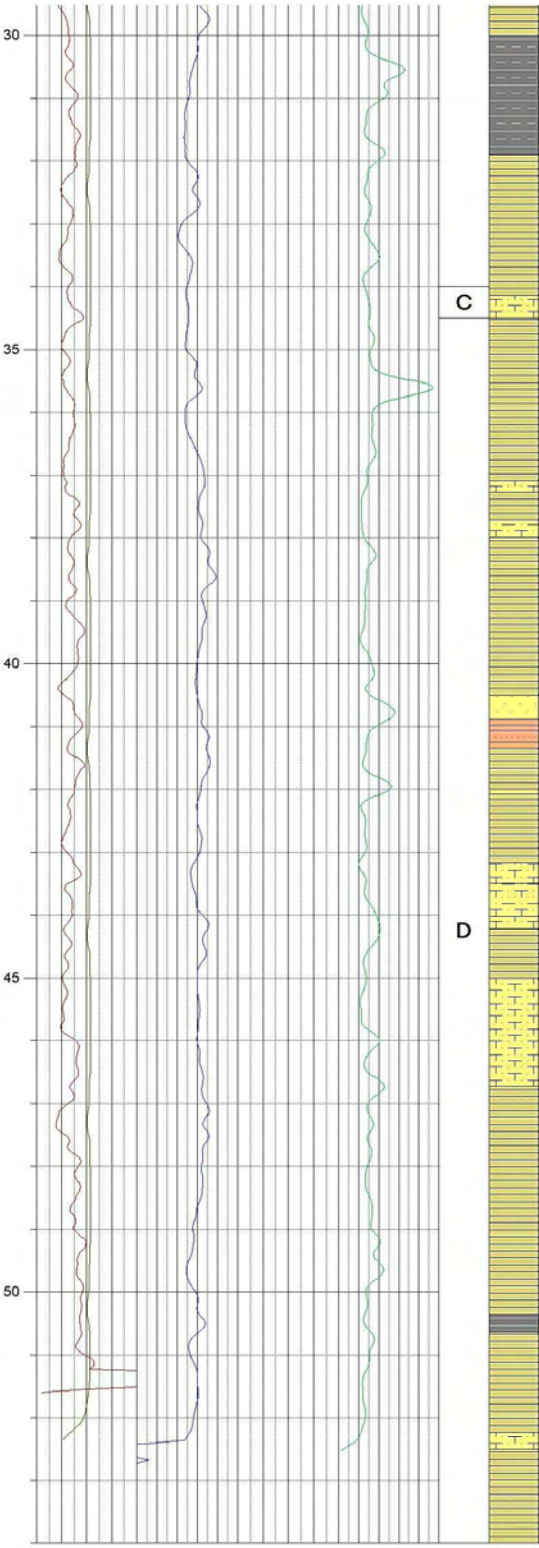
CLAY Interbeded ORGANICS: Arcilla marrón-pálida (10YR 6/2) con abundantes niveles milimetricos de arcilla negra muy deformados por avance y alta plasticidad.

Depth (m): 0, 5, 10, 15, 20, 25

Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 24-10-2010	COORDINATES (POSGAR 94 Zone 3) E: 3430000	WELL REFERENCE: C-10
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 28-10-2010	N: 7406498	
	METHOD: SONIC	DEPTH: 54m	Elevn: 3938,907	LOGED BY: Geol. FERNANDO A. MARTÍN

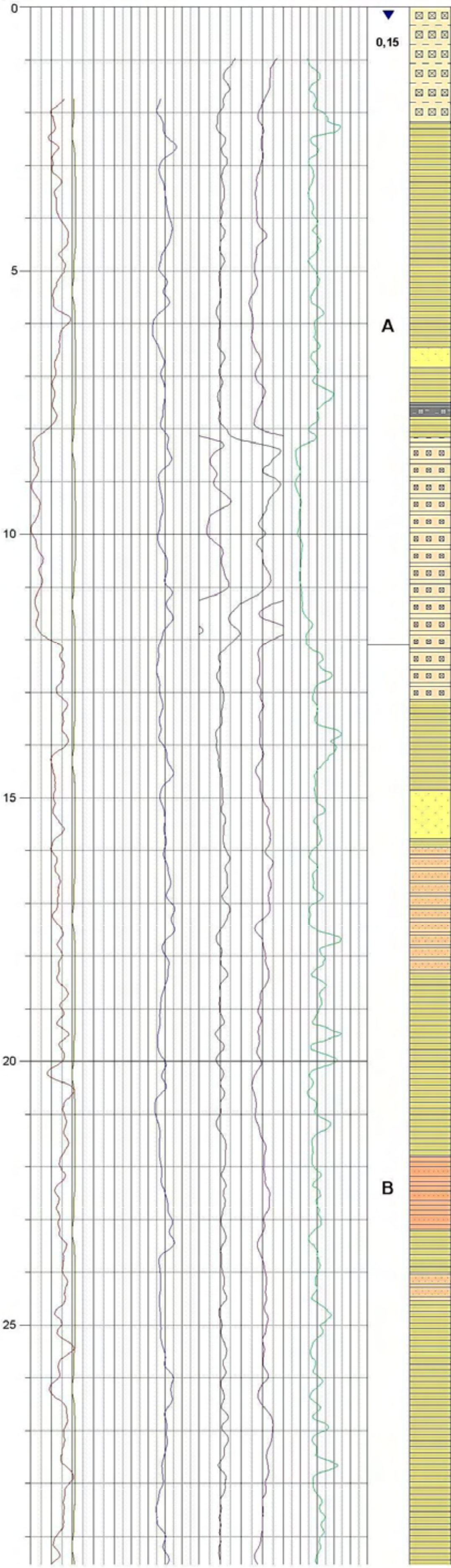
Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



- CLAY: Arcilla marrón-oscura (10YR 4/2) con finos y muy escasos niveles (2 a 5mm) de arena fina limo-arcillosa. Papas de ulexita (1 a 2cm) y escasos cristales de selenita (hasta 1cm).
- CLAY Interbeded ORGANICS: Arcilla marrón-pálida (10YR 6/2). Abundantes rastros irregulares muy deformados de de arcilla negra. Papas y niveles escasos (1 a 2cm) de ulexita. Fuerte dformación por avance y alta plasticidad.
- CLAY: Arcilla rojiza-pálida (10R 5/4) con nivel deformado en tope (9cm) de arcilla gris-verdosa (5Y 5/2).
- CLAY: Arcilla marrón-pálida (10YR 6/2) muy escasos niveles (2 a 5mm) de arcilla negra y menor ulexita. Muy escasas y finas manchas anaranjadas pulverulentas (rejalgar/oropimente?). Intercala con nivele (8cm) de arcilla rojiza (10R 4/6) y nivel (25cm) de arcilla verde (10GY 5/2).
- CLAY: Arcilla verde (10GY 5/2) con nivel en tope (19cm) de arcilla rojiza (10R 4/6).
- SILTY SAND: Arena fina a media limosa gris-oscura a negra (N2) con muy escasa arcilla negra de ditribución irregular. Conformada por granos subredondeados de cuarzo(?45%), carbonatos masivos(?40%), magnetita(?5%) y biotia(<1%).
- CLAY: Arcilla verde (10GY 5/2) con nivel (12cm) de arcilla marrón-rojiza (5YR 4/4) y muy escasos rastros muy irregulares de arcilla negra.
- SILTY SAND: Arena fina a muy fina limosa marrón (5YR 4/4) intercala con tres niveles de arcilla arenosa marrón (?2cm).
- CLAY: Arcilla marrón (5YR 4/4) pasa a arcilla verde (10GY 5/2) con muy escasos rastros irregulares de arcilla marrón.
- SILTY SAND with CLAY: Arena fina a muy fina limo-arcillosa gris-oscura a negra. Abundnate agua. Conformada por cuarzo(?75%), liticos(?12%), carbonatos masivos(?8%), magnetita(?5%) y biotita(<1%).
- CLAY: Arcilla marrón (5YR 4/4).
- CLAY: Arcilla marrón-oscura (10YR 4/2) muy escasas papas de ulexita (1cm). Alterada y contamianda por SPT.
- CLAY: Arcilla rojiza-oscura (10R 3/4) a ligeramente marrón. Escasas papas (1 a 2cm) y niveles (2 a 5mm) de ulexita. Muy escasos rastros muy irregulares de arcilla negra.
- SAND: Arena media a fina gris (N4) con muy escaso a nulo limo, conformada por cuarzo(?75%), magnetita(?10%), carbonatos masivos(?10%), yeso?(?3%), liticos(?2%) y biotita(<1%).
- CLAY Interbeded SAND: Arcilla rojiza-pálida (10R 5/4) con abundantes papas (1 a 3cm) y menor niveles de ulexita. Intercala con niveles (1 a 4cm) de arena fina a media gris con escaso limo. Intercalación de arcilla con arena.
- CLAY: Arcilla rojiza (10R 4/6) a marrón (5YR 5/2) contacto difuso muy irregular con nivel (7cm) de arena fina a media gris (N4) con escaso limo.
- SILTY SAND: Arena media a fina limosa gris (N5) con nivel (7cm), en tope, de arcilla rojiza.
- SILTY SAND with CLAY: Arena fina a media limo-arcillosa marrón (10YR 4/4), conformada por cuarzo(?65%), magnetita(?20%), yeso?(?10%), liticos(?5%) y biotita(<1%).
- SILTY SAND: Arena fina a media limosa gris (N5) con escasa arcilla en los últimos 7cm. Conformada por cuarzo(?70%), magnetita(?15%), yeso?(?8%), carbonatos masivos(?5%), liticos(?2%) y biotita(<1%).
- CLAY: Arcilla marrón-pálida (10YR 6/2).
- CLAY: Arcilla rojiza (10R 4/6) con escasos rastros de arcilla gris-verdosa. Muy finos niveles (2 a 5mm) de arena muy fina limosa gris.
- SILTY SAND: Arena fina limosa gris (N3) conformada por cuarzo(?55%), magnetita(?33%), liticos(?5%), carbonatos masivos(?5%), yeso?(?2%) y biotita<1%). Contaminada con arcilla por SPT.
- CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza. Abundantes rastros de arcilla gris-verdosa (5Y 5/2) de contacto difuso muy irregular y en la base nivel (36cm) confinos niveles (0,5 a 1cm) de ulexita. Finos (2 a 7mm) y escasos niveles de arena fina limosa gris.
- CLAY: Arcilla rojiza (10R 4/6).
- CLAY: Arcilla gris-verdosa (5Y 5/2) y hacia la base (44cm) pasa a arcilla verde (10GY 5/2).
- CLAY: Arcilla marrón-palida (10YR 6/2) intercala con dos niveles (5 y 3cm) de arcilla negra. Abundantes manchas anaranjadas-amarillentas (rejalgar/oropimente?). En tope, escasos niveles (1cm) de arcilla verde.
- BLACK CLAY: Arcilla negra con escasos rastros de arcilla marrón y verde. Manchas anaranjadas-amarillentas (rejalgar/oropimente?).
- CLAY: Arcilla marrón-pálida (10YR 6/2) con dos niveles (4 y 3cm) de arcilla negra. Muy escasas manchas anaranjadas-amarillentas (rejalgar/oropimente?). EN la base, últimos 32cm, pasa a arcilla rojiza-pálida (10R 5/4) muy escasos niveles (0,2 a 1cm) de arcilla negra.
- CLAY: Arcilla marrón (5YR 5/2) muy escasos rastros irregulares de arcilla negra. Niveles de 2cm en tope y 27cm en la base de arena fina limosa gris (N3).
- CLAY: Intercalan arcilla rojiza-pálida (10R 6/2) a ligeramente marrón con niveles (10 a 15cm) de arcilla gris-verdosa (5Y 5/2) con contactos muy difusos. Escasos niveles (0,5 a 1cm) alternados de arcilla negra. Papas (2 a 3cm) y niveles (?1cm) de ulexita. Manchas anaranjadas-amarillentas (rejalgar/oropimente?).

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	04-06-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	11-06-2010	E: 3424998	C-11
		METHOD:	SONIC	DEPTH:	54m	N: 7403999	Page 1 of 2
						Elevn: 3939,199	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



HALITE: Halita granular a masiva (muy compacta) en cristales euhedros (1 a 3mm). Nivel con alta porosidad. Escasos rastros (inclusión en cristales) de material clástico arcillo-limoso marrón (5YR 5/6) y hacia la base gris-oscuro.

CLAY : Arcilla marrón (5YR 4/4) y nivel con halita.

HALITE: Halita compacta con cristales translucidos euhedros (1 a 2mm) y abundante presencia de matrial limo-arcillo arenoso gris (N5).

CLAY : Arcilla gris-verdosa (5Y 5/2). Niveles con ulexita en papas (2cm) y niveles (1 a 2cm) con cristales euhedros y translucidos de halita (1 a 4mm). En la base nivel de arena muy fina arcillosa con abundantes cristales de selenita. Nivel (39cm) de arcilla marrón-oscura (10YR 4/2)

CLAY : Arcilla marrón (5YR 6/2) hacia la base intercala con escasos niveles (1 a 2cm) de arcilla negra (Materia orgánica) y muy escasos niveles de ulexita (0,5cm).

SAND: Arena muy fina limo-arcillosa gris (N5). Muy escasos rastros de materia orgánica (arcilla negra) y cuatro niveles de ulexita (1 a 2cm).

CLAY : Arcilla marrón (10YR 6/2) intercala con niveles (2 a 3cm) de arena fina arcillosa conformada por cristales de selenita. Muy escasos rastros irregulares de materia orgánica (arcilla negra).

BLACK CLAY with HALITE: Arcilla gris-oscura a negra con abundantes microcristales de selenita (?) dando al nivel una textura arcillo-arenosa.

BLACK CLAY : Arcilla negra con escasos rastros de arcilla marrón y finos niveles deformados (0,5cm) de ulexita.

HALITE WITH CLAY: Halita masiva negra (muy compacta) y granular con cristales euhedros translucidos de tamaño variable (0,5 a 3mm). Abundante presencia de materia orgánica (arcilla negra). Intercala con escasos niveles de arcilla negra con escasos cristales de halita.

CLAY : Arcilla rojiza (10R 4/6) intercala con abundantes niveles (2 a 5cm) de arcilla marrón (10YR 6/2). Muy escasas y finas (0,5 a 1cm) papas de ulexita. Muy escasos niveles (0,5cm) de arcilla negra.

CLAY : Arcilla marrón (10YR 6/2) con abundantes y finos niveles (0,5 a 1cm) de arena muy fina ligeramente limosa gris. Muy escasos bancos de arcilla rojiza.

SAND: Arena fina a muy fina gris-oscura (N4) con muy escaso a nulo limo, conformada por cuarzo(?80%), magnetita(?10%), liticos(?5%), yeso?(?4%), carbonatos masivos(?1%) y biotita(<1%).

CLAY : Arcilla rojiza (10R 4/6) intercla con arcilla marrón (10YR 6/2). Muy escasos rastros de arcilla negra (materia orgánica).

SAND interbeded CLAY: Intercalación de arena fina a muy fina gris (N4) y arcilla marrón oscura (10YR 6/2). Arena conformada por cuarzo(?50%), magnetita(?30%), yeso?(?10%), liticos(?7%), carbonatos masivos(?3%) y biotita(<1%).

CLAY : Arcilla rojiza (10R 4/6). Escasos y finos niveles (2 a 3mm) de arena muy fina con escaso limo gris. Intercalan nivel (24cm) de arcilla gris-verdosa (5Y 5/2) y nivel (19cm) arena mediana a fina gris (N5). Hacia la base con abundantes niveles (1 a 3cm) de arcilla negra.

CLAY interbeded SAND: Arcilla gris-verdosa (5 Y 5/2) intercala con escasos niveles (1 a 2cm) de arena media a fina gris.

CLAY : Arcilla rojiza-palida (10R 5/4) intercala con tres niveles (5,6 y 2cm) de arcilla verde-clara (10GY 5/2).

SAND interbeded CLAY: Arena fina a media arcillosa gris (N5) Intercala con escasos niveles de arcilla marrón.

CLAY : Arcilla marrón (10YR 6/2) intercala con muy escasos y finos niveles de arcilla verde.

CLAY : Arcilla rojiza (10R 5/4) intercala con escasos y finos niveles de arena fina ligeramente limosa de color gris.

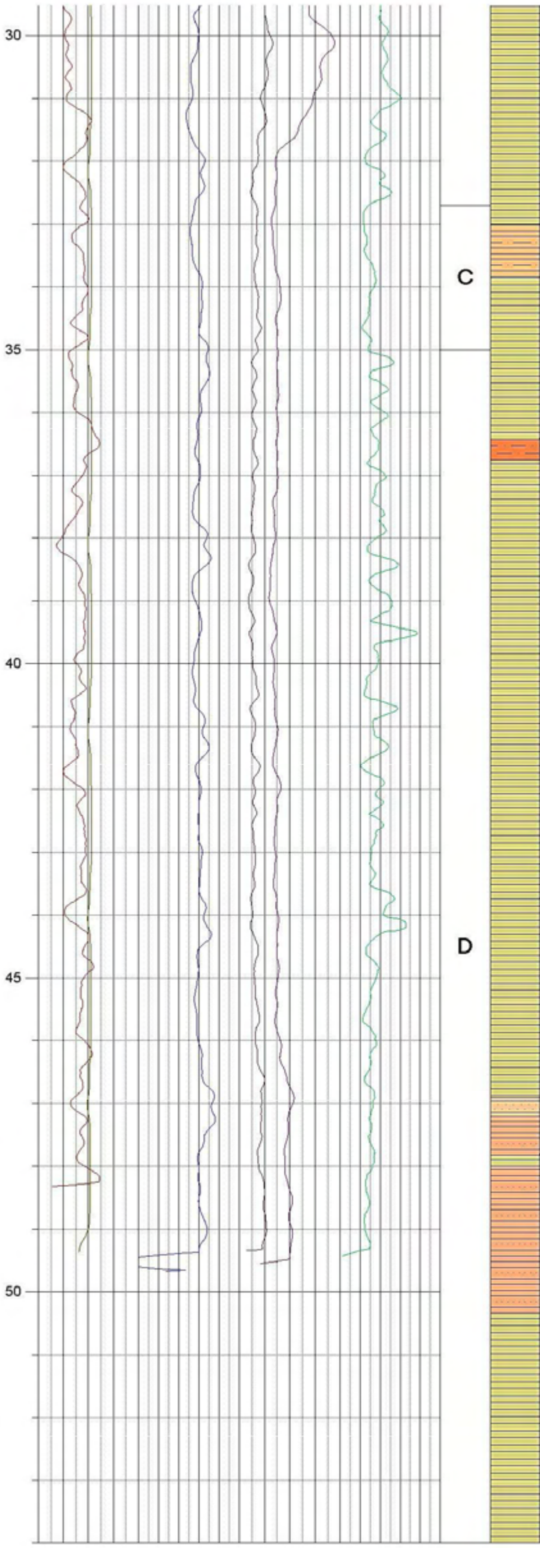
CLAY : Arcilla marrón (10YR 6/2) intercala con escasos niveles de arena arcillosa gris y muy escasos niveles (1cm) de arcilla negra. A los 26,23mts nivel (3cm) de ulexita. Muy escasos y aislados cristales y agregados policristalinos (1cm) de selenita (rosa del desierto).

CLAY : Arcilla verde (10GY 5/2) intercala con nivel (5cm) de arcilla marrón. Hacia la base arcilla rojiza (10R 4/6)

CLAY : Arcilla marrón (10R 6/2) intercala con abundantes y finos niveles (1 a 2cm) de arcilla negra. Escasos niveles de ulexita de 2 a 4cm. Hacia el tope arcilla gris-verdosa a marrón y aislados cristales (0,5cm) de selenita.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	04-06-2010	COORDINATES (POSGAR 94 Zone 3) E: 3424998	WELL REFERENCE:	C-11
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	11-06-2010	N: 7403999	Page 2 of 2	
		METHOD:	SONIC	DEPTH:	54m	Elevn: 3939,199	LOGED BY:	Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY Interbeded ORGANICS: Arcilla negra intercala, rítmicamente, con niveles de arcilla marrón (10YR 6/2) en niveles de 1 a 5cm. Arcilla marrón con manchas anaranjadas pulverulentas (rejalgar/oropimente?). Muy escasos y finos niveles (1cm) de arena fina gris.

CLAY : Arcilla rojiza (10R 4/6) intercala con tres niveles (3, 7 y 18cm) de arcilla verde (10GY 5/2). Transicional con el nivel inferior. Escasos cristales de selenita (1cm).

CLAY interbeded SANDY CLAY: Arcilla verde (10GY 5/2) d. Intercala con escasos niveles deformados (2 a 4cm) de arcilla negra arenosa (arena muy fina).

CLAY : Arcilla marrón (5YR 4/4). Con escasas papas de ulexita (0,5 a 2cm) concentradas entre 34,68 y 34,89m y arcilla marrón (10YR 4/2) con abundantes rastros irregulares (1 a 2cm) de arcilla negra (materia orgánica).

SANDY CLAY: Arcilla arenosa (arena muy fina) marrón (10YR 4/2) con papas de ulexita a lo largo de todo el nivel (2 a 4cm). Intercala con nivel (2cm) de arena fina amuy fina gris.

CLAY : Arilla marrón (5YR 5/4) con escasos niveles de contacto irregular (0,5 a 1cm) de arcilla negra. Tres niveles con ulexita (2 a 3cm).

CLAY : Arcilla negra con abundantes y finos cristales (<0,5mm) de halita. Intercala con 2 niveles de arcilla marrón (3 y 5cm) y finos niveles de ulexita en papas (1 a 2cm).

CLAY : Arcilla rojiza (10YR 4/2).

CLAY : Arcilla marrón (5YR 6/4) con finas y escasas papas de uexita (1 a 2cm). Hacia 41,5m intercala (10cm) con finos niveles con abundantes cristales de selenita (?1mm) muy escasos alcanzan 1cm.

CLAY : Arcilla rojiza (10R 4/6) muy escasos niveles (2 de 1cm cada uno) con abundantes y muy finos crisales de selenita (?1mm).

CLAY : Arcilla marrón (10YR 6/2) con muy escasos niveles (0,5 a 1cm) de arena fina a muy fina gris. Intercala con nivel de arcilla arenosa negra (2cm). Escasos y gruesos cristales de selenita (hasta 4cm).

CLAY : Arcilla rojiza (10R 4/6) intercala con niveles (1cm) equidistantes (15 a 20cm) de arcilla negra. A lo largo del nivel manchas anaranjadas pulverulentas (rejalgar/oropimente?).

SAND interbeded CLAY: Arena muy fina limosa intercala en la base con tres niveles (0,5cm) de arcilla marrón.

CLAY interbeded SAND: Arcilla marrón (10YR 4/2) con dos niveles de 2 y 3cm de arena final limosa.

CLAY : Arcilla gris verdosa (5Y 5/2).

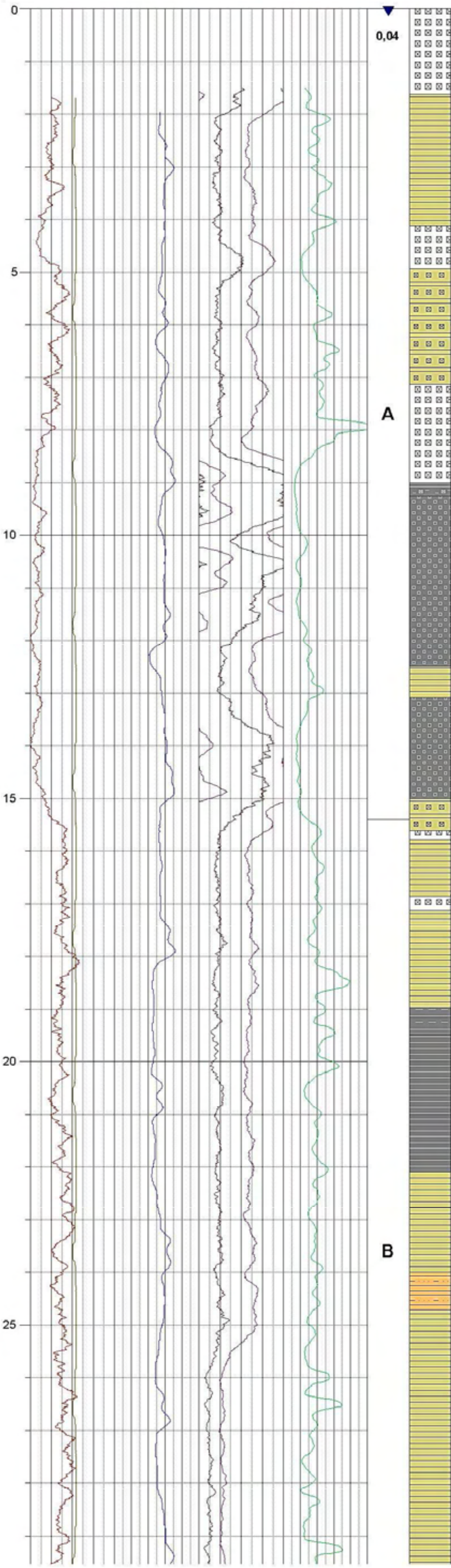
CLAY interbeded SAND: Arcilla rojiza (10YR 4/6) con nivel (22cm) de arena muy fina gris (N5) ligeramente limosa y ceniza volcánica? (14cm) textura limo color gris-claro a blanquecino (N7), muy finos cristales y micocristales (?15%) de biotita y otros mafitos, menor cuarzo?.

CLAY : Arcilla marrón (5YR 5/2) muy escasos niveles (1 a 2cm) de arena fina a muy fina gris y niveles irregulares (2 a 3cm) de arcilla negra (materia orgánica).

CLAY : Arcilla gris-verdosa (10GY 5/2) con muy escasos rastros de materia orgánica (arcilla negra). Escasas manchas pulverulentas anaranjadas (rejalgar/oropimente?).

OROCOBRE OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 11-06-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-12
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 20-06-2010	E: 3426998	Page 1 of 2
	METHOD: SONIC	DEPTH: 54m	N: 7403998	LOGED BY: Geol. FERNANDO A. MARTÍN
			Elevn: 3938,998	

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



HALITE: Halita granular con cristales de tamaño variable (1 a 3mm). Abundante presencia de material clástico (como inclusiones y en poros) gris-oscuro a negro y ligeramente anaranjado. En todos los casos cristales euhedros y translucidos. Intercala nivel (4cm) con muy finos cristales (?0,2mm) con escasa presencia de material clástico gris.

CLAY : Arcilla marrón-clara (10YR 6/2) con abundantes papas de ulexita (?2cm) y abundantes cristales de selenita (?1cm) individuales o formando agregados policristalinos (rosa del desierto).

CLAY : Arcilla gris-verdosa (5Y 5/2). Niveles de ulexita (2a 4cm) y nivel irregular (2 a 3cm) con abundantes y muy finos cristales de (?0,5mm) selenita.

CLAY : Arcilla marrón-oscura (10YR 4/2). Niveles (2 a 5mm) con abundantes cristales de selenita (?0,5mm) y nivel de 2cm con cristales de halita (2 a 5mm).

HALITE: Nivel de halita masiva (muy compacta) con abundante presencia de materia orgánica que tiñe de negro el nivel. Hacia la base granular con cristales euhedros hasta 2mm, pocos ejemplares alcanzan 1cm.

CLAY with HALITE: Arcilla marrón (5YR 5/2) con gruesos y aislados cristales (1 a 2cm) anehdrales, translucido de halita. Arcilla negra en el tope.

CLAY with HALITE: Arcilla marrón-oscura (10YR 4/2). Papas de ulexita (1 a 4cm). Intercala con finos y muy escasos niveles (0,5 a 1cm) conformados por cristales de selenita (?1mm) y tres niveles (1 a 2cm) con material limoso gris-claro a blanquecino con abundnates cristales en matriz blanquecina (10%) conformados por muy finos cristales de cuarzo? (vidrio?) y muy escasos cristales máficos biotita y magnetita? . Hacia la base intercalación rítmica con arcilla negra.

HALITE: Halita granular con abundante arcilla negra y agua. Selenita escasa (2mm). Halita en cristales euhedros a subhedros de 2 a 3mm. Intercala nivel (6cm) de arcilla marrón-clara (10YR 6/2). Hacia la base halita compacta.

BLACK CLAY with HALITE: Arcilla negra intercala con muy escasos y finos niveles (0,5cm) con abundantes cristales de halita (?0,5mm) en arcilla negra.

BLACK HALITE: Halita masiva (compacta) negra. Finos y escasos niveles granulares con abundante arcilla negra (3 a 4cm). Muy escasas papas de ulexita (3 a 4cm). En la base (últimos 50cm) fuerte alteración del sedimento: Halita con lexan fundido.

CLAY : Arcilla marrón (10YR 5/4). Muy finas (0,5cm) y escasas papas de ulexita. Rastros de arcilla negra. Fino nivel (3mm) con abundante halita (1mm) euhedros y translucidos. Intercala nivel (22cm) de halita negra muy compacta con microcristles hasta 0,5mm.

BLACK HALITE: Halita negra masiva (muy compacta) intercala en el tope con nivel de arcilla negra (16cm) con papas (3cm) de ulexita y en la base con nivel (3cm) de arcilla marrón.

CLAY with HALITE: Intercala arcilla rojiza (10R 5/4) con niveles (3cm) de halita con distinto tamaño según el nivel (tamaño arena media a fina hasta 1cm: dominan 1 a 2mm) euhedros y translucidos. Muy escasa ulexita (1cm). Escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

HALITE: Halita granular muy friable con abundante agua. Escasa presencia de material clástico limo-arcilloso gris (N5).

CLAY : Arcilla rojiza (10R 5/4) intercala con muy escasos niveles y papas de ulexita (1 a 2cm). Escasos y aislados cristales de selenita (hasta 1cm) individuales o en agregados policristalinos (rosa del desierto). Muy escasos y finos niveles (1cm) con cristales de selenita (1 a 2mm).

HALITE: Halita granular tamaño arena media a fina en cristales subhedros translucidos. Escaso material clástico arcillo-limoso tiñe de gris (N5) el nivel. Muy escasos cristales alcanzan los 5mm.

CLAY : Intercalación de arcilla verde (10GY 5/2) y rojiza (10R 5/4). Hacia la base abundantes rastros de materia orgánica (arcilla negra) y escasos cristales translucidos de halita euhedra (1 a 2mm). Y termina con nivel de 17cm con arcilla arenosa (arena muy fina) gris-verdosa (5Y 5/2)

CLAY interbeded ORGANICS: Intercalación rítmica entre arcilla marrón (5YR 5/2) y negra (materia orgánica) con 1cm aproximadamente cada nivel. Finos cristales de halita y niveles de arena muy fina arcillosa (?1mm).

BLACK CLAY: Arcilla negra (materia orgánica) intercala con escasos niveles (2 a 3mm) de arcilla marrón (5YR 5/2). Nivel de arcilla verde (10GY 5/2) de 3cm. Muy escasos y muy finos niveles (?1mm) de arena muy fina limosa gris (N6).

CLAY Interbeded ORGANICS: Arcilla rojiza (10R 4/6) intercala con abundantes niveles (1 a 3cm) de arcilla negra. Muy escasas papas de ulexita (1cm) y manchas anaranjadas pulverulentas (rejalgar/oropimente?). Muy escasos y aislados cristales de selenita (?1cm) individuales y agregados policristalinos (rosa del desierto). Intercalan muy escasos y finos (?1mm) niveles de arena muy fina limosa gris.

CLAY interbeded CLAYEY SAND: Arcilla gris-verdosa (5Y 5/2) intercala con niveles de arena muy fina limo-arcillosa, fino nivel (3mm) con abundantes y muy finos cristales de selenita (?0,5mm) y, hacia la base, con dos niveles de arena media a fina gris (3cm). Muy escasas papas de ulexita (1cm).

CLAY : Arcilla verde (10GY 5/2) con muy escasos rastros de arcilla rojiza (5R 6/2). Escasos y muy finos niveles (<1mm) con muy fino a microcristales de yeso y escasos rastros de materia orgánica.

CLAY : Arcilla rojiza (5R 5/2) intercala (contaco irregular) con arcilla verde (10GY 5/2). Muy escasos agregados policristalinos intercrecidos (2cm) de selenita (rosa del desierto).

BLACK CLAY: Arcilla negra. Escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?) y rosas del desierto (1cm).

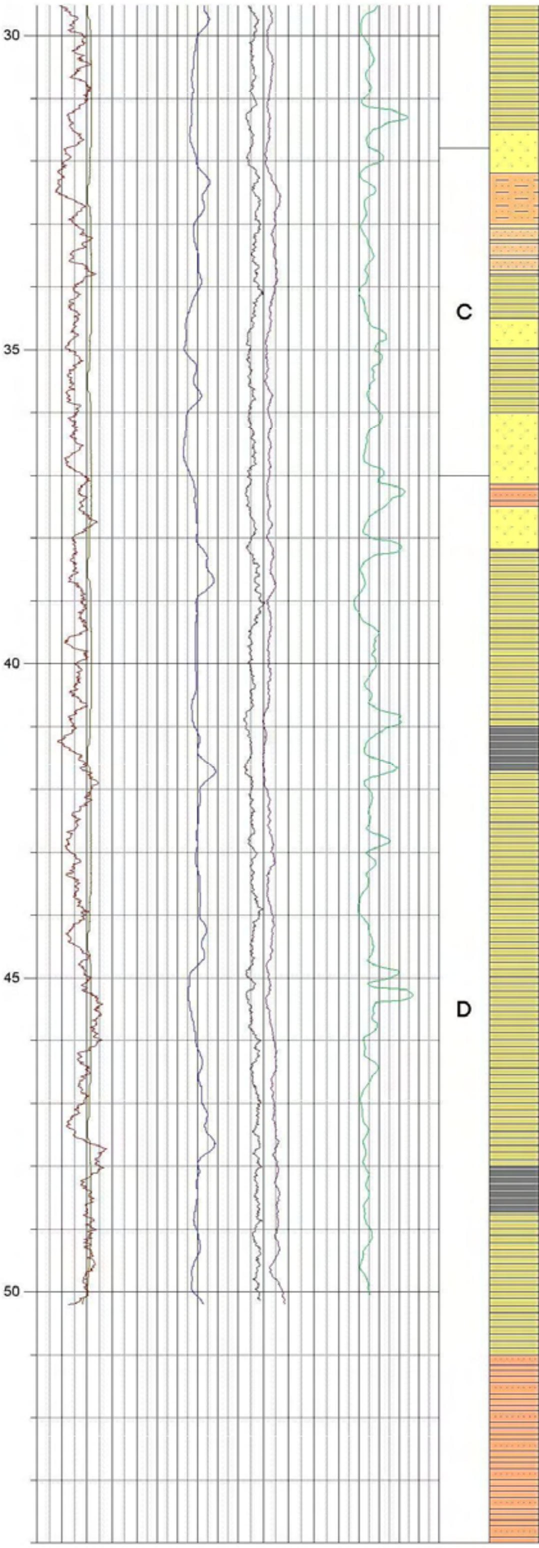
CLAY : Arcilla marrón (10YR 4/2) intercala con nivel (25cm) de arrcilla rojiza-palida (10R 6/2) y escasos bancos (2 a 3cm) de arcilla verde (10GY 5/2). Escasos niveles (1cm) de arcilla negra. Niveles y papas de ulexita (1cm). Agregados policristalinos intercrecidos de selenita alcanzan los 2cm. Manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY : Arcilla marrón (10YR 4/2) con escasos rastros de arcilla negra y papas de ulexita (1cm). Cristales aislados de selenita (?1cm) individuales o en agregados policristalinos intercrecidos (rosa del desierto). Nivel de arena muy fina limosa (5cm).

Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM			
CONTRACTOR: BLY	START DATE: 11-06-2010	COORDINATES (POSGAR 94 Zone 3) E: 3426998	WELL REFERENCE: C-12
DRILL RIG: SONIC	END DATE: 20-06-2010	N: 7403998	Page 2 of 2
METHOD: SONIC	DEPTH: 54m	Elevn: 3938,998	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

CLAY : Arcilla marrón (10YR 6/2) con escasos rastros, en el tope, de arcilla gris-verdosa (10Y 6/2). Muy escasos y finos lentes (?5mm) de arena fina gris.

SAND: Arena fina a muy fina gris (N5) con muy escaso a nulo limo, conformada por cuarzo(?55%), líticos volcánicos(?30%), magnetita(?10%) y yeso?(?5%).

CLAYEY SAND: Arena fina a muy fina ligeramente arcillosa (abundante agua) de color gris-oscuro a negro. Intercala con escasos niveles (1 a 2cm) de arcilla negra y arena fina gris (N5). Arena conformada por cuarzo(?70%), líticos volcánicos(?20%), magnetita(?9%), carbonatos masivos(?1%) y yeso?(<1%).

SAND interbeded CLAY: Arena fina a muy fina gris (N5) intercala con muy escasos niveles de arcilla verde y marrón (?5mm). Hacia la base se torna negra con muy escasa presencia de arcilla.

CLAY : Arcilla rojiza (10R 4/6) Intercala con nivel (20cm) de arcilla verde (10GY 5/2).

SAND: Arena fina a muy fina gris-oscura a negra con escasos a nulo limo. Intercala con nivel de arcilla verde (2cm) y arcilla marrón (1cm). Sedimento alterado por Split spoon.

CLAY : Arcila verde (10GY 5/2) muy escasos e irregulares rastros de arcilla rojiza.

SAND: Arena fina a muy fina gris (N5), conformada por cuarzo(?60%), líticos volcánicos(?25%), magnetita(?10%), carbonatos masivos(?4%) y yeso?(?1%).

CLAY interbeded SAND: Mix de contacto irregular entre arcilla marrón, rojiza y verde con menor presencia de arena fina a muy fina gris (intercalaciones deformadas?).

SAND: Arena fina a muy fina gris (N5) intercala con dos finos niveles (?1cm) de arcilla rojiza. Se torna, en la base, ligeramente arcillosa.

CLAY : Arcilla rojiza (10R 4/6) intercala con escasos niveles deformados (1 a 2cm) de arcilla verde.

CLAY : Arcilla marrón (10YR 6/2). Intercalan muy escasos niveles (?1cm) de arcilla negra, verde y arena muy fina limosa. Abundante ulexita en papas y niveles de 2 a 3cm.

BLACK CLAY: Arcilla negra con escasas y finas papas (?1cm) de ulexita. Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?). Nivel (10cm) de arena muy fina limosa gris.

CLAY : Arcilla rojiza (10R 4/6) con escasas papas de ulexita (1 a 2cm).

CLAY : Arcilla marrón (10YR 6/2) muy escasos y niveles deformados de arena muy fina (?1cm). Escasas y finas papas de ulexita (1 a 2cm)

CLAY : Arcilla rojiza (10R 4/6) intercalan niveles de arcilla limosa gris. Muy escasas papas de ulexita (<1cm) y rastros irregulares de arcilla marrón.

CLAY : Arcilla marrón (10YR 6/2) intercala con escasos niveles de arena muy fina gris (?5mm). Fuerte deformación por split spoon.

CLAY : Arcilla rojiza (10R 4/6) y hacia la base verde (10Gy 5/2).

BLACK CLAY: Arcilla negra intercala con arcilla marrón (10YR 6/2) en niveles de 2 a 3cm. Muy escasos cristales de selenita (?0,5mm) y manchas anaranjadas pulverulentas (rejalgar/oropimente ?). Hacia la base, nivel (4cm) de arcilla gris-verdosa (5Y 5/2).

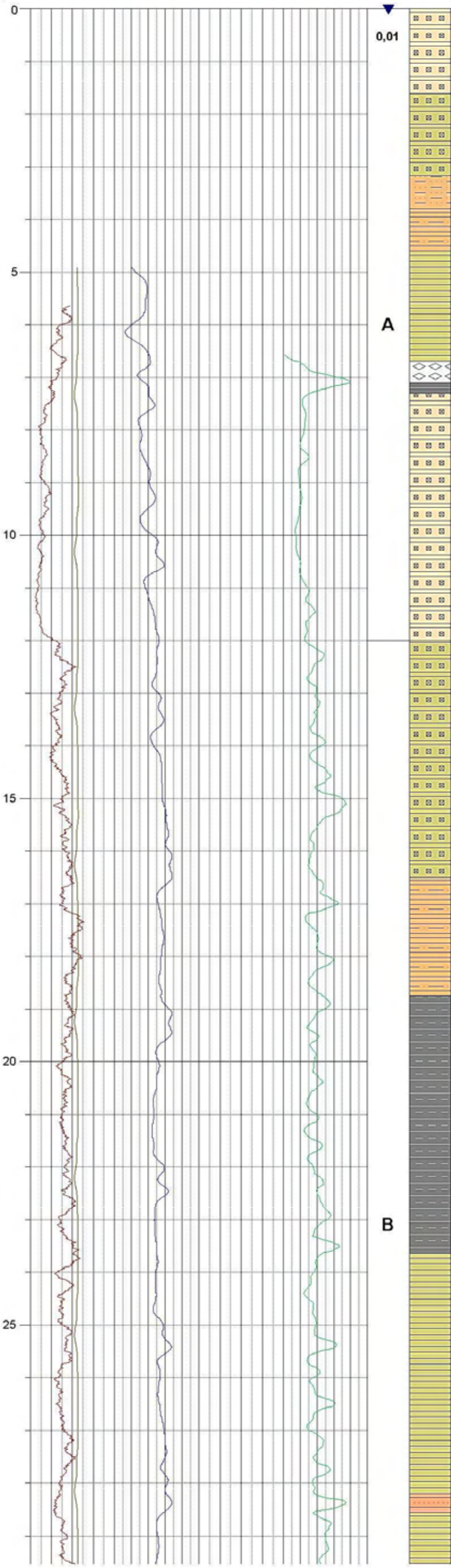
CLAY Interbeded ORGANICS : Arcilla rojiza (10R 6/2) intercala con abundantes niveles de arcilla negra (2 a 3cm). Muy escasas y finas papas (<5mm) de ulexita. Fino nivel (1mm) de arena muy fina gris.

CLAY : Arcilla marrón (10YR 6/2) con escasos y finos niveles (2mm) de arena fina gris. Muy escasos rastros de arcilla gris-verdosa.

CLAY interbeded SAND: Arcilla rojiza (10R 4/6) con dos niveles (14 y 15cm) de arena media a fina gris (N5) con escasos componentes de arena gruesa.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 13-04-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-13
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC	END DATE: 18-04-2010	E: 3428999	Page 1 of 2
		METHOD: SONIC	DEPTH: 55,5m	N: 7403999	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 3939,069	

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



HALITE with CLAY: Halita porosa hacia la base granular con inclusiones clásticas arcillo-limosas marrón-rojizas y gris-oscura a negra. Niveles de papas de ulexita (1 a 2cm).

HALITE with CLAY: Mix de muy finos cristales de halita y arcilla marrón (10YR 5/4) y limo-arcilla gris-oscura (N5). Abundantes papas de ulxita hasta 5cm.

CLAY with HALITE: Arcilla marrón-rojiza (10YR 4/2) y arcilla marrón (5YR 5/2) con abundantes y finos cristales de halita. Escasas papas de ulexita (2cm) y rastros de material limo-arcillosos gris (N5) con halita muy fina. Cristales de selenita (hasta 2cm).

CLAYEY SAND: Arena arcillosa (10YR 5/4) con finos cristales de yeso (?), intercala con finos niveles (1cm) de arcilla gris-verdosa (10Y 4/2). Escasos cristales de selenita (2cm).

CLAY interbeded SANDY CLAY: Mix de arcilla gris-verdosa (10Y 4/2) y arcilla marrón (5YR 5/2) con escasos cristales de selenita (1cm) y muy escasa ulexita. A 4m, nivel de arena arcillosa y hacia la base, arcilla gris-verdosa (5GY 5/2) con abundantes y muy finos cristales de halita.

CLAY : Arcilla marrón (10YR 4/2) y arcilla gris-verdosa (10Y 4/2) con niveles discontinuos de arcilla negra. Escasos y grandes cristales de selenita intercresidos (rosa del desierto).

CLAY : Intercalan en niveles de espesor variable arcilla marrón, verde y negra. Contactos irregulares. Hacia el fondo (7cm) solo arcilla negra con selenita (hasta 1cm).

GYPSUM: Muy finos cristales de yeso (?) con abundante materia arcillo-limosos gris-verdoso (10Y 4/2).

BLACK CLAY : Arcilla negra (N1) con abundante ulexita en papas (2cm).

HALITE WITH CLAY: Halita cristalina masiva y granular con niveles de 22 y 40cm con materia orgánica (arcilla negra). Cristales ehuedros a subhedros de hasta 2mm.

CLAY with HALITE: Arcilla marrón (10YR 5/4) intercala, de forma irregular, con finos niveles discontinuos de halita muy fina (hasta 1mm). Halita fina con abundante material clástico arcillo-limoso negro. Ulexita escasa en papas de hasta 3cm y cristales de selenita.

CLAY interbeded SANDY CLAY: Arcilla marrón oscura (10YR 4/2) intercala con arcilla verde (5G 4/2) y con finos y escasos bancos milimétricos de arcilla negra (materia orgánica). Nivel (30cm) de arcilla arenosa con abundante agua.

CLAY interbeded ORGANICS: Intercalación rítmica de arcilla marrón (10YR 4/2) y bancos de arcilla negra de aproximadamente 1cm cada uno.

CLAY interbeded ORGANICS: Intercalación de arcilla marrón (10YR 4/2) y arcilla negra (materia orgánica) cada 10 a 15 cm y grosores de 1 a 2cm. Muy escasos cristales de selenita hasta 1cm. Manchas anaranjadas de aspecto pulverulento (rejalgar?).

CLAY : Arcilla marrón-rojiza (10R 5/4).

CLAY : Arcilla verde (5G 4/2) con finos (1 a 3mm) y muy escasos banco intercaladosde arcilla negra (materia orgánica).

CLAY : Arcilla marrón-oscura (10YR 4/2) con finos lentes (5mm) de arena muy fina con yeso (?).

CLAY : Arcilla gris verdosa con abundantes y muy finos cristales de yeso (?) dan textura de arcilla arenosa. Dos finos niveles (2cm) con papas de ulexita.

CLAY : Arcilla verde (5G 4/2) con fino nivel (2cm) de mix de cristales de selenita y arcilla verde. Selenita de tamaño variable (<1 a 10mm).

CLAY : Mix de arcilla verde (5G 4/2) y arcilla marrón-rojiza (10R 5/4). Finos niveles con agregados intercrecidos de selenita (hasta 2cm). Hacia la base (últimos 5cm) solo arcilla marrón-rojiza.

CLAY : Arcilla marrón rojiza (10R 5/4) con muy escasos rastros de arcilla verde y cristales de selenita (2cm).

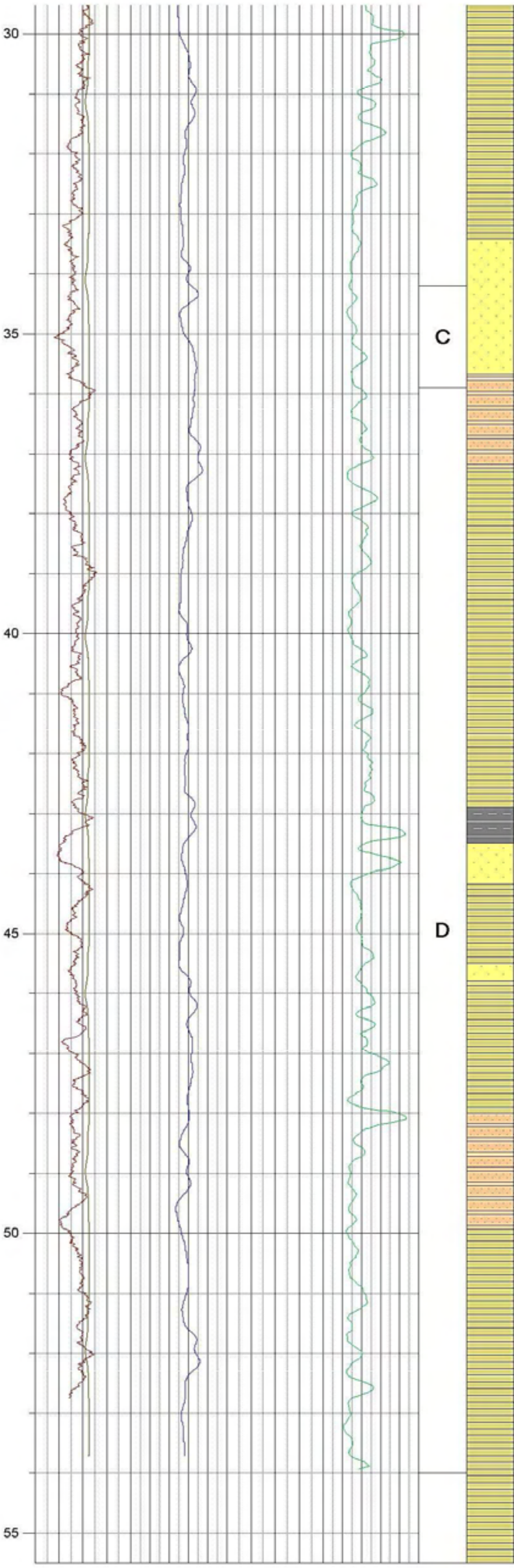
CLAY interbeded SAND: Intercalación de finos niveles de arcilla gris-verdosa con abundante ulexita (hasta 4cm) y arena muy fina (3cm).

CLAY : Arcilla marrón (10YR 4/2) con rastros de materia orgánica en aislados bancos de arcilla negra. Ulexita en papas en finos niveles (a los 31mts de 3 a 4cm). Finos y escasos lentes de arena muy fina con cristales de yeso(?). Muy escasos rastros de arcilla verde y rojiza (hacia los 32mts). En todo el perfil escasos y aislados cristales de selenita (1cm). Manchas anaranjadas aisladas (rejalgar/oropimente?).

Depth (m)	Elevn. (m)
0	
	3935
5	
	3930
10	
	3925
15	
	3920
20	
	3915
25	
	3910

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM					
CONTRACTOR:	BLY	START DATE:	13-04-2010	COORDINATES (POSGAR 94 Zone 3) E: 3428999	WELL REFERENCE: C-13
DRILL RIG:	SONIC	END DATE:	18-04-2010	N: 7403999	
METHOD:	SONIC	DEPTH:	55,5m	Elevn: 3939,069	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SAND: Arena fina a media con muy escaso material fino (limo-arcilloso) (N4), conformada por cuarzo(?60%), líticos volcánicos(?20%), magnetita(?15%) y yeso?(?5%). En la base 4cm de arena blanquecina. Nivel intermedio de arena arcillosa (poca arcilla), conformada, casí en su totalidad (?99%) por granos blanquecinos subangulosos a subredondeados (escasos con brillo satinado) de agregados de muy finos cristales (criptocristales) traslucidos y blanquecinos (volcánico retrabajado?). Escasos cristales de biotita, cuarzo y yeso?.

SAND interbeded CLAY: Arcilla rojiza (10R 4/6) intercala con nivel (80cm) de arena fina a media gris (N4) con muy escaso a nulo material fino.

CLAY : Arcilla verde (5G 4/2) escasos niveles con selenita (<1cm).

CLAY : Arcilla marrón-rojiza (10YR 4/2) con arcilla verde (5G 4/2) escasos cristales de selenita (<1cm) y muy escasos rastros de materia orgánica.

CLAY : Arcilla marrón (10YR 4/2). Abundante ulexita en papas de hasta 5cm en todo el perfil. Muy escaso rastros de materia orgánica. Finos cristales de yeso(?) color gris oscuro y muy blandos (?1cm).

CLAY interbeded ORGANICS: Intercalación de arcilla verde (5GY 3/2) y negra (5mm aprox) (materia orgánica). Con niveles de ulexita (1cm).

SAND: Arena fina a muy fina limosa de color negro con muy escasa a nula arcilla. Abundantes papas de ulexita en todo el perfil de tamaño variable (hasta 5cm).

CLAY : Arcilla rojiza (10R 4/6). En el tope (20cm) abundantes papas de ulexita (5cm). Hacia el fondo con finos lentes (1cm) de arena muy fina y abundante materia orgánica (arcilla negra). Escasos y aislados cristales de selenita intercrecidos.

SAND: Arena fina a media arcillosa con abundante agua. Color rojizo (10R 5/4).

CLAY : Intercalan arcilla marrón-clara (10YR 6/2) y rojiza (10R 5/4). Muy escasos y finos (1cm) lentes de arena muy fina.

CLAY : Arcilla rojiza (10R 6/2) con escasos y muy finos lentes (1 a 3mm) de arena muy fina gris. Muy escasos y aislados cristales de selenita (hasta 2cm).

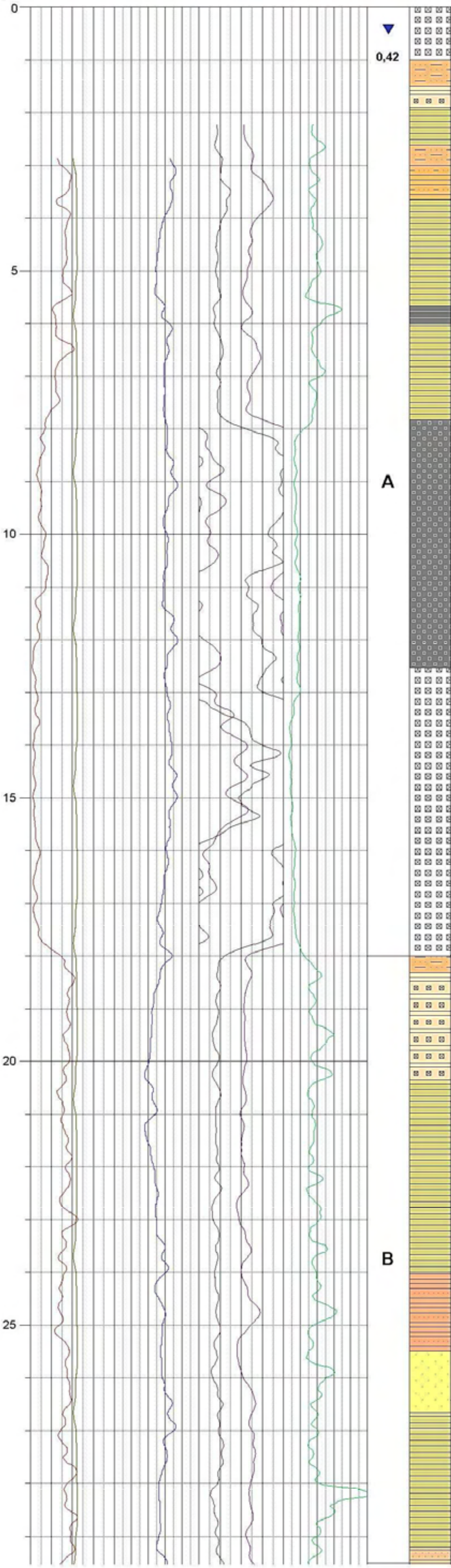
SAND interbeded CLAY: Intercalación de arena fina con buena selección (N3) y arcilla marrón (5YR 5/2) con escasas papas de ulexita. Arena conformada por cuarzo(?65%), magnetita(?65%), líticos(?25%), carbonatos masivos(?7%), yeso?(?3%) y biotita(<1%).

CLAY : Arcilla marrón (5YR 5/2) con finos y escasos niveles continuos y lenticulares de arena muy fina arcillosa. Papas de ulexita en distintos niveles (hasta 3cm). Escasos cristales de selenita hasta 2cm y rastros de materia orgánica.

CLAY : Arcilla rojiza (10R 4/6) con muy escasos y aislados cristales de selenita (hasta 1cm).

CLAY : Intercalalción rítmica de arcilla marrón (5YR 5/2) y menor arcilla verde. Niveles de arcilla negra (1 a 2cm). Escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 25-05-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-14
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC	END DATE: 03-06-2010	E: 3425999	Page 1 of 2
		METHOD: SONIC	DEPTH: 54m	N: 7401496	
				Elevn: 3939,100	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

HALITE: Nivel compuesto solo por halita en el tope (superior), microcristales que gradan hacia la base del nivel a cristales ehuedros hasta 2 mm. Cristales limpios con color blanquecinos en el conjunto. Escasa presencia de material clástico (limo-arcilloso) rojizo.

CLAYEY SAND: Arena fina arcillosa con abundantes cristales (4 a 8cm) de halita (tamaño arena) en matriz arcillosa color marrón intercala con niveles de arcilla negra con escasos cristales de halita (<0,5mm) y con un nivel de ulexita.

HALITE WITH CLAY: Cristales de halita (hasta 5 mm) euhedrales, translúcidos con tamaño aproximadamente uniforme. Abundante presencia de limo arcilloso gris oscuro a negro y agua.

CLAY : Arcilla marrón (10YR 6/2) intercala con niveles de arena limosa muy fina con abundantes microcristales de halita? (niveles de 2mm) y ulexita (2cm) con material arcilloso marrón. Fino nivel con cristales (2mm) euhedrales de halita.

CLAYEY SAND: Arena limosa muy fina con escasa arcilla (10YR 4/2) con abundantes microcristales de halita. Escasos niveles y papas (1 a 2cm) de ulexita.

CLAY interbeded CLAYEY SAND: Arcilla gris oscura verdosa (5Y 3/2) intercala con niveles de arena arcillosa con abundantes cristales de halita (2 de 5cm c/u) y un nivel (3cm) de arena fina arcillosa. Muy escasos y gruesos cristales de selenita (2cm).

CLAY : Arcilla marrón-rojiza (10R 5/4) intercala con 2 niveles (en el tope) de arena muy fina arcillo limosa (2cm) y niveles (5 a 7cm) en la base de arcilla gris oscura con aundantes cristales de halita (2 niveles).

CLAY : Arcilla marrón (10YR 6/2) con niveles escasos (1 a 2cm) de contacto irregular y con arcilla negra (materia orgánica). Muy escasos cristales de selenita (2mm).

BLACK CLAY : Arcilla negra con niveles (1 a 2cm) de ulexita con arcilla marrón. Hacia la base nivel de arena limosa muy fina con ulexita en papas.

CLAY : Arcilla marrón-oscura (10YR 4/2), intercalan escasos niveles (1 a 2cm) de arena fina a muy fina y muy escasas papas de ulexita (1 a 2cm). En la base con abundante materia orgánica (arcilla negra)

BLACK HALITE: Halita muy compacta (masiva) microcristalina intercala con distinto contenido de materia orgánica y un nivel (2cm) de solo arcilla negra. En la base con abundante material clástico limo arcilloso marrón claro.

HALITE: Halita cristalina masiva, muy compacta de color blanco lechoso, intercala con niveles de tonos rojizos, grises y grises-oscuros y negro por inclusión de material clástico (de 2 a 3cm) arcilloso en distintos niveles. Hacia los 15 m nivel (10cm) con cristales gruesos, euhedrales a subhedrales translúcidos, intercalan con escasos niveles arcillosos. 13 a 13,10 m nivel de arcilla marrón con escasas papas de ulexita. 14,12 y 14,30 m niveles de 1cm con arcilla marrón y abundantes cristales de halita. 16,5 a 16,80 halita negra (materia orgánica) con muy escasas ulexitas (?0,5cm). 16,95 a 16,97 nivel de arcilla negra con escasa ulexita (1cm).

CLAYEY SAND: Arena arcillosa, gris verdosa (5Y 3/2) con abundantes cristales de halita de distintos tamaños (<0,1 a 1mm) euhedrales, translúcidos. Muy escasos rastros de ulexita.

HALITE with CLAY: Arcilla marrón-rojiza (10R 5/4) Intercala con dos niveles (15 y 8cm) con abundantes cristales de halita (muy friable) euhedros y translucidos de tamaño uniforme (0,5 a 1mm)

BLACK CLAY : Arcilla negra con muy finos niveles intercalados (0,5 a 1mm) de arcilla marrón-rojiza (10R 5/4).

CLAY : Arcilla marrón (10YR 5/2) intercala con escasos y finos niveles (0,5 a 1cm) de arcilla negra.

CLAY : Arcilla marrón-rojiza (10R 5/4) intercala con muy escasos niveles (1cm) de arcilla negra con abundantes cristales (1 a 2mm) euhedro y translucidos de halita. Muy escasas y finas papas de ulexita (?1cm) en la base nivel de 4cm.

CLAY : Arcilla verdosa pasa transicionalmente a arcilla marrón (10GY 5/2-5YR 5/2) con escasos rastros de materia orgáncica.

CLAY interbeded SAND: Arcilla gris verdosa (5Y 5/2) Intercala, rítmicamente, con tres niveles (9 a 14cm) de arena media a fina gris (N4) y escasos niveles de ulexita (2cm). Arena conformada por cuarzo(?63%), líticos volcánicos(?15%), magnetita(?12%), yeso?(?10%) y biotita(<1%).

SAND: Arena media a fina gris (N4).

CLAY : Arcilla gris-verdosa (5Y 5/2) con escasos rastros (niveles deformados?) de arcilla negra y fino nivel (0,5cm) de ulexita.

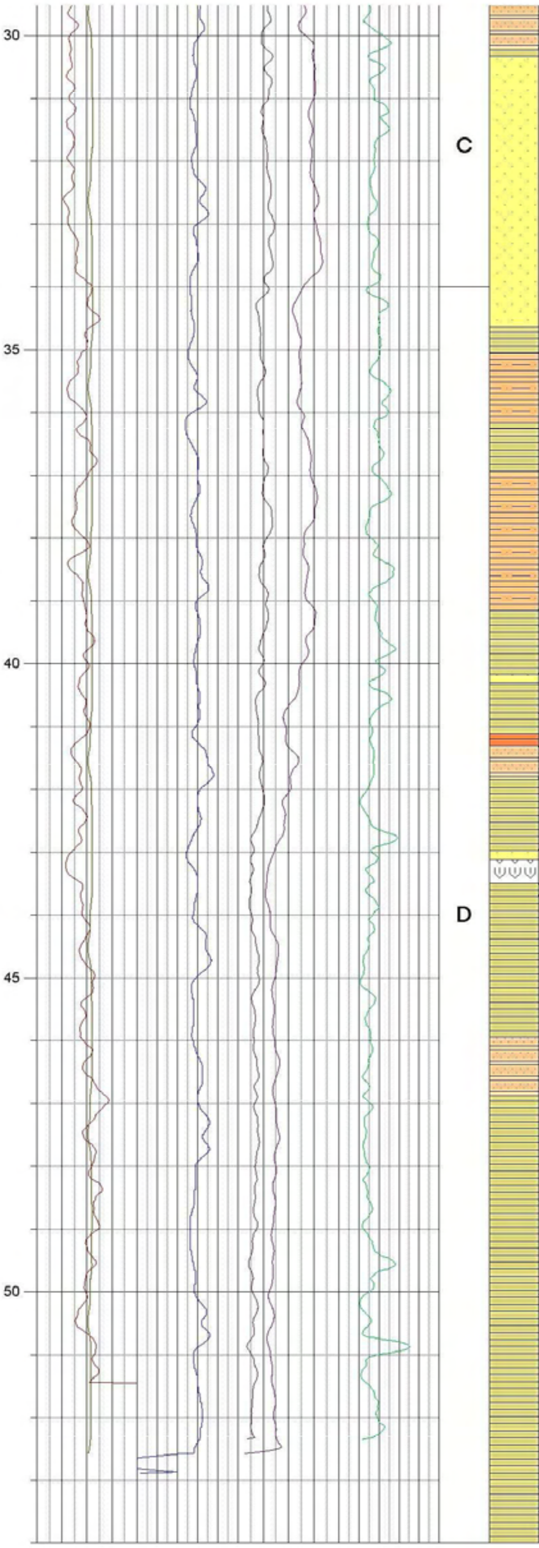
CLAY : Arcilla marrón-rojiza (5YR 5/2) con finos y escasos niveles (0,5 a 1cm) de arcilla negra y finos niveles (0,5cm) de ulexita. Hacia el tope tres niveles (1cm) de arena fina a muy fina gris. Escasos cristales de selenita (hasta 1cm). Manchas anaranjadas pulverulentas (rejalgar/oropimente?).

SAND interbeded CLAY: Arena fina a muy fina con escasos y finos niveles de arcilla marrón y ulexita (1cm). Arena conformada por cuarzo(?75%), magnetita(?15%), líticos

Depth (m): 0, 5, 10, 15, 20, 25
Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	25-05-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	03-06-2010	E: 3425999	C-14
		METHOD:	SONIC	DEPTH:	54m	N: 7401496	Page 2 of 2
						Elevn: 3939,100	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

volcánicos(?8%), yeso?(?2%) y biotita(<1%).

CLAY : Arcilla marrón (5YR 5/2) con finos niveles (0,5cm) deformados de arcilla negra.

SAND: Arena fina a muy fina gris (N4) conformada por cuarzo(?75%), liticos volcánicos(?15%), magnetita(?9%) y yeso?(?1%). Dos niveles gris-claro blanquecinos (1 a 2cm hacia los 31,15m) conformado por fragmentos blanquecinos (volcánico retrabajado?)(?85%), cuarzo(?10%), liticos volcánicos(?3%) y magnetita(?2%). Nivel (7cm) con papas de ulexita (0,5cm). Transicional con nivel inferior.

CLAY : Arcilla rojiza (10R 4/6) pasa a arcilla verde (5G 5/2) en la base.

CLAY interbeded SANDY CLAY: Arcilla verde (5G 7/2) intercala con niveles (3 a 5cm) de arena fina a muy fina arcillosa y finos niveles (1cm) de arcilla rojiza.

CLAY : Arcilla rojiza (10R 4/6) intercalan muy escasos y finos niveles (0,5mm) de arena fina a muy fina.

CLAY interbeded SANDY CLAY: Arcilla marrón (5YR 4/4) intercala con muy finos y escasos niveles (?0,5mm) de arena fina a muy fina. Intercala con nivel (40cm) con abundantes cristales de halita (tamaño arena fina a muy fina) y muy escasa arena muy fina en matriz arcillosa marrón.

CLAY : Arcilla verde (10GY 5/2) hacia la base pasa a arcilla marrón.

CLAY : Arcilla marrón (5YR 5/2). Intercala, en zona central, con nivel (1cm) de arena fina a muy fina gris-oscura. Hacia la base con niveles (0,5 a 1cm) de arcilla negra con manchas anaranjadas pulverulentas (rejalgar/oropimente?).

SAND: Nivel de arena fina a muy fina ligeramente arcillosa con papas de ulexita (2cm).

CLAY : Arcilla marrón (5YR 5/2) con grueso nivel (5cm) de ulexita y papas hasta 4cm.

CLAY : Arcilla rojiza (10R 4/2) con fino nivel (1cm) de arena fina a muy fina gris-oscura. Muy escasos rastros irregulares de materia orgánica y papas de ulexita (1cm).

SANDY CLAY with SILT: Arcilla limo arenosa con abundantes rastros de materia orgánica y papa (3cm) de ulexita.

SAND interbeded CLAY: Arena fina a muy fina gris (N4) con niveles irregulares de materia orgánica, conformada por cuarzo(?74%), liticos volcánicos(?20%), magnetita(?5%), carbonatos masivos(?1%) y yeso?(<1%).

CLAY : Arcilla marrón (5YR 5/2) intercala con escasos niveles (2 a 3cm) de arena fina a muy fina gris-oscura y arcilla negra. Escasos y finos cristales (1mm) de selenita. Nivel (19cm) con arena media a fina negra con abundante agua.

SAND: Nivel de arena media a fina negra. Dos papas de ulexita (2cm).

ULEXITE: Ulexita con abundante material clástico gris-verdoso a negro (arcilloso). Intercala con finos niveles (0,5cm) de arcilla negra y arena fina. Finos cristales (?1mm) de selenita en matriz arcillosa gris-verdosa.

CLAY : Arcilla rojiza (10R 4/2) con abundantes papas de ulexita (0,5 a 1cm).

CLAY : Arcilla marrón (5YR 5/2) intercala con niveles (0,5 a 2cm) de arena fina gris y con ulexita en papas en distintos niveles (1 a 5cm).

SAND interbeded CLAY: Arena media a fina gris (N4) conformada por cuarzo(?80%), liticos volcánicos(?13%), magnetita(?5%), carbonatos masivos(?2%) y yeso?(?<1%). Intercala un nivel (6cm) de arcilla gris verdosa (5Y 5/2).

CLAY : Arcilla rojiza (10R 4/2) con nivel transicional de arcilla gris-verdosa (5Y 5/2). Muy escasos y finos cristales (?1mm) de selenita.

CLAY : Arcilla gris verdosa (10GY 5/2) con escasos rastros de materia orgánica (arcilla negra). Finos y escasos crsitales de selenita (1 a 2mm). Manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY Interbeded ORGANICS : Arcilla marrón (5YR 5/2) intercala, ritmicamente, con niveles (0,5 a 3cm) de arcilla negra. Escasos niveles con abundantes cristales de selenita (1 a 2mm).

CLAY : Arcilla rojiza (10R 4/2) con muy escasos rastros de materia orgánica (arcilla negra) y finas (?0,5cm) papas de ulexita. Escasos niveles (5mm) de selenita (?1mm).

CLAY : Arcilla verde (10GY 5/2) transicion gradual con nivel superior e inferior.

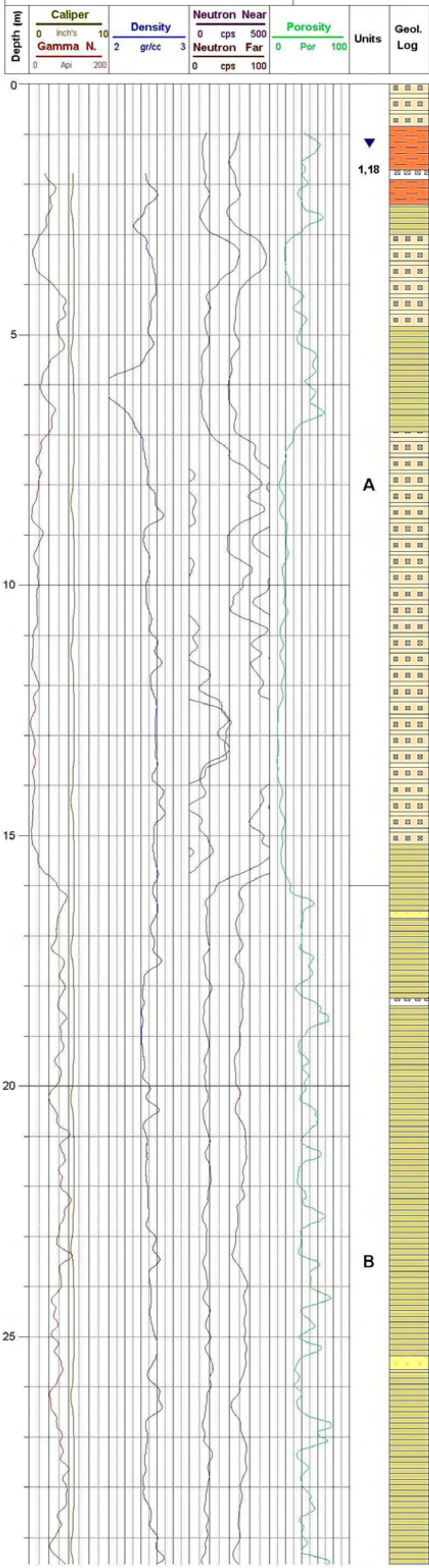
CLAY : Arcilla rojiza (10R 4/2).

Depth (m)	Elevn. (m)
30	
	3905
35	
	3900
40	
	3895
45	
	3890
50	

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY DRILL RIG: SONIC METHOD: SONIC	START DATE: 19-04-2010 END DATE: 27-04-2010 DEPTH: 63m	COORDINATES (POSGAR 94 Zone 3) E: 3428000 N: 7401496 Elevn: 3939,023

WELL REFERENCE: C-15

LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

HALITE with CLAY: Halita compacta y porosa. Hacia el fondo granular con abundante material clástico limo-arcilloso de color rojizo (10R 4/6).

SANDY CLAY: Arena fina a mediana arcillosa con escasas y muy finas papas de ulexita y cristales de selenita. Intercala con bancos (2cm) de arcilla marrón rojiza (10R 4/6).

HALITE: Gruesos cristales de halita (hasta 5mm) con abundante material arcillo-limoso intercala con dos finos bancos de arcilla marrón-rojiza.

SANDY CLAY: Intercalan bancos de arena fina arcillosa con barras de ulexita de 5cm aprox.

CLAY : Arcilla marrón (10YR 5/2) intercala con escasos y muy finos bancos de arcilla arenosa del mismo color.

HALITE with CLAY: Halita masiva muy compacta y poco porosa. Con abundantes papas de ulexita (hasta 3cm) en distintos niveles. Hacia la base gruesos cristales de halita (5mm) con abundante arcilla arenosa color marrón (5YR 3/2). Escasas papas de ulexita (2cm).

CLAY : Arcilla marrón rojiza (10R 5/4) intercala con finos bancos milimétricos de arcilla negra (materia orgánica) y en el tope con arcilla verde (5Y 5/2). Niveles de halita (1 a 3cm) y cristales de selenita (1cm).

BLACK CLAY : Arcilla negra intercala con finos bancos (1cm) de arcilla arenosa gris-verdosa y niveles de ulexita (barras de 1cm). Hacia la base con abundante cristales de halita.

HALITE with CLAY: Halita muy compacta, masiva (poco porosa), Con intercalación de halita compacta negra (materia orgánica) y niveles con arcilla negra y abundantes cristales de halita.

HALITE with CLAY: Halita granular gruesa cristales euhedros a subhedros de hasta 5mm. Hacia el fondo finas y escasas papas de ulexita (2 a 5cm).

HALITE with CLAY: Halita muy fina microcristalina (textura de limo) con material clástico limo-arcilloso gris (N6). Intercala con finos niveles centimétricos de halita masiva muy compacta sin material clástico. Posee abundantes cristales de halita euhedros a subhedros de hasta 5mm.

CLAY : Arcilla marrón (5YR 5/2) con escasos cristales de halita (5mm) y muy escasas papas de ulexita.

SAND: Arena fina con muy escaso limo. Cristales intercrecidos de selenita (rosa del desierto) de hasta 3cm.

CLAY : Arcilla verde (10GY 5/2) con finos niveles en el tope (3 a 5mm) de arena muy fina con cristales de selenita (1cm). Muy escasos rastros de materia orgánica.

HALITE: Halita muy fina (textura arena fina) con material clástico (arcillo-limoso) gris-oscuro a negro. Interclala con finos niveles de arcilla negra.

CLAY Interbeded ORGANICS : Arcilla marrón (5YR 5/2) intercala ritmicamente con niveles de arcilla negra que varía de 1 a 3cm. Escacasos y aislados cristales de selenita (hasta 2cm). A 21mts barra de ulexita 1,5cm. A 22,5mts intercala con muy finos y escasos niveles de arcilla verde de aprox. 3mm. Mayor contenido de agua a los 22,5mts.

CLAY : Arcilla verde (10Y 5/4) muy escasos rastros de arcilla marrón (5YR 5/2) y finos lentes (1cm) de arena muy fina en el tope. En la base arcilla gris-verdosa (5Y 5/2) con abundantes rastros de materia orgánica

SAND: Arena fina a mediana gris-clara con escasa arcilla arenosa hacia la base.

CLAY : Arcilla gris verdosa (10Y 4/2) intercala con bancos de ulexita (1cm) y niveles de arena mediana gris (3 y 4cm). Muy escasos rastros de materia orgánica.

CLAY interbeded SAND: Arcilla marrón (5YR 4/4) con muy escasos y finos niveles de arcilla negra y ulexita (ambos 5mm). Intercala, en la base, con niveles (1 y 18cm en la base) de arena fina con y abundantes y finas papas de ulexita, conformada por líticos volcánicos(?80%), cuarzo(?10%), magnetita(?5%), selenita(?3%), yeso?(?2%) y biotita(<1%).

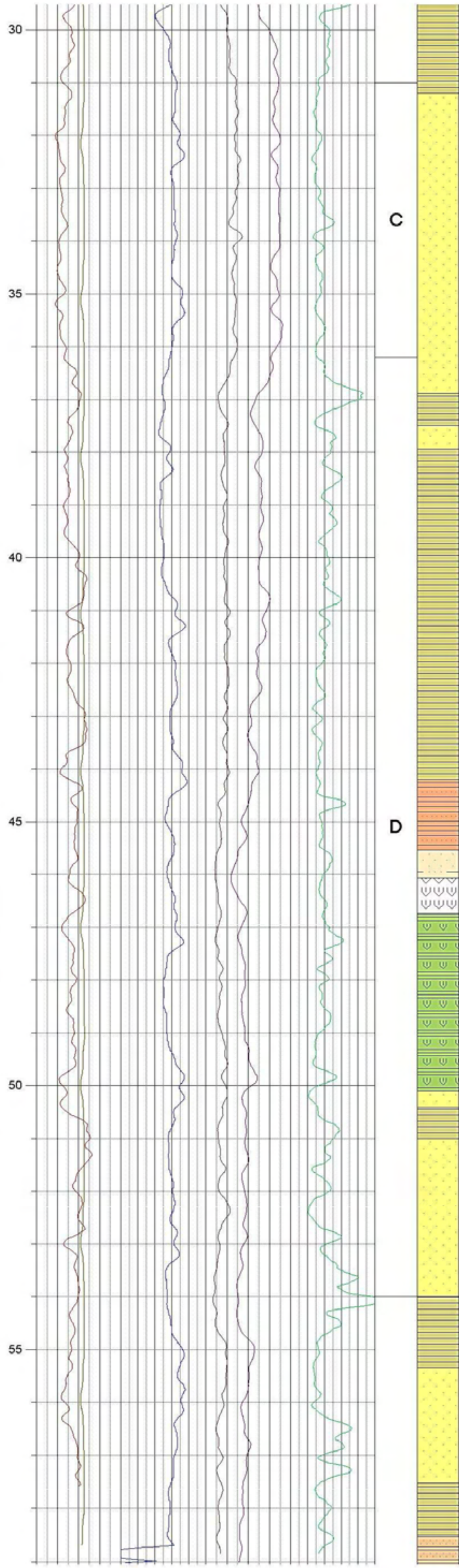
CLAY : Arcilla marrón (10YR 4/2) intercala con niveles de (0,5 a 1cm) de arena muy fina gris. Escaso niveles (hasta 3cm) de ulexita.

CLAY interbeded SAND: Arcilla gris-verdosa (5Y 5/2) con abundantes niveles de ulexita (2cm), un nivele con clastos de halita con material clástico (intraclasto?) de 5mm. Finos lentes de arcilla negra y niveles en la base de arena media a fina (11 a 14cm).

Depth (m)	Elevn. (m)
0	
	3935
5	
	3930
10	
	3925
15	
	3920
20	
	3915
25	
	3910

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 19-04-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:	C-15
		DRILL RIG: SONIC	END DATE: 27-04-2010	E: 3428000		
RESOURCE EVALUATION PROGRAM		METHOD: SONIC	DEPTH: 63m	N: 7401496	Page 2 of 3	
				Elevn: 3939,023	LOGED BY: Geol. FERNANDO A. MARTÍN	

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SAND: Arena mediana a fina gris (N4) conformada por cuarzo(?70%), liticos volcánicos(?20%), magnetita(?10%), biotita(?1%) y yeso?(?<1%). Intercala con bancos areno arcillosos hacia la base.

CLAY : Arcilla marrón (5YR 4/4) intercala con finos y escasos niveles de arcilla negra (1cm). Hacia el tope con barras y papas (3cm) de ulexita. Hacia el fondo grueso nivel (5cm) de ulexita.

SAND: Arena fina a mediana con escasos granos blanquecinos (N4), conformada por cuarzo(?75%), liticos volcánicos(?15%), magnetita(?10%) y yeso?(<1%).

CLAY : Arcilla verde (5G 5/2) con cristales de selenita (3 a 5mm). Intercala con arcilla marrón (10YR 4/2) con abundantes rastros de materia orgánica (arcilla negra) de contacto muy irregular y muy escasos cristales de selenita.

CLAY : Arcilla gris-verdosa (5Y 3/2) y marrón (5YR 4/4) con abundantes papas y barras de ulexita (hasta 5cm). Intercalan bancos y lentes de arena fina gris (2 a 5cm) y arcilla arenosa (3 a 5cm).

CLAY interbeded SAND: Intercalación de arcilla marrón (10YR 4/2) con abundantes lentes (1cm) y niveles de arena fina. Gruesas (4cm) y abundantes papas de ulexita. Rastros de arcilla negra en escasos niveles.

SAND interbeded CLAYEY SAND: Arena media a fina gris (N4) intercala con escasos niveles areno arcillosos (3cm) con niveles de ulexita (1cm) y escasos de materia orgánica (arcilla negra).

ULEXITE: Grueso nivel de ulexita intercalado con arena negra, arcillas negras y arena arcillosa negra de aproximadamente 5cm cada uno.

CLAY : Arcilla rojiza (10R 5/4) con abundantes papas de ulexita en el tope (hasta 3cm) con manchas anaranjadas (rejalgar/oropimente?) y nivel (47,47 a 47,75) con abundantes y finas papas de ulexita (2cm). En todo el nivel muy escasos cristales de selenita (5mm).

CLAY: Arcilla verde (10GY 5/2) muy escasos rastros de arcilla rojiza.

SAND: Arena media a fina gris (N4) con muy escaso a nulo material fino (limo).

CLAY : Arcilla marrón (5YR 4/4) con finos niveles areno-arcillosos (hasta 3cm) y abundantes papas de ulexita a lo largo del nivel (3cm). Escasos cristales de selenita (5mm).

SAND: Arena media a fina gris (N4) intercala con finos niveles (0,5 a 3cm) de arena arcillosa y un fino nivel de ulexita (2mm). Conformada por cuarzo(?85%), liticos volcánicos(?12%), magnetita(?3%) y yeso?(<1%).

CLAY : Arcilla gris-verdosa (5Y 4/1) con niveles alternados (?15cm) de ulexita en barra y finos niveles de materia orgánica (arcilla negra) hasta 3cm. Muy escasos y finos lentes (1cm) de arena gris muy fina. Rejalgar/orpoimente? En manchas anaranjadas pulverulentas.

SAND: Arena media gris (N4). Nivel de (14cm) arena arcillosa gris-oscura (N3)

CLAY : Arcilla verde (5G 5/2) con gruesos cristales de selenita (3cm) escasos rastros de materia orgánica.

CLAY : Arcilla marrón (5YR 5/2) con muy escasos cristales de selenita (2cm). Pocos niveles (1 a 3cm) de arcilla negra (materia orgánica). Escasos y muy finos niveles (1mm) de arena media gris (N4).

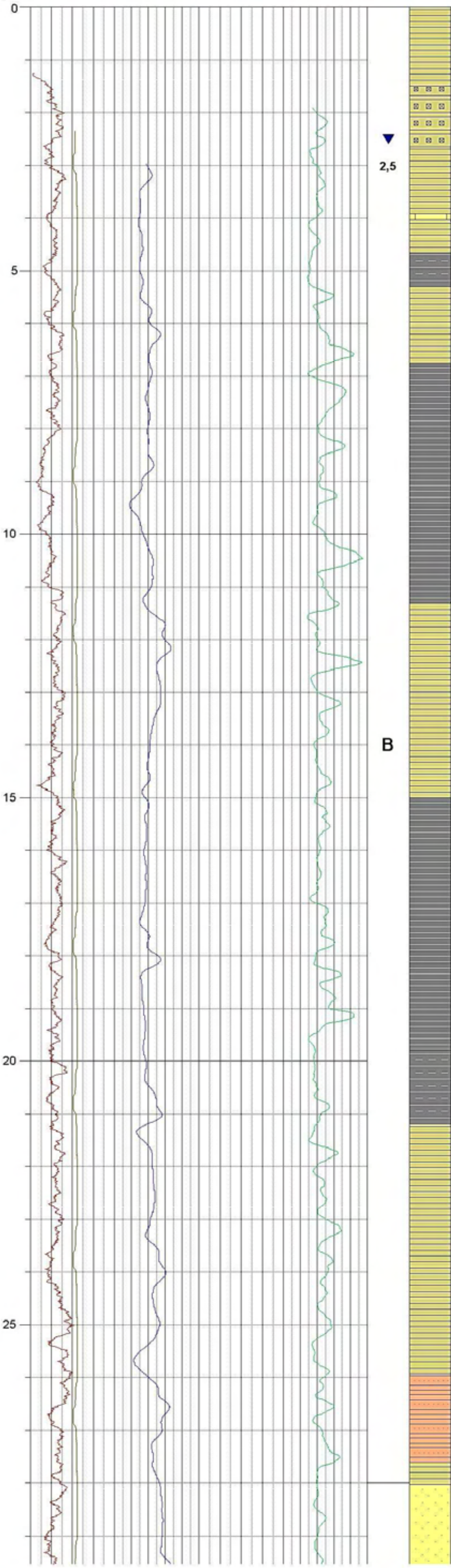
SAND interbeded CLAY: Arena mediana a fina (N4) conformada por cuarzo(?65%), liticos volcánicos(?20%), magnetita(?7%), liticos metamórficos?(?4%), yeso?(?2%) y carbonatos masivos(?2%). Pocos sectores con menor contenido de arcilla (Arena ligeramente arcillosa). Intercala con escasos y muy finos bancos obliterados (deformados) de arcilla marrón (5YR 4/4) y muy escasa ulexita (1cm).

OROCOBRE OLAROZ PROJECT RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY	START DATE: 19-04-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-15
	DRILL RIG: SONIC	END DATE: 27-04-2010	E: 3428000	Page 3 of 3
	METHOD: SONIC	DEPTH: 63m	N: 7401496	LOGED BY: Geol. FERNANDO A. MARTÍN
			Elevn: 3939,023	

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)
							arcilla marrón (5YR 4/4) y muy escasa ulexita (1cm).		3880
60							SANDY CLAY: Arcilla arenosa negra con poco contenido de arena fina y abundante agua. Muy escasos rastros de ulexita (1cm). Intercala con fines niveles de arcilla marrón (5YR 4/4) deformados (STP) en la parte superior del nivel (50cm).	60	
							SAND: Arena fina con abundante cantidad de agua (N4) conformada por cuarzo(?75%), líticos volcánicos(?17%), magnetita(?5%), líticos metamórficos?(?3%) y biotita(<1%).		

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 20-05-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC	END DATE: 25-05-2010	E: 3425001	C-16
		METHOD: SONIC	DEPTH: 54m	N: 7398999	Page 1 of 2
				Elevn: 3938,967	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

CLAY : Arcilla rojiza (10R 4/6) con niveles (2 a 3cm) y papas hasta 8 cm de ulexita. Muy escasos rastros de materia orgánica (arcilla negra) en finos niveles (1 a 2mm). Niveles escasos con finos cristales (< 0,5mm) de selenita y halita?. Parte superior (a 1cm del tope) nivel (1cm espesor) con halita granular (0,5mm) friable de contacto irregular con arcilla.

CLAY : Arcilla marrón (5YR 6/4) con abundantes cristales de selenita (1mm) intercala con nivel (3cm) de yeso y halita con material clástico (limo) de color gris. Fino nivel (1cm) de ulexita.

CLAY with HALITE: Arcilla marrón (10YR 4/2) con escasas y finas papas de ulexita (1cm) y rastros de materia orgánica (arcilla negra). Intercala con nivel (3cm) de halita granular con abundante presencia de material clástico (arcilla limosa).

CLAY with HALITE: Arcilla gris verdosa (5Y 5/2) con niveles de arcilla negra (2cm) y un nivel (3cm) de ulexita. Intercalan niveles (2 a 6cm) de cristales de selenita y halita tamaño arena muy fina a limo con material clástico (limoso) de color gris. Nivel de halita microcristalina.

CLAY : Arcilla marrón (5YR 6/4) escasas manchas irregulares (1 a 2cm) de arcilla negra (materia orgánica).

CLAY : Arcilla verde (5Y 5/2) con finos niveles lenticulares (?1cm) muy escasos con muy finos cristales de selenita? y material clástico limoso negro.

SILTY SAND: Niveles con abundantes cristales de selenita? tamaño arena muy fina a limo con material limoso gris a oscuro.

CLAY : Arcilla marrón (5YR 5/2) con muy escasos rastros de materia orgánica (arcilla negra) y arcilla verde.

CLAY Interbeded ORGANICS : Arcilla verde (5GY 5/2) con abundante materia orgánica (arcilla negra) con bancos irregulares de 1 a 15mm. Finos niveles (1 a 2cm) con microcristales (selenita/halita) y muy escasos rastros de arcilla marrón.

CLAY : Arcilla marrón (5YR 5/2) intercala ritmicamente con niveles (0,5 a 1cm) de arcilla negra (materia orgánica) con muy escasos lentes limosos (microcrstales de selenita con material clástico) y manchas anaranjadas pulverulentas (rejalgar/oropimento?).

BLACK CLAY : Arcilla negra (materia orgánica) intercala con finos niveles (0,2 a 1cm) de arcilla verde (5GY 5/2) y muy fino nivel con microcristales (yeso/halita) de 0,5cm con material clástico limoso gris oscuro. Intercala con arcilla marrón (5YR 5/2). Ulexita hasta 2 cm y 0,2mm. Menor arcilla verde. Nivel (20cm) de ulexita en la base.

CLAY : Arcilla verde (5GY 5/2) con escasos rastros con contacto irregular de arcilla negra (1cm).

CLAY: Arcilla marrón (5YR 6/4) con escasos lentes y niveles (1 y 4cm) de arena fina a muy fina con escaso limo y gránulos sabulíticos (2mm).

CLAY : Arcilla verde (5G 5/2) intercala con nivel (oxidación) de 4cm más oxidado (arcilla marrón verdosa).

BLACK CLAY : Arcilla negra intercalada ritmicamente con muy finos niveles (?1cm) arcilla marrón, muy escasos niveles en la zona del tope y alcanza 1cm. Intercalada con arcilla verde (17,00 - 17,10m). Ultimos 25cm transición hacia la base, bancos de arcilla marrón (1cm).

CLAY Interbeded ORGANICS : Intercala arcilla marrón-rojiza (5R 6/2) con arcilla negra (materia orgánica).

CLAY : Arcilla verde (10GY 5/2) en el tope intercala arena fina a muy fina limo arcillosa (5GY 3/2) .

CLAY : Arcilla marrón (5YR 5/2) intercala con escasos y finos bancos de arena fina a media con escaso limo (1 a 5mm). (Intercalaciones 21,61-22,5 y 23,22-23,46).

CLAY : Mix de contacto muy irregular de arcilla gris verdosa (5Y 5/2), marrón (5YR 5/2) y negra.

CLAY interbeded SAND: Arcilla gris-verdosa (5Y 5/2) intercala ritmicamente con niveles (0,5 a 3cm) de arena muy fina, negra con escaso limo y arcilla. Y escasos niveles (?0,5cm) de arcilla negra.

CLAY : Arcilla marrón (5YR 5/2) intercala ritmicamente con niveles (1cm) de materia orgánica (arcilla negra).

SAND: Arena fina a muy fina, muy escaso a nulo limo gris (N6), hacia la base (últimos 40cm) intercala con niveles mas claros y oscuros (blanquecinos a negros) aislados de 0,5 a 1cm con mayor o menor presencia de cuarzo (hasta 90%). En general, conformada por cuarzo(?75%), liticos volcánicos(?15%), magnetita(?10%) y biotita(<1%).

Depth (m): 0, 5, 10, 15, 20, 25

Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910

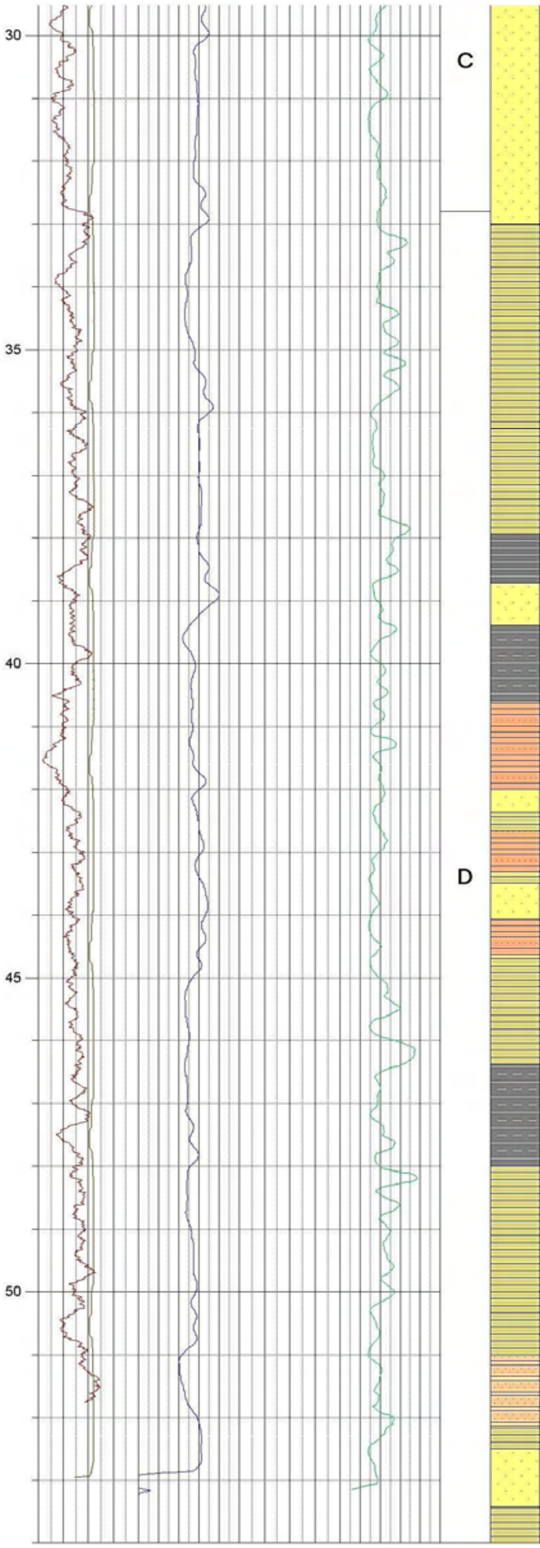
OROCOBRE

OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR:	BLY	**START DATE:**	20-05-2010	COORDINATES (POSGAR 94 Zone 3) E: 3425001	**WELL REFERENCE:** **C-16**
DRILL RIG:	SONIC	**END DATE:**	25-05-2010	N: 7398999	
METHOD:	SONIC	**DEPTH:**	54m	Elevn: 3938,967	**LOGED BY:** Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY : Arcilla rojiza (10R 4/6). Hacia la base (últimos 13cm) se toma ligeramente verdosa (10GY 5/2).

CLAY : Arcilla marrón (5YR 6/4) intercala con niveles de arena fina limo arcillosa negra y niveles de arcilla negra (1 a 2cm). Zona de transición con nivel inferior.

BLACK CLAY : Arcilla negra (materia orgánica) con muy escasos rastros de arcilla marrón-clara y niveles (1cm) de arena negra fina limoarcillosa hacia la base nivel (17cm) de arcilla marrón (5YR 6/4).

SAND: Arena fina a muy fina con muy escasa presencia de limo (N3 a N4,conformada por cuarzo(?80%), líticos volcánicos(?15%), magnetita(?4%) y yeso?(?1%).

CLAY Interbeded ORGANICS : Arcilla marrón (5YR 5/2) intercala ritmicamente con arcilla negra (materia orgánica) en niveles de 0,5 a 1cm y 2 niveles (1,5cm cada uno) de arena fina a muy fina gris (N4). Hacia la base (10cm) de arena gris-oscura (N3).

CLAY interbeded SAND: Arcilla verde (10Y 6/2) intercala ritmicamente con niveles (1 a 3cm) de arena fina a gris oscura.

CLAY interbeded SAND: Arcilla negra (materia orgánica) escasos niveles (1cm) con abundantes cristales de halita?. Nivel (22cm) de arena fina a muy fina gris-oscuro (N3), conformada por cuarzo(?75%), magnetita(?12%), líticos volcánicos(?12%) y yeso?(?1%).

SAND: Arena fina a muy fina negra con clastos blanquecinos. Intercala con un nivel (4cm) de arcilla gris oscura a negra.

CLAY : Arcilla marrón (5YR 5/2), intercala con niveles (1cm) de arena negra y niveles (2mm) con ulexita.

CLAY interbeded SAND: Intercalan arcillas rojizas (10R 4/6) con arena negra fina. Hacia la base finos bancos de arena (1cm), en el tope (10 a 7cm).

CLAY : Arcilla verde (5Y 5/2) con menor arcilla rojiza (contacto irregular). Fragmentos de arenisca muy fina cementada (1cm).

SAND: Arena fina a muy fina gris (N4), conformada por cuarzo(?70%), líticos volcánicos(?20%), magnetita(?9%) y yeso?(?1%).

CLAY interbeded SAND: Arcilla rojiza (10R 4/6), intercala con abundantes niveles (1 a 2cm) de arena fina a muy fina, rojiza y gris oscura.

CLAY : Arcilla verde (10GY 5/2), muy escasos niveles de arena fina gris (2mm) y un nivel irregular (1 a 2cm) de arcilla negra. Hacia la base, arcilla verde a marrón-verdosa con escasas manchas pulverulentas anaranjadas (rejalgar/oropimente?).

CLAY Interbeded ORGANICS : Arcilla marrón (5YR 4/4), intercala ritmicamente con niveles (1 a 3cm) de arcilla negra (materia orgánica). Muy escasas manchas anaranjadas pulverulentas.

CLAY : Arcilla rojiza (10R 4/6), intercala con muy escasos niveles (0,5cm) de arcilla negra y arena fina a muy fina.

CLAY : Arcilla verde (5GY 5/2), escasos rastros de arcilla negra; y muy escasos y finos niveles (1 a 2cm) de arena fina a muy fina.

CLAY : Arcilla marrón (5YR 5/2), intercala con escasos niveles (0,5 a 1cm) de arena fina a muy fina. Muy escasos rastros de materia orgánica.

SAND interbeded CLAY: Arena gris oscura a negra (N3) fina a muy fina, conformada por cuarzo(?75%), líticos volcánicos(?15%), magnetita(?6%), yeso?(?2%), carbonatos masivos(?1%) y biotita(?1%). Intercala con 2 niveles (7 y 8cm) de arcilla marrón (5YR 5/2) Con escasos rastros de arcilla verde y menor arcilla negra (materia orgánica). Hacia la base (5cm) nivel limoso (?) gris verdoso (microcristales de yeso ?)

CLAY : Arcilla marrón (5YR 5/2) con escasos rastros de materia orgánica (arcilla negra) y nivel (1cm) deformado de arena fina a muy fina gris.

SAND: Arena media a fina, gris (N4), conformada por cuarzo(?60%), líticos volcánicos(?30%), magnetita(?7%), yeso?(?2%) y carbonatos masivos(?1%). Hacia la base intercala con niveles limosos y muy escasos niveles de arcilla rojiza (10R 4/6) de 0,5cm.

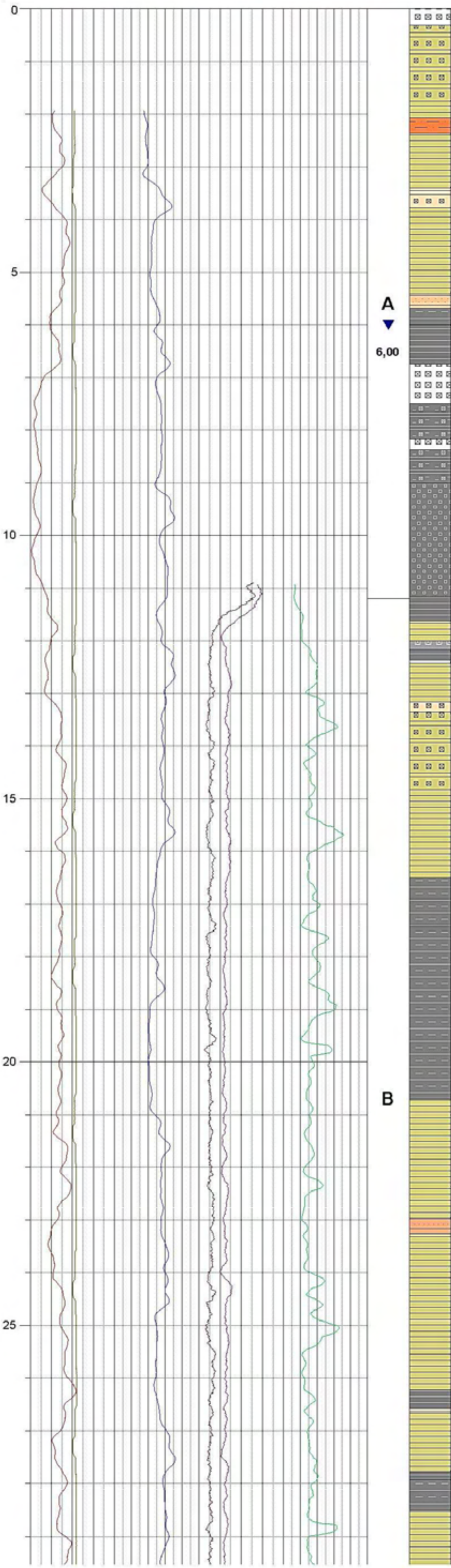
CLAY : Arcilla rojiza (10R 4/6) con escasos niveles (1cm) de arena fina a muy fina gris oscura.

Depth (m): 30, 35, 40, 45, 50

Elevn. (m): 3905, 3900, 3895, 3890, 3885

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	31-10-2010	COORDINATES (POSGAR 94 Zone 3)		WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG:	SONIC	END DATE:	03-11-2010	E:	3427006	C-17
		METHOD:	SONIC	DEPTH:	54m	N:	7398996	Page 1 of 2
						Elevn:	3939,100	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



HALITE: Cristales sueltos de halita (1 a 5mm) blanquecinos subhedros con poca presencia de material clástico (arcillo-limoso) marrón-rojizo y negro.

CLAY with HALITE: Arcilla marrón (5YR 4/4) con abundante cristales (2 a 4mm) de halita. Escasas papas de ulexita (1 a 2cm).

CLAY: Arcilla gris-verdosa (5Y 5/2) Muy escasos niveles (3mm) de halita masiva microcristalina.

SANDY CLAY: Arcilla arenosa (arena fina a media) gris a gris-verdosa. Arena (?10%).

CLAY: Arcilla gris-verdosa (5Y 5/2) escasas papas de ulexita (1 a 3cm) y muy escasos rastros irregulares de arcilla negra. Muy escasos niveles (2 a 3cm?) muy deformados de arcilla negra.

HALITE with CLAY: Sedimento muy deformado con abundante agua. Cristales traslucidos de halita (2 a 5mm) euhedros en matriz arcillosa gris-verdosa (5Y 5/2). Niveles muy deformados (?3cm) de arcilla gris-verdosa con papas de ulexita.

CLAY: Arcilla rojiza-pálida (10R 5/4).

CLAY: Arcilla marrón (5YR 5/2).

CLAY: Arcilla marrón-pálida (10YR 6/2) hacia la base con niveles muy deformados de abundante arcilla negra. Gruesos cristales anhedros (2 a 3cm) de halita traslucida.

HALIE Interbeded CLAY: Abundantes microcristales de halita. Intercala con niveles de arcilla gris-verdosa. Abundantes papas (3 a 4cm) de ulexita. Color del conjunto gris-verdoso (5Y 5/2).

CLAY Interbeded ORGANICS: Arcilla marrón-pálida (10YR 6/2) con niveles (0,5 a 1cm) de arcilla negra. Escasos y gruesos (?3cm) cristales anhedros de halita traslucida..

BLACK CLAY: Halita masiva muy compacta negra. Finos niveles, de contacto muy irregular (2 a 3cm), de arcilla negra.

HALITE: Halita masiva muy compacta blanquecina, muy escasos rastros de arcilla negra. Fuerte alteración por avance de perforación.

BLACK CLAY with HALITE: Arcilla negra con niveles de abundantes cristales de halita subhedros (2 a 4mm).

HALITE: Halita masiva muy compacta blanquecina.

BLACK CLAY with HALITE: Arcilla negra con abundantes cristales de halita con niveles muy deformados de halita masiva blanquecina.

BLACK HALITE: Halita masiva negra muy compacta. Escasos niveles muy difusos de arcilla negra con abundantes cristales de halita.

BLACK CLAY: Arcilla negra. Hacia la base intercalan finos niveles (0,5 a 1cm) de ulexita y arcilla marrón (5YR 5/2).

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza. Finos niveles (1 a 3mm) de arena fina a muy fina limosa y arena muy fina arcillosa. Nivel lenticular (2cm) con cristales (2 a 5mm) de halita blanquecina.

BLACK HALITE with CLAY: Cristales de halita con arcilla negra (?10%). Cristales subhedros (2 a 4mm) blanquecinos.

CLAY Interbeded ORGANICS: Arcilla marrón-pálida (10YR 6/2) con abundantes rastros de arcilla negra muy irregulares.

CLAY: Arcilla marrón-pálida (10YR 6/2) con niveles (1 a 3cm?) muy deformados con abundantes microcristales de selenita y menor halita?. Nivel inicial (7cm) de ulexita.

HALITE WITH CLAY: Abundnates cristales de halita subhedros traslucidos (1 a 3mm) en matriz (?30%) de arcilla negra con abundnate agua.

CLAY with HALITE: Arcilla marrón (5YR 5/2) con muy escasos niveles (1 a 2cm) de arcilla con abundantes microcristales de halita y menor arena muy fina limosa y nivel (1cm) de arena muy fina gris. Muy escasas manchas irregulares de arcilla negra.

CLAY: Arcilla verde (10GY 5/2) con dos niveles aislados (3 y 2cm) con abundnates microcristales (<0,5cm) de selenita y menor halita?.

CLAY Interbeded ORGANICS: Intercalación rítmica? (niveles extremadamente deformados) de arcilla marrón (5YR 5/2) y negra. Niveles ed 0,5 a 2cm?.

CLAY: Arcilla rojiza-pálida (10R 4/6) con escasos niveles intercalados (0,5 a 1cm) de arcilla negra. Muy escasas manchas anaranjadas-amarillentas (rejalgar/oropimente?).

CLAY: Arcilla marrón-pálida (10YR 6/2) con escasos niveles (1cm) con abundantes microcristales de halita (tamaño arena fina) en matriz arcillosa.

CLAY Interbeded SAND: Arcilla gris-verdosa (5Y 5/2) intercala con niveles (2 a 3cm) de arena media a gruesa con escasos cristales de halita.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza-pálida (10R 5/4) a ligeramente marrón. Muy escasos niveles (1mm) de arena muy fina limosa gris.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla gris-verdosa (5Y 5/2). Muy escasas papas de ulexita (1cm) y ratsros de arcilla negra.

CLAY: Arcilla marrón-pálida (10YR 6/2) con escasos niveles (0,5 a 1cm) de arcilla negra.

BLACK CLAY: Arcilla negra con manchas anaranjadas-amarillentas (rejalgar/oropimente?).

HALITE with CLAY: Abundnates microcristales de halita en matriz escasa de arcilla marrón y negra.

CLAY: Arcilla marrón (5YR 5/2) a marrón pálida (10YR 6/2) con escasos y finos niveles (1 a 3cm) con abundantes microcristales de halita (tamaño arena fina) y rastros de arcilla negra. Muy escasas papas (1 a 2cm) de ulexita.

BLACK CLAY: Arcilla negra con muy escasas manchas anaranjadas-amarillentas (rejalgar/oropimente?).

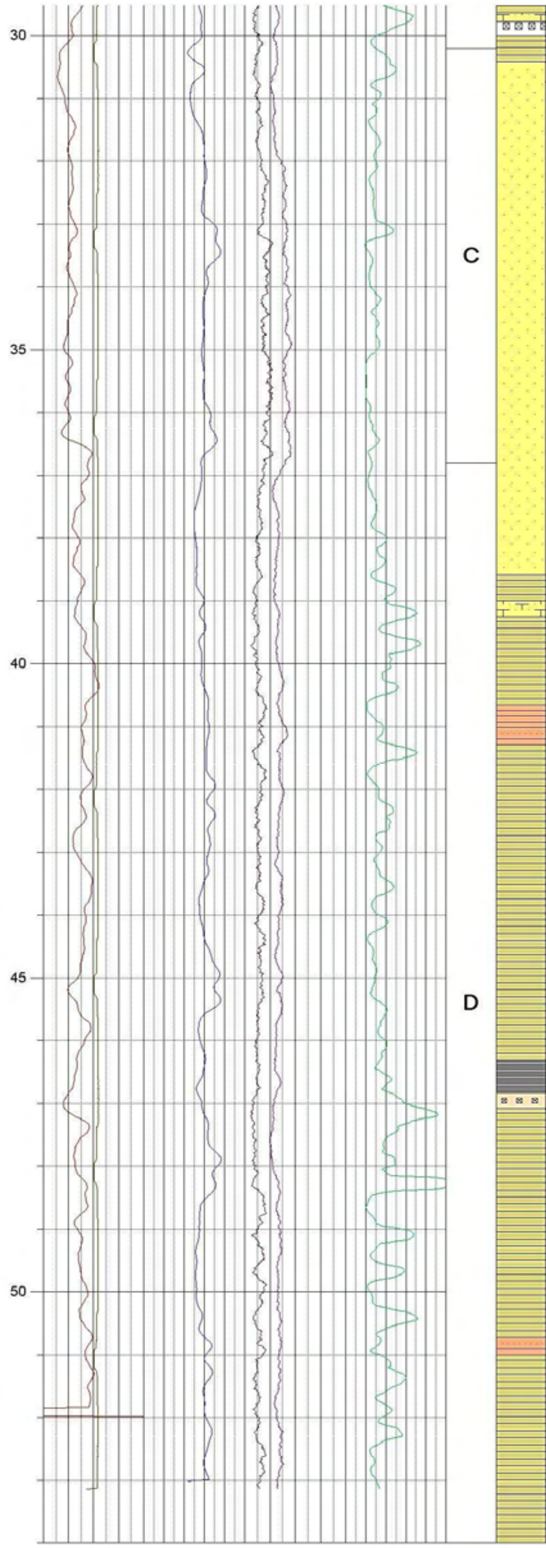
CLAY Interbeded ORGANICS: Arcilla marrón (5YR 5/2) con niveles alternados (2 a 3cm) de arcilla negra. Escasas papas (?1cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con escasas papas (1 a 2cm) de ulexita. Muy escasos niveles (1cm?) muy deformados de arcilla negra. Rastros muy irregulares y difusos de arcilla gris-verdosa (5Y 5/2).

Depth (m)	Elevn. (m)
0	
	3935
5	
	3930
10	
	3925
15	
	3920
20	
	3915
25	
	3910

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 31-10-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-17
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC	END DATE: 03-11-2010	E: 3427006	Page 2 of 2
	METHOD: SONIC	DEPTH: 54m	N: 7398996	
			Elevn: 3939,100	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

SILTY SAND: Arena fina a muy fina limosa negra (6cm) pasa a arena fina a muy fina limosa gris (N4).

HALITE: Halita microcristalina (tamaño arena muy fina) blanquecina friable con nivel (6cm) de ulexita.

CLAY: Arcilla marrón (5YR 4/4) muy escasas papas (?1cm) de ulexita. Alterada y contaminada por SPT.

SAND: Arena media a gruesa gris (N4) con nivel (?3cm) muy deformado de arcilla marrón (5YR 4/4). Abundantes niveles y papas (2 a 3cm) deformados de ulexita.

SAND: Arena media a fina gris (N4) con muy escaso a nulo limo. Nivel (24cm) con escasos componentes gruesos. Conformada por granos subredodneados de cuarzo(?55%), líticos volcánicos(?40%), magnetita(?5%) y yeso?(<1%).

SAND: Arena fina gris (N4) con escaso limo, conformada por cuarzo(?70%), líticos volcánicos(?25%) y magnetita(?5%).

SAND: Arena fina a media gris (N4) con muy escaso limo, conformada por cuarzo(?70%), líticos volcánicos(?20%) y magnetita(?10%). Muy escasos niveles (a los 36mts) de arcilla marrón muy deformados (tres niveles de 0,5cm?).

CLAY: Arcilla verde (10GY 5/2) con fina papa (0,5cm) de ulexita y nivel (1cm) de arena fina gris con escaso limo.

SILTY SAND: Arena fina limosa gris (N4).

CLAY: Arcilla verde (10GY 5/2) alterada y contaminada por SPT.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles rojizos (10R 4/6) y niveles (0,5cm) de arcilla negra. Muy escasos niveles (1 a 2mm) de arena fina arcillosa.

CLAY Interbeded SAND: Intercalación de arcilla marrón-oscura (10YR 4/2) y niveles (1 a 3cm) de arena fina limosa gris. Grueso nivel (8cm) de ulexita y muy escasas papas (1 a 2cm).

CLAY: Arcilla marrón-oscura (10YR 4/2) con niveles y papas (2 a 3cm) de ulexita. Niveles deformados de arcilla arenosa (arena fina a muy fina). Muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla verde-oscura (5GY 3/2) con papas (1 a 3cm) de ulexita y rastros muy irregulares de arcilla negra. Alterada y contaminada por SPT.

CLAY: Arcilla marrón (5YR 5/2) con papa (2cm) y nivel (1cm) de ulexita. Escasos rastros muy irregulares de arcilla negra.

SAND: Arena fina a media gris (N4) con muy escaso limo, conformada por cuarzo(?80%), líticos volcánicos(?10%) y magnetita(?10%). Nivel (2cm) de ulexita. Muy escasos niveles (1cm?) muy deformados de arcilla marrón.

CLAY: Arcilla marron-oscura (5YR 3/2) con abundantes papas (1 a 2cm) y nivel (3cm) de ulexita. Escasos rastros irregulares de arcilla negra. Ateración por SPT.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles (?1cm) de arcilla negra muy deformados y papas (1 a 2cm) de ulexita.

BLACK CLAY: Arcilla negra con abundantes papas (3 a 4cm) de ulexita y microcristales de halita. En la base, nivel (1cm) de halita con arcilla negra.

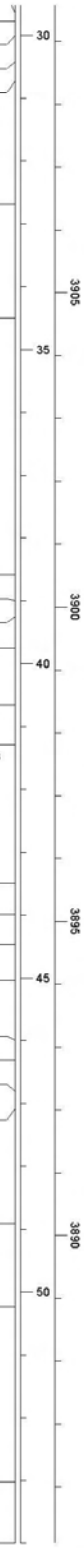
HALITE with CLAY: Nivel con abundantes microcristales de halita y matriz arcillosa rojiza-pálida. Abundantes papas y niveles (1 a 3cm) de ulexita. Escasos rastros muy irregulares de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) con abundantes papas (1 a 2cm) de ulexita. Muy escasos y finos (?0,5cm) niveles de arcilla negra. En la base ligeramente gris-verdosa, transicional con nivel inferior.

CLAY: Arcilla verde (10GY 5/2) niveles (a los 49,5mts de 4 y 3cm) de arena media a fina con escaso limo.

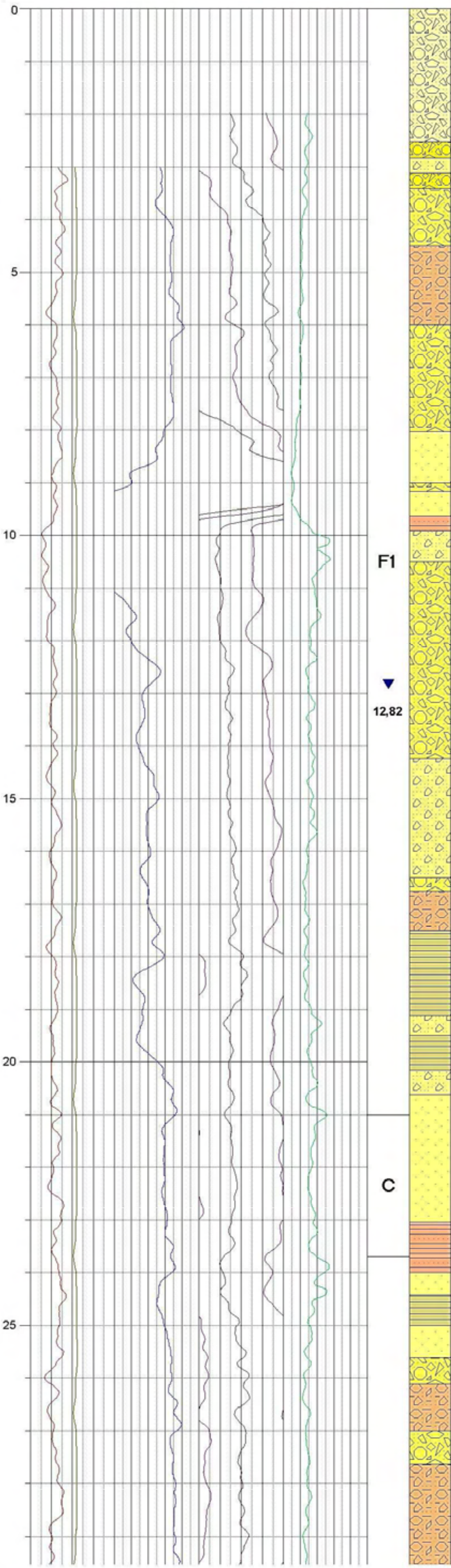
CLAY: Arcilla gris-verdosa (5Y 5/2) a ligeramente marrón. Abundantes papas (1 a 3cm) de ulexita. Niveles (1 a 3cm) de arena media a fina. Nivel (28cm) de arcilla marrón (5YR 5/2) con abundantes y finos niveles (1 a 3mm) de arena media a fina.

CLAY: Arcilla rojiza (10R 4/6) con papa (1cm) de ulexita. Muy escasos cristales (1cm) de selenita y nivel basal (29cm) de arcilla verde (10GY 5/2).



OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY	START DATE:	14-05-2010	COORDINATES (POSGAR 94 Zone 3)		WELL REFERENCE:
		DRILL RIG:	SONIC	END DATE:	20-05-2010	E:	3423994	C-18
RESOURCE EVALUATION PROGRAM		METHOD:	SONIC	DEPTH:	54m	N:	7396496	Page 1 of 2
						Elevn:	3953,901	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SANDY GRAVEL with SILT: Grava areno limosa con muy escasa a nula presencia de arcilla. El conjunto presenta un color marrón-claro (5YR 5/6) con clastos subredondeados a redondeados. Clastos conformados por pelitas y wackes silicificadas gris-verdosas (con ligero metamorfismo: Or) que alcanzan 4cm. Matriz areno-limosa con arena fina a muy fina. Escasos rastros de raices y ramas.

SANDY GRAVEL with SILT: Grava areno limosa con muy escasa presencia de arcilla. El conjunto posee color marrón-rojizo (10R 4/6). Clastos 3mm a 4cm dominan 1 a 2cm subredondeados a bien redondeados conformados por `pelitas y wakes silicificadas. Matriz de arena fina a muy fina limosa con muy escasos componentes de arena media a gruesa, conformada por magnetita(?55%), cuarzo(?40%) y liticos metamórficos(?5%). Nivel (2,26 a 2,32) intercalado de arena media a fina. En la base (3cm) con fuerte presencia de magnetita.

GRAVEL: Nivel de grava compacto con escasa matriz de arena media a fina. Clastos hasta 2cm con escasos granos sabulíticos (2 a 4mm) conformados por pelitas y wakes silicificadas gris-verdosas.

SAND with GRAVEL: Arena gravosa marrón rojiza (10R 4/6). Clastos aislados subredondeados alcanzan 3cm. Arena media a fina con escaso limo.

GRAVEL: Nivel de grava compacto con escasa matriz de arena media a fina. Clastos hasta 2cm con escasos granos sabulíticos (2 a 4mm) conformados por pelitas y wakes silicificadas gris-verdosas.

SANDY GRAVEL: Grava arenosa rojiza. Clastos subredondeados hasta 3cm conformados por pelitas y wakes metamórficas. Matriz de arena media a fina con escaso limo. Hacia la base la matriz se toma arcillosa.

SANDY GRAVEL with CLAY: Grava areno arcillosa. Clastos subredondeados de hasta 6cm conformados por pelitas y wakes metamórficas. Matriz de arena media a fina limo arcillosa rojiza (10R 4/6). Finos y escasos niveles (1 a 2cm) con mayor presencia de arcilla.

SANDY GRAVEL: Grava arenosa marrón-rojiza (10R 4/6). Clastos subredondeados de 3mm a 3cm conformados por pelitas y wakes gris-verdosas. Matriz de arena media a fina con escasa a nula presencia de limo. Nivel (7,00 a 7,16) con muy pocos clastos tamaño grava (hasta 5cm) y finos niveles (1mm) de arena negra.

SAND: Arena media a fina con muy escasa a nula presencia de limo. Nivel color marrón-rojizo (10R 4/6).

SANDY GRAVEL: Grava arenosa con clastos redondeados de hasta 4cm. Arena media a fina con escaso limo.

SAND: Arena media a fina con clastos subredondeados de hasta 3mm (sábulo). Presencia de manchas amarillentas FeOx. Hacia la base (últimos 10cm) solo arena medi a fina.

CLAY interbeded SAND: Arcilla marrón-clara (5YR 6/4) intercala con dos niveles (2 y 4cm) de arena media a fina con presencia de FeOx.

SAND with GRAVEL: Arena media a fina con presencia, en escasos sectores de FeOx y muy escasos niveles (1cm) de arcilla. Muy escasos clastos subredondeados (0,5 a 2cm) conformados por wakes y pelitas gris-verdosas silicificadas.

SANDY GRAVEL: Grava arenosa con clastos de 0,5 a 5cm conformados por wakes y pelitas gris-verdosas. Intercala con niveles de mayor proporción de arena media a fina y nivel (5cm) de arcilla marrón-clara.

SANDY GRAVEL: Grava arenosa (10R 4/2) con clastos de hasta 4cm subredondeados conformados por pelitas y wakes gris-verdosa metamórficos. Matriz arenosa con escasos niveles de arena arcillosa (muy baja proporción de arcilla).

SAND with GRAVEL: Arena gravosa. Arena media a fina con muy escaso a nulo limo. (10R 4/6). Escasos clastos subredondeados conformados por pelitas y wakes hasta 2cm.

SANDY GRAVEL: Grava fina (2 a 6mm) en matriz arenosa con escasa arcilla (10YR 6/2). Clastos conformados por wakes y pelitas gris verdosas. Clasto soportada.

SANDY GRAVEL with CLAY: Grava arcillo-limosa. Arcilla arenosa marrón-clara (10YR 6/2) con abundantes clastos (2 a 6cm) subredondeados (pelitas y wakes). Matriz soportada.

CLAY: Arcilla rojiza (10R 4/6) intercala con dos niveles (5cm) limo areno-arcillosos y escasos lentes (2cm) de arena muy fina.

SAND with GRAVEL: Arena gravosa. Arena media a fina con muy escasa presencia de limo Escasos clastos subredondeados de hasta 2cm, conformados por pelitas gris-verdosas silicificadas. Hacia el fondo fino nivel (1cm) de arcilla rojiza.

CLAY : Arcilla rojiza (10R 4/6).

SAND with GRAVEL: Arena media a fina con muy escasos clastos subredondeados (1cm) de pelitas y wakes silicificadas gris-verdosas (Or) Intercala con dos niveles deformados de de arcilla rojiza (10R 4/6) con potencias de 1 a 2cm.

SAND: Arena mediana a fina gris-rojiza (10R 6/2) con escaso limo, conformada por finos granos de cuarzo(?90%), yeso?(?5%), liticos metamórficos(?3%) y magnetita(?2%).

CLAY interbeded SAND: Arcilla rojiza (10R 4/6) intercala en el tope con 5 niveles (4 a 6cm) de arena media a muy fina y lentes (1cm) en todo el nivel. Hacia la base muy escasos rastros de arcilla verde.

SAND: Arena mediana gris (N6) con escasa arena fina a muy fina. Intercala con un nivel deformado (2cm) de arcilla marrón y verde.

CLAY : Arcilla rojiza (10R 4/6), menor arcilla verde y arena media gris (N6).

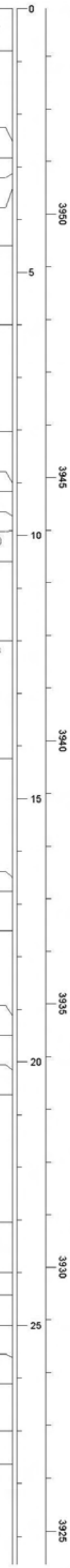
SAND: Arena mediana a muy fina gris (N6) muy escasos granos tamaño arena gruesa y muy escasos fragmentos sabulíticos.

SANDY GRAVEL: Grava fina arenosa. Fragmentos subredondeados (2 a 6mm) conformados por pelitas, wakes y menor cuarcitas silicificadas (Or) en matriz de arena muy gruesa a fina.

SANDY GRAVEL with CLAY: Grava areno-arcillosa marrón (10YR 6/2). Clastos subredondeados de 0,2 a 4cm conformados por wakes y pelitas silicificadas gris-verdosas en matriz areno-arcillosa.

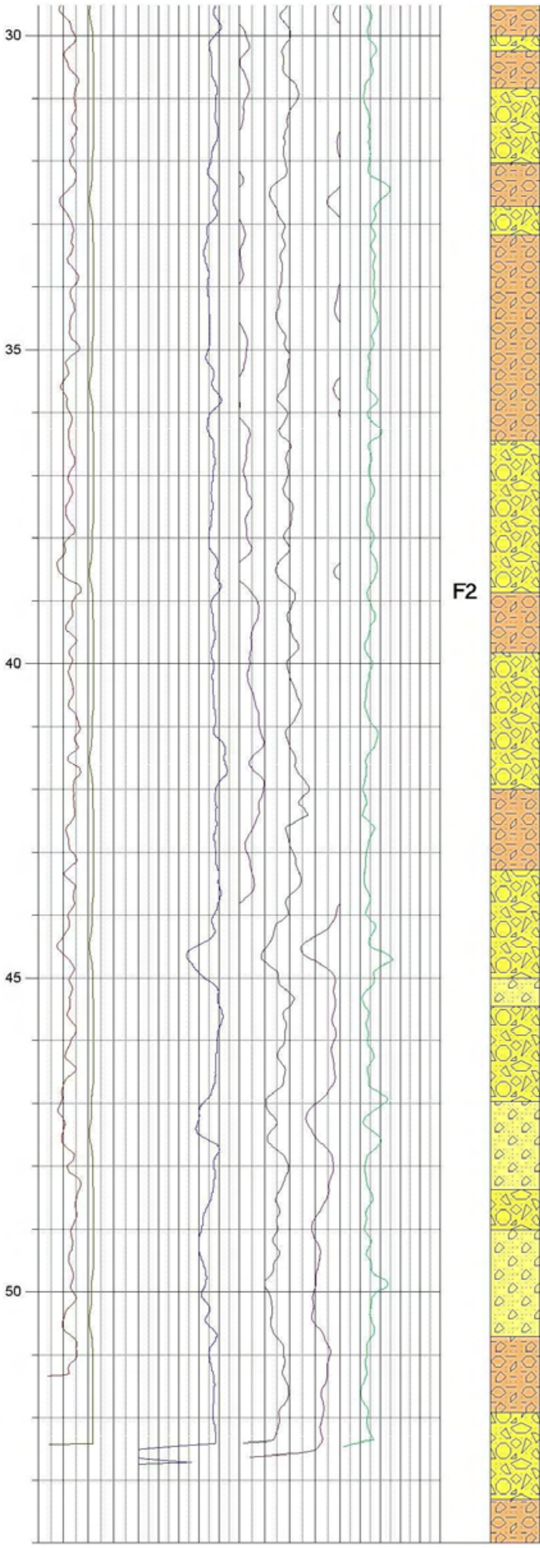
SANDY GRAVEL: Grava arenosa. Clastos subredondeados en los que domina fracción de 2 a 4mm y alcanzan 2cm (20mm) en matriz de arena media a fina con poca proporción de guesa.

SANDY GRAVEL with CLAY: Grava areno-arcillosa rojiza (10R 4/6). Clastos subredondeados alcanzan los 4cm conformados por pelitas y wakes silicificadas de color gris-verdoso. Matriz areno-arcillosa rojiza (poca proporción de arcilla ?10%). Nivel (29,03-29,18m) areno-arcilloso rojizo con escasos clastos de grava (? 5mm).



OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY	START DATE: 14-05-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-18
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC	END DATE: 20-05-2010	E: 3423994	Page 2 of 2
		METHOD: SONIC	DEPTH: 54m	N: 7396496	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 3953,901	

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SANDY GRAVEL: Grava arenosa. Clastos subredondeados hasta 4cm (dominan 0,5 a 1cm) conformados por pelitas y wakes silicificadas gris-verdosas.

SANDY GRAVEL with CLAY: Grava areno-arcillosa marrón (10YR 5/4) conformada por clastos subredondeados (hasta 3cm) de wakes y pelitas silicificadas gris-verdosas en matriz areno-arcillosa (arcilla?15%).

SANDY GRAVEL: Grava arenosa. Clastos (pelitas y wakes) subredondeados hasta 3cm (dominan 3 a 5mm) en matriz de arena media a fina con muy escasa presencia de limo (10R 4/6).

SANDY GRAVEL with CLAY: Grava areno-arcillosa. Clastos subredondeados (hasta 4cm, dominan 0,3 a 1cm) conformados por wakes y pelitas silicificadas en matriz de arena media a fina limo arcillosa (arcilla?10%). Escasos lentes arcillo-arenosos (2cm). Color del conjunto marrón-claro (10YR 5/2).

SANDY GRAVEL: Grava arenosa. Clastos subredondeados (2cm, dominan 1cm) en matriz de arena media a fina.

SANDY GRAVEL with CLAY: Grava areno-arcillosa. Clastos subredondeados (hasta 7cm, dominan 1 a 2cm) conformados por pelitas y wakes silicificadas en matriz de arena madia a fina limo arcillosa (arcilla?10%). Intercalan, a lo largo del nivel, con niveles areno gravosos (arena fina a media) con clastos subredondeados de 2 a 5mm.

SANDY GRAVEL: Grava arenosa. Clastos subredondeados (hasta 8cm, dominan 1 a 2cm). Conformados por pelitas, wakes y menor cuarcitas y cuarzo lechoso (Qz vein?) en matriz de arena gruesa a fina, conformada por magnetita(?55%), cuarzo(?40%)y líticos metamórficos(?5%). . Escasos niveles (4cm) con arena negra y menor lentes (1cm) de arcilla arenosa. Hacia la base arena gravosa (matriz soportada) con clastos subredondeados (?1cm).

SANDY GRAVEL with CLAY: Grava areno arcillosa . Clastos subredondeados a subangulosos (de 0,5 a 2cm) conformados por wakes, pelitas y menor cuarzo lechoso (Qz veins?). Color del conjunto rojizo (10R 4/6).

SANDY GRAVEL: Grava arenosa rojiza (10R 4/6) . Clastos subredondeados a subangulosos (de 0,5 a 2cm) conformados por wakes, pelitas y menor cuarzo lechoso (Qz veins?).

SANDY GRAVEL: Grava arenosa. Clastos de 0,2 a 4cm subredondeados. Escasa matriz de arena media a fina y menro proporción en niveles (2 a 4cm) con muy escasa arcilla. En la base intercala con nivel (3cm) de arena media a fina. El color del conjunto es gris (N6).

SANDY GRAVEL with CLAY: Grava areno-arcillosa. Clastos subredondeados (hasta 4cm, dominan 1 a 2cm) conformados por wakes, pelitas y menor frgmentos de cuarzo lechoso (Qz veins?) en matriz de arena gruesa a fina arcillosa marrón (10R 6/2). Intercala con dos niveles (3cm) con matriz de solo arcilla.

SANDY GRAVEL: Grava arenosa. Clastos subredondeados (hasta 4cm, dominan 1 a 2cm) conformados por wakes, pelitas y menor frgmentos de cuarzo lechoso (Qz veins?) en matriz de arena gruesa a fina con muy escaso limo (5YR 5/6).

SAND with GRAVEL: Arena media a fina con abundantes clastos tamaño sábulo y grava muy fina (2 a 5mm). Transicional con el nivel inferior.

SANDY GRAVEL: Grava arenosa. Clastos (2 a 4mm en 15%) conformados principalmente por metamórfitas (pelitas y wakes silicificadas) subredondeadas. Matriz de arena media a fina con escaso a nulo limo (N6) conformada por cuarzo(?85%), líticos metamórficos(?8%), magnetita(?5%) y líticos volcánicos(?2%).

SAND with GRAVEL: Arena media a fina con abundantes clastos tamaño sábulo y grava muy fina (2 a 5mm), conformada por granos subredodneados de cuarzo(?85%), magnetita(?7%), líticos metamórficos(?6%) y líticos volcánicos(?6%). Intercalan escasos y finos lentes (1cm) de arcilla marrón. Hacia la base se toma de color anaranjado (FeoX?).

SANDY GRAVEL: Grava arenosa. Clastos tamaño sábulo y grava muy fina (2 a 5mm).

SAND with GRAVEL: Arena media a fina con muy escasa grava (clastos de 0,7 a 2cm) conformada por pelitas y wakes. Conformada por cuarzo(?90%), líticos metamórficos?(?7%), y magnetita(?3%). Intercala con finos y escasos niveles (3 a 4cm) de arcilla marrón (10YR 5/4).

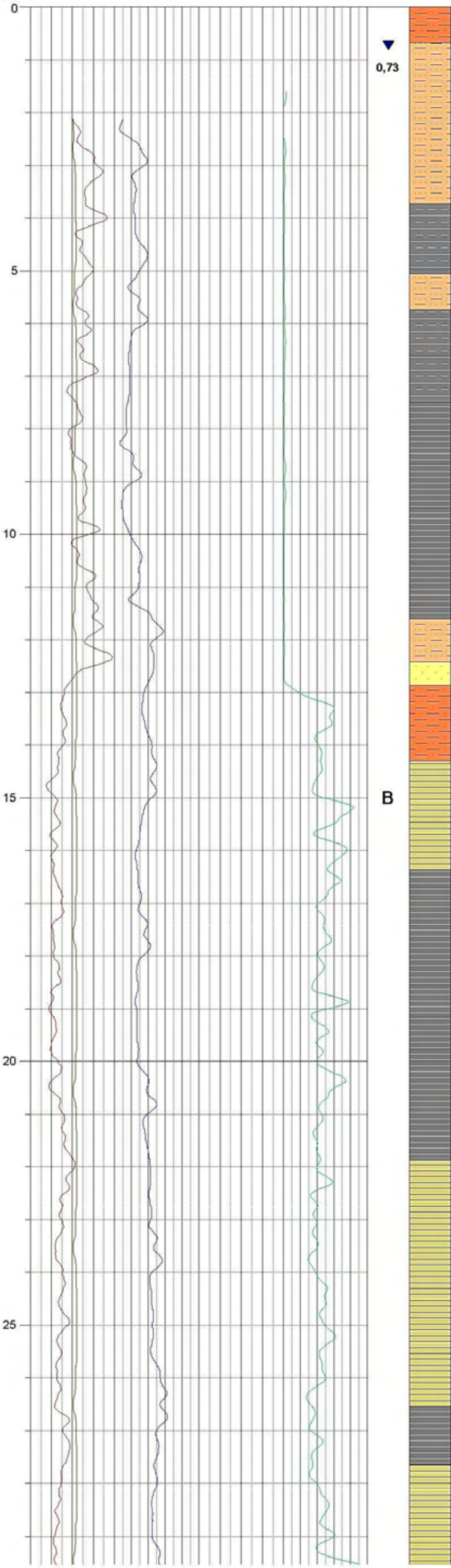
SANDY GRAVEL with CLAY: Grava areno-arcillosa. Clastos subredondeados (hasta 6cm, dominan 1 a 2cm) conformados por wakes y pelitas silicificadas en matriz areno-arcillosa.

SANDY GRAVEL: Grava arenosa. Clastos subredondeados (hasta 4cm) en escasa matriz de arena media a fina con escaso limo y muy escasa a nula arcilla.

SANDY GRAVEL with CLAY: Gava areno-arcillosa rojiza (10R4/6) clastos matriz soportados (escasos) de hasta 6cm en matriz rojiza de arena media afina limo-arcillosa (fuerte variación de la proporción de arcilla, disminuye hacia la base).

OROCOBRE RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT	CONTRACTOR: BLY DRILL RIG: SONIC METHOD: SONIC	START DATE: 02-05-2010 END DATE: 14-05-2010 DEPTH: 54m	COORDINATES (POSGAR 94 Zone 3) E: 3425997 N: 7396496 Elevn: 3938,960	WELL REFERENCE: C-19 Page 1 of 2 LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SANDY CLAY: Arcilla limo arenosa rojiza (10YR 5/4), con muy baja proporción de arena. Niveles de ulexita de 2 a 3cm.

CLAYEY SAND: Arena arcillosa intercala con niveles (2cm) de arena gris con intraclastos (3cm) de arenisca cementada (?). Y muy fino nivel de arcilla marrón (5YR 4/4).

CLAYEY SAND: Arena fina limo arcillosa (10YR 5/4) con abundante agua, conformada por cuarzo(?80%), magnetita(?10%), líticos metamórficos?(?5%) y yeso?(?5%). Proporción de arcilla variable es más abundante en tope y base del nivel. Escasas papas de ulexita (1cm) y rastros de materia orgánica. En tope del nivel muy escasos intraclastos? (2cm) de arena fina ligeramente friable.

CLAY Interbeded ORGANICS: Mix de arcilla verde (10GY 5/2) con arcilla negra (materia orgánica) de contacto muy irregular. En la base intercalación rítmica (5mm) con finos niveles de arena fina (1a 2cm).

CLAYEY SAND: Arena fina arcillosa gris-oscura (N2) intercala con nivel (3cm) de arcilla verde (10GY 5/2).

CLAY Interbeded ORGANICS: Intercalción rítmica de arcilla verde (10GY 5/2) y arcilla negra en bancos de aproximadamente 1cm cada uno. Muy escasa ulexita.

BLACK CLAY : Arcilla negra (materia orgánica). Muy escasos rastros de arcilla verde y finas papas de ulexita (1cm). Hacia la base (8cm) arcilla marrón rojiza (5YR 6/4).

CLAYEY SAND: Arena arcillosa fina gris-oscura a negra (N2). Muy escasos arcilla arenosa marrón rojiza. Intraclastos (2cm) de arenisca fina cementada (?).

SAND: Arena fina gris (N4) con escasos rastros de arcilla negra en finos lentes (1cm), conformada por cuarzo(?65%), magnetita(?25%), líticos metamórficos?(?5%), líticos volcánicos(?3%) y yeso?(?2%).

SANDY CLAY: Arcilla arenosa marrón (10YR 6/2) con abundantes y muy finos cristales de yeso(?) y rastros de materia orgánica (arcilla negra). Muy escasos lentes de arena fina negra (3cm).

CLAY : Arcilla verde (10GY 5/2) con muy finos lentes (2mm) de arena fina negra. Intercala con niveles de arcilla marrón (10YR 6/2), con menor materia orgánica hacia la base.

BLACK CLAY : Arcilla negra con muy finos y escasos niveles (<1 a 5mm) de arcilla marrón (10YR 6/2). A partir de 19mts conforman una secuencia rítmica cada 1 a 3cm de arcilla negra 1 a 5mm de arcilla marrón.

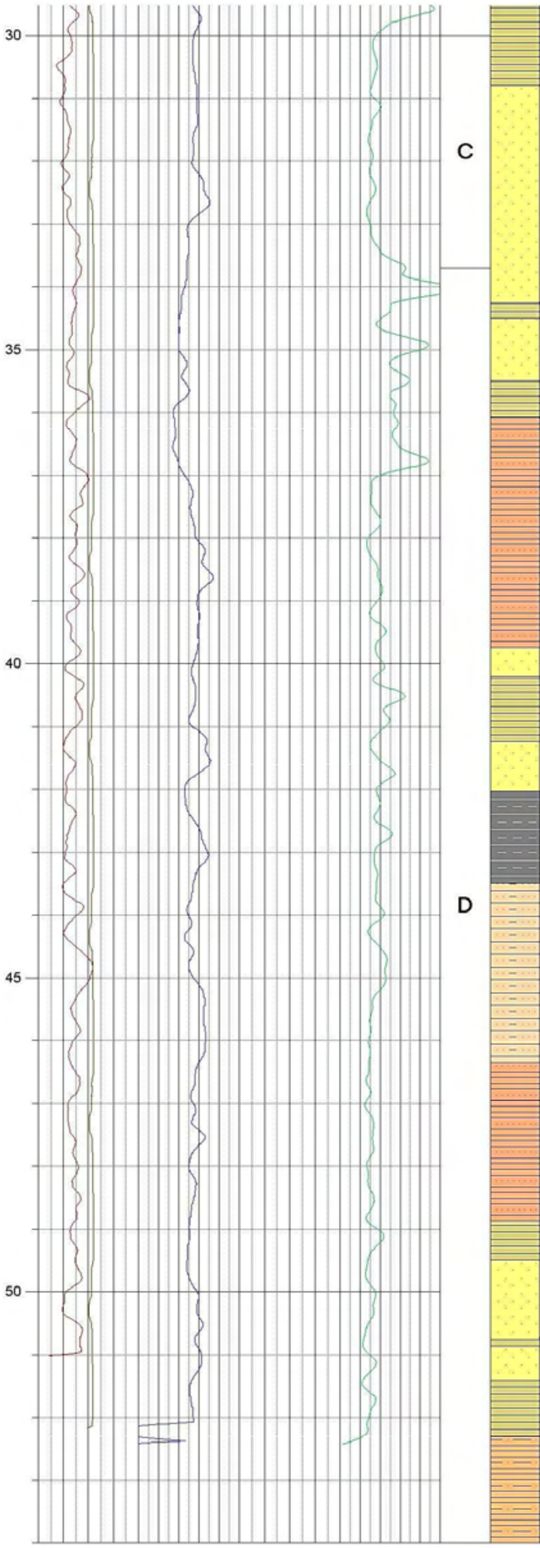
CLAY : Arcilla marrón (10YR 6/2) intercala con arcilla verde (10GY 5/2) y menor arcilla negra. Muy escasos y finos (5mm) lentes de arena fina arcillosa.

BLACK CLAY : Arcilla negra con escasos y finos niveles (1cm) de arcilla verde. De 27 a 27,65 mts sediemento muy deformado y obliterado por STP.

CLAY : Arcilla verde (5GY 5/2) intercala con arcilla marrón (5GY 5/2). Escasos rastros de materia orgánica (arcilla negra). Nivel de 5cm con arcilla gris-oscura a negra y muy finos cristales de selenita (?).

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY	START DATE: 02-05-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: C-19
	DRILL RIG: SONIC	END DATE: 14-05-2010	E: 3425997	Page 2 of 2
	METHOD: SONIC	DEPTH: 54m	N: 7396496	
			Elevn: 3938,960	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SAND: Arena fina a media con muy escaso limo gris (N4) y escasos niveles (2cm) de arena media a fina con clastos blanquecinos, conformada por cuarzo(?65%), magnetita(?65%), líticos volcánicos(?7%), yeso?(<1%) y biotita(<<1%).

CLAY : Arcilla rojiza (10R 4/6)

SAND: Arena fina gris (N4) con escaso limo y granos blanquecinos.

CLAY : Mix de arcilla marrón y marrón-rojiza (10R 4/6) con menor arcilla verde. Intercala con nivel de arcilla negra (4cm). En la base nivel de arena fina gris (3cm).

CLAY : Arcilla negra.

CLAY interbeded SAND: Arcilla marrón (5YR 5/2) con niveles y lentes intercalados cada 20 a 30 cm de arena fina gris y arena arcillosa negra. Rastros de materia orgánica en finos niveles (?1cm). Sediemnto muy obliterado en el tope (STP). Hacia la base abundante arcilla negra (materia orgánica).

SAND: Arena fina a media a gris con escaso limo, niveles más oscuros 2 a 3cm. Intercala con fino nivel (2cm) de arcilla arenosa (5YR 5/2).

CLAY : Arcilla marrón (5YR 4/4) con muy escasos y finos niveles (5mm) de arcilla negra. Muy escasos lentes de arena fina negra y gris (4cm). Escasas y finas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

SAND: Arena fina grada a hacia el fondo a arena media gris oscura (N3) a negra, conformada por cuarzo(?65%), líticos metamórficos?(?17%), líticos volcánicos(?8%), magnetita(?7%) y yeso?(?3%). Escasos sectores con mayor cantidad de materia orgánica (3cm). En la base nivel de calcreta (?) de 3cm, masivo gris-blanquecino a rosado con muy finas y escasas inclusiones de cristales y criptocristales (Bt?, Mt? Y Qz?).

CLAY Interbeded ORGANICS: Arcilla negra con niveles de arcilla gris-verdosa (5Y 5/2). Hacia la base nivel (1cm) con abundantes cristales de halita (hasta 5mm). Esacasos lentes de arena fina negra (2cm).

SANDY CLAY Interbeded SAND: Arcilla arenosa (arena fina) negra y gris-verdosa (5Y 5/2) intercala con niveles de arena gris (20 a 80cm) conformada por cuarzo(?78%), magnetita(?10%), yeso?(?7%), líticos volcánicos?(?5%) y carbonatos masivos(<1%). Muy escasos niveles de arcilla rojiza.

CLAY interbeded SAND: Arcilla marrón (10YR 4/2) intercala rítmicamente con niveles (3cm) de arena fina negra y menor lentes y niveles (1 a 2mm) de arena fina (10YR 4/2) y fino nivel de calcita (caliche?) a los 48,45 (1cm). Hacia tope y base niveles con arcilla verde (10GY 5/2).

CLAY : Arcilla gris-rojiza (10R 4/2) transicional en color con nivel superior. Muy escasos niveles de arcilla y arena muy fina negra (1 a 2mm).

SAND: Arena fina a media gris (N4) conformada por cuarzo(?70%), magnetita(?15%), líticos volcánicos?(?12%) y yeso?(?3%).

CLAY : Arcilla gris-verdosa (5Y 5/2) con fino nivel de arena muy fina negra (2mm).

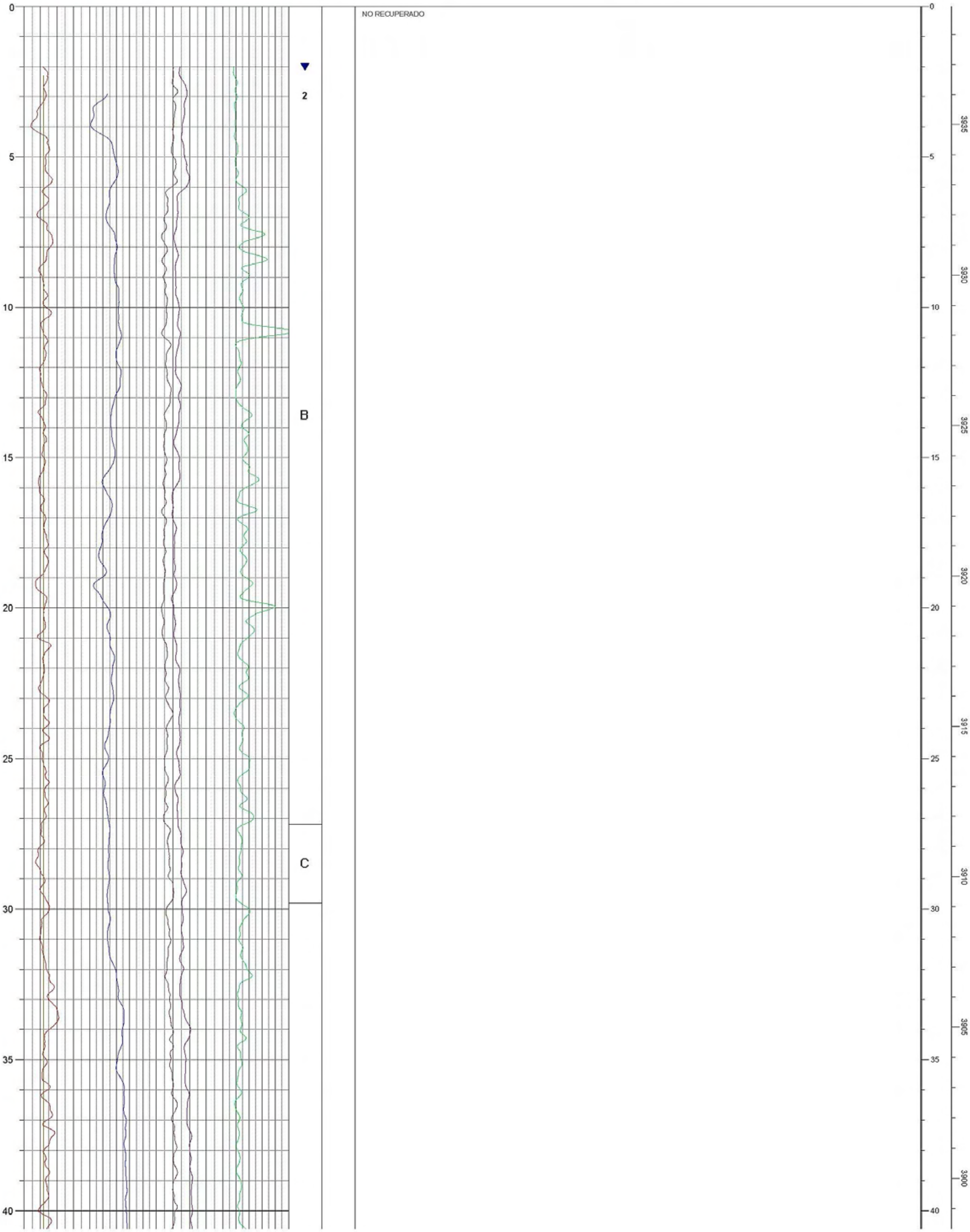
SAND: Arena fina a media gris (N4) con granos blanquecinos intercala con un nivel (40cm) de arena fina arcillosa rojiza (10R4/6) hacia la base.

CLAY : Arcilla rojiza (10R 4/6) intercala con muy escasos y finos niveles (5mm) de arcilla negra y menor arena muy fina negra (1mm).

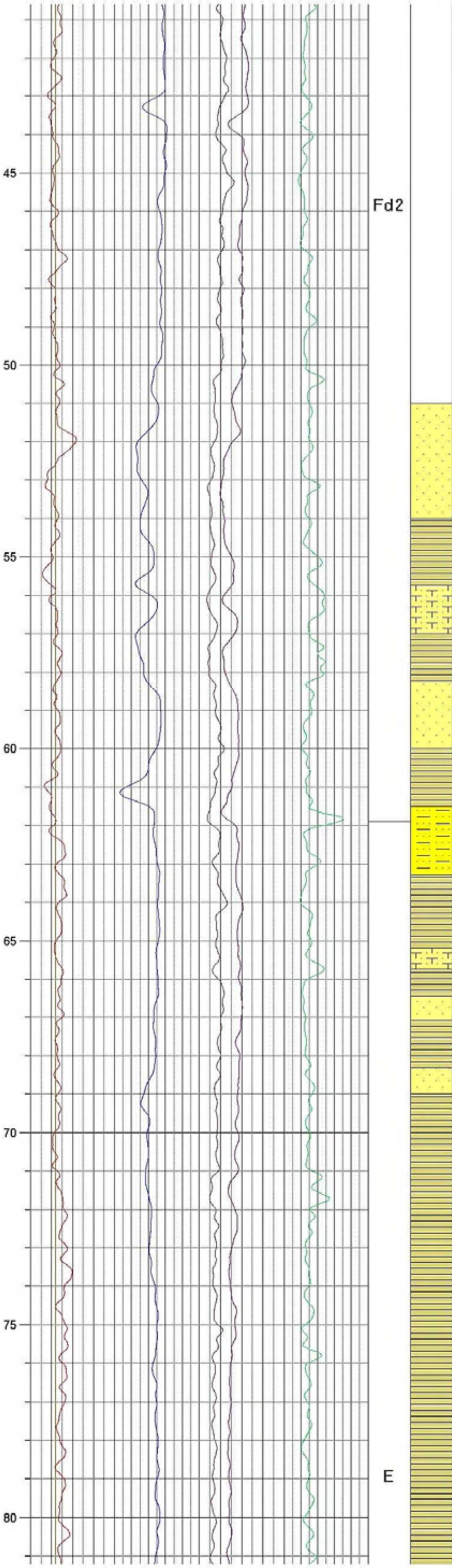
CLAY interbeded SANDY CLAY: Arcilla verde (10GY 5/2) con escasos niveles (2cm) deformados de arcilla arenosa gris (poca arena muy fina). Nivel (3mm) de arcilla negra en la base.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY/MAJOR	START DATE: 01-10-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC/DIAMON BIT	END DATE: 13-10-2010	E: 3430012	CD-01
		METHOD: SONIC-DIAMON BIT	DEPTH: 195,5m	N: 7412010	Page 1 of 5
				Elevn: 3938,930	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



SAND: Arena media a fina gris (N4) con muy escaso limo. Muy escasos y aislados fragmentos de arcilla marrón (5YR 4/4).

CLAY: Arcilla verde (5GY 5/2) con niveles deformados (2 a 5mm) de arcilla negra. Escasos rastros muy irregulares de arcila marrón-rojiza.

CLAY: Mix de arcilla marrón-rojiza (10R 5/4) y verde (5GY 5/2) con escasos y muy finos niveles (?5mm) de arena media a fina gris.

SILTY SAND: Arena fina a muy fina limosa gris-oscura a negra. Dos niveles (2 a 18cm) intercalados de arcilla marrón (10R 5/4) y verde (5GY 5/2) respectivamente.

CLAY: Arcilla verde (10GY 5/2). Abundantes y gruesas papas (hasta 7cm) de ulexita. Hacia la base (10cm) intercala con finos niveles de arena media a fina gris, transicional con nivel inferior.

SAND: Arena media a fina gris (N3) con escaso limo. Hacia la base (últimos 15cm) con muy escasa presencia de limo y arcilla?.

CLAY: Arcilla rojiza (10R 4/6) intercala con finos y aislados niveles (?1cm) limosos grises.

SANDY SILT: Limo con muy escasa arena muy fina gris (N4), intercala con niveles (2 a 10cm) de arcilla rojiza (10R 4/6). Hacia la base (últimos 29cm) grada a arena muy fina limosa.

CLAY: Arcilla rojiza (10R 4/6) con escasos y finos niveles (?5mm) de arena fina a muy fina limosa gris.

SILTY SAND: Arena fina a muy fina limosa gris (N5) con finos (1cm) y escasos niveles de arcilla rojiza.

CLAY: Arcilla rojiza (10R 4/6) con escasos y finos niveles de arena fina a muy fina limosa gris.

SAND: Arena fina a muy fina gris (N4) con escasos y aislados niveles (?1cm) de arcilla rojiza (10R 4/6).

CLAY: Arcilla rojiza (10R 4/6) con escasos y finos niveles (?1cm) de arena fina a muy fina limosa gris.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros irregulares de arcilla negra.

SAND: Arena fina a muy fina limosa con escasa arcilla de distribución muy irregular y muy escasos niveles deformados (?5mm?) de arcilla marrón (5YR 5/2).

CLAY: Intercalan, en bancos de 10 a 20cm, arcilla marrón rojiza-pálida (10R 6/2) y arcilla gris-verdosa oscura (10Y 4/2) con muy escasos rastros irregulares de arcilla negra y niveles (lenticulares? ?1cm) de arena fina gris.

CLAY: Arcilla gris verdosa oscura (10Y 4/2) rastros escasos y muy irregulares de arcilla negra y niveles lenticulares? (?1cm) de arena fina gris.

CLAY: Arcilla rojiza (10R 4/6) muy escasas y finas manchas? De arcilla verde (10GY 5/2).

CLAY: Arcilla gris-verdosa oscura (10Y 4/2). Escasos rastros irregulares de arcilla marrón-oscura (10YR 4/2). Muy escasa presencia de limo.

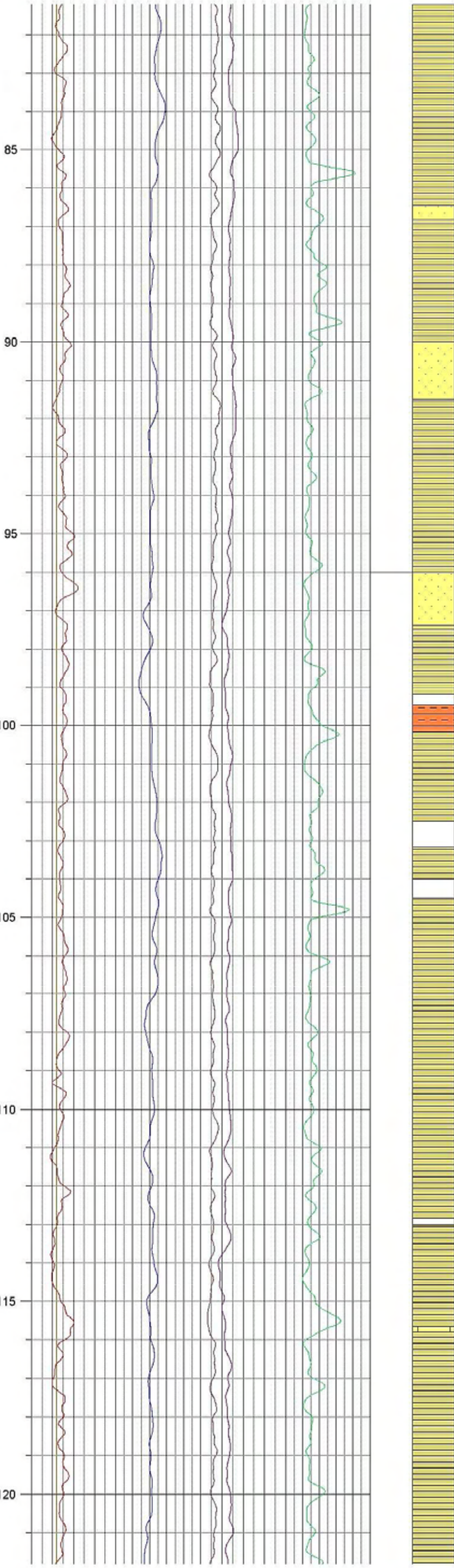
CLAY: Arcilla marrón-oscura (10YR 4/2) con rastros muy irregulares de arcilla gris-verdosa oscura (10Y 4/2).

Depth (m): 45, 50, 55, 60, 65, 70, 75, 80

Elevn. (m): 3895, 3890, 3885, 3880, 3875, 3870, 3865, 3860

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY/MAJOR	START DATE: 01-10-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-01
	DRILL RIG: SONIC/DIAMON BIT	END DATE: 13-10-2010	E: 3430012	Page 3 of 5
	METHOD: SONIC-DIAMON BIT	DEPTH: 195,5m	N: 7412010	LOGED BY: Geol. FERNANDO A. MARTÍN
			Elevn: 3938,930	

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla marrón-pálida (5YR 5/2) a ligeramente rojiza con rastros irregulares y niveles muy deformados (2 a 5mm) de arcilla negra. Muy escasos y finos niveles lenticulares? (?2mm) de arena muy fina.

CLAY: Arcilla rojiza-oscura (10R 3/4) con dos niveles (tope: 20cm y base: 18cm) de arcilla gris verdosa-oscura con escaso limo.

SAND: Arena fina a muy fina gris limosa (N4).

CLAY: Arcilla gris-rojiza (10R 4/2) con niveles (2 a 5mm) aislados de arcilla negra.

SAND: Arena media con escasos componentes gruesos y finos. Gris (N5) a ligeramente marrón.

CLAY: Arcilla gris-verdosa (5Y 5/2) con escasas manchas irregulares de arcilla negra. Muy escasa presencia de limo.

CLAY: Arcilla marrón-pálida (5YR 5/2) con muy escasos rastros irregulares de arcilla negra.

SAND: Arena media a fina gris (N5) con muy escaso limo.

CLAY: Arcilla gris-verdosa (5GY 5/2) con rastros irregulares y escasos de arcilla negra. Hacia la base estos rastros son más abundnates con papas (?5mm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con escasos rastros irregulares de arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropimente?).

NO RECUPERADO

SILTY CLAY: Arcilla limosa gris-verdosa oscura (10Y 4/2) con nivel central (20cm) de arcilla marrón (5YR 5/2) con rastros de arcilla negra y papas (2cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla marrón (5YR 5/2) con muy escasos y finos niveles (2 a 3mm) de arcilla negra. Nivel (5cm) de arena fina limosa gris (N4).

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) a pálida (10R 5/4) en la base. Muy escasos niveles (1cm) de arena limosa negra y arena fina a muy fina arcillosa marrón.

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla marrón (5YR 5/2) con niveles (2 a 5cm) intercalados de arena fina limosa con escasa arcilla. Escasos rastros irregulares y manchas anaranjadas pulverulentas (rejalgar/oropimente?).

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) con escasas manchas irregulares de arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY: Arcilla marrón (5YR 5/2) por sectores ligeramente rojiza. Finas papas y niveles de ulexita. Rastros escasos y muy irregulares de arcilla negra. Manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY: Arcilla gris-verdosa (5Y 5/2) con papas y niveles (1 a 2cm) de ulexita. Hacia la base (últimos 8cm) arcilla negra. Nivel (3cm) de arena fina limosa.

CLAY: Arcilla marrón (5YR 5/2) con papas (hasta 3cm) de ulexita y muy escasas e irregulares manchas de arcilla negra.

SILTY SAND: Nivel de arena fina limosa gris (N5) con nivel (3cm) deformado de arcilla marrón.

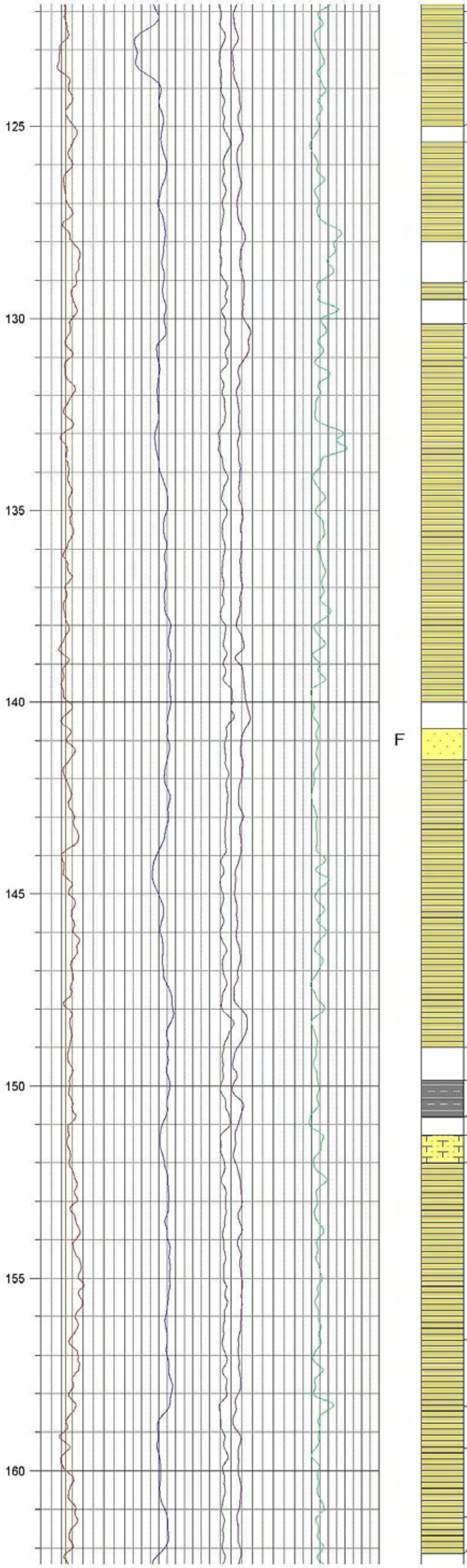
CLAY: Arcilla rojiza (10R 4/6) con muy escasa papas (0,5 a 2cm) de ulexita y manchas irregulares de arcilla negra. Nivel central (43cm) de arcilla gris verdosa (5Y 5/2).

CLAY: Arcilla marrón-rojiza oscura (10R 3/4) con nivel (19cm) de arcilla gris-verdosa (5Y 5/2) y nivel (2cm) de arcilla negra. Muy escasas papas (2cm) de ulexita.

CLAY: Arcilla gris-verdosa (5Y 5/2) con niveles (20 a 30cm) de contacto irregular con arcilla marrón (5YR 5/2). Niveles (0,5 a 1cm) escasos de arcilla negra.

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY/MAJOR DRILL RIG: SONIC/DIAMON BIT METHOD: SONIC-DIAMON BIT	START DATE: 01-10-2010 END DATE: 13-10-2010 DEPTH: 195,5m	COORDINATES (POSGAR 94 Zone 3) E: 3430012 N: 7412010 Elevn: 3938,930	WELL REFERENCE: **CD-01** Page 4 of 5 LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla rojiza-oscura (10R 3/4) con nivel (17cm) de arcilla verde (10GY 5/2). Escasos ratsros de arcilla negra y papas (1cm) de ulexita.

CLAY: Arcilla verde (10GY 5/2) a gris-verdosa (5Y 5/2) con escasas papas (2 a 4cm) de ulexita y niveles (1 a 2cm) de arcilla negra.

NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) con nivel cercano al tope (11cm) de arcilla arenosa marrón con fragmentos (?2cm) de arcilla verde. Niveles de contacto irregular (1 a 4cm) escasos de arcilla negra. Papas de ulexita (hasta 4cm).

NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) a gris-verdosa (5Y 5/2) con abundantes papas (1 a 3cm) de ulexita y niveles deformados de arcilla negra.

NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) con niveles de contactos difusos (3 a 4cm) de arcilla negra.

CLAY: Intercalan niveles (20 a 40cm) de arcilla verde (10GY 5/2) a gris-verdosa (5Y 5/2) y arcilla marrón (5YR 5/2) a marrón-pálida (10YR 6/2). Escasos niveles (?1cm) deformados de arcilla negra y muy escasas papas (1 a 3cm) de ulexita.

NO RECUPERADO

SAND: Arena media a fina gris (N5) con papas (1 a 2cm) de ulexita. Muy escaso limo.

CLAY: Arcilla verde (10GY 5/2) transicional con nivel inferior.

CLAY: Arcilla marrón-pálida (10YR 6/2) con niveles (?5cm) alternados de arcilla verde (10GY 5/2) y arcilla gris-verdosa (5Y 5/2). Escasos niveles deformados de arcilla negra (?1cm) y papas (hasta 3cm) de ulexita.

NO RECUPERADO

CLAY Interbeded ORGANICS: Mix muy deformado y alterado de arcilla marrón-pálida (10YR 6/2) y arcilla negra (intercalación?). Escasas papas (2cm) de ulexita.

NO RECUPERADO

SILTY SAND: Arena media a fina limosa gris-oscura (N3). Muy escasos rastros de arcilla negra.

CLAY: Arcilla verde (10GY 5/2) intercala con escasos niveles (5 a 10cm) de arcilla marrón-pálida (10YR 6/2). Muy escasos rastros irregulares de arcilla negra y papas (2cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) a ligeramente marrón. Con muy escasos rastros irregulares de arcilla gris-verdosa.

CLAY: Arcilla marrón-pálida (10YR 6/2) con escasos niveles (2 a 3cm) intercalados de arcilla negra. Escasas a finas papas (1 a 2cm) de ulexita. En la base nivel (6cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con nivel (13cm) de arcilla gris-verdosa con papas de ulexita y rastros de arcilla negra. Muy escaso rastros y niveles (2cm) de arcilla negra.

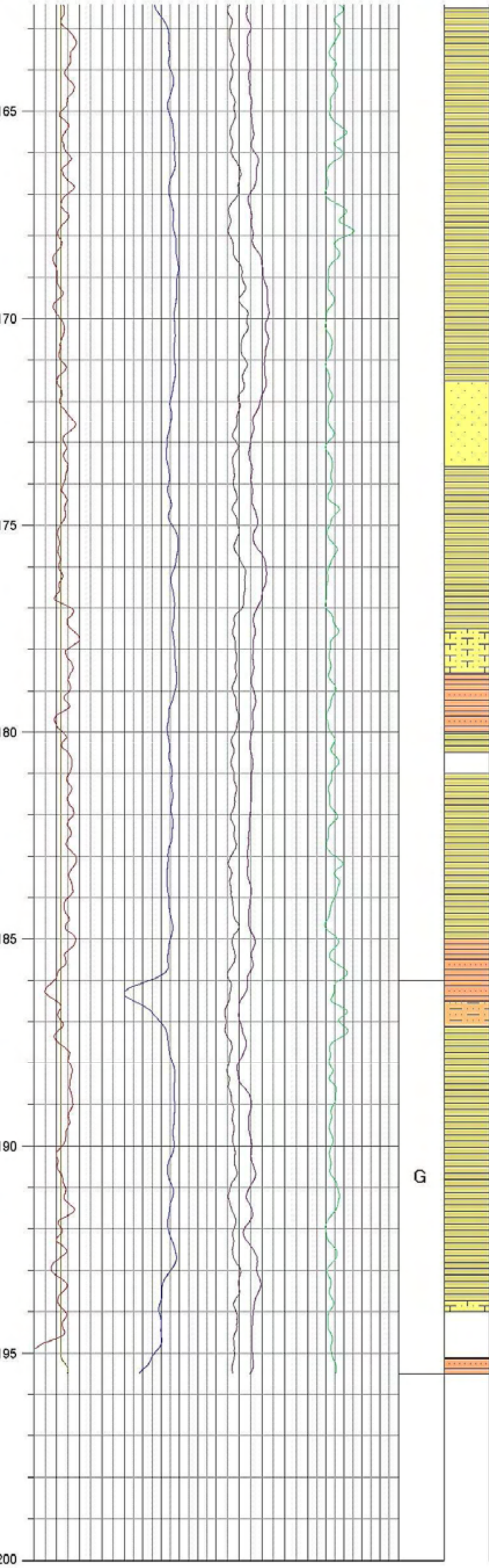
CLAY: Arcilla verde (10GY 5/2). Hacia la base intercala con arcilla rojiza (10cm)

NO RECUPERADO

Depth (m): 125, 130, 135, 140, 145, 150, 155, 160

Elevn. (m): 3815, 3810, 3805, 3800, 3795, 3790, 3785, 3780

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: BLY/MAJOR	START DATE: 01-10-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
	DRILL RIG: SONIC/DIAMON BIT	END DATE: 13-10-2010	E: 3430012	**CD-01**
			N: 7412010	Page 5 of 5
RESOURCE EVALUATION PROGRAM	METHOD: SONIC-DIAMON BIT	DEPTH: 195,5m	Elevn: 3938,930	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

CLAY: Arcilla rojiza (10R 4/6) con nivel (4cm) de arcilla blanquecina limosa.

CLAY: Arcilla verde (10GY 5/2) con escasos rastros irregulares de arcilla rojiza.

CLAY: Arcilla marrón (10YR 6/2) con escasos ratsros irregulares de arcilla verde (10GY 5/2) en tope.

CLAY: Arcilla gris-verdosa (5Y 5/2) a ligeramente marrón intercala con niveles (?1cm) de arena fina a muy fina limosa gris.

CLAY: Arcilla marrón-pálida (5YR 5/2) con escasos rastros de arcilla verde y escasos niveles y manchas irregulares de arcilla negra.

SAND: Arena media a fina gris (N4) con escaso limo.

CLAY: Arcilla marrón-oscura (10YR 4/2) con escasos niveles (1cm) de arena fina limosa gris y rastros irregulares de arcilla negra.

SILTY SAND: Arena media a fina gris (N4) limosa.

CLAY Interbeded SAND: Arcilla gris-verdosa (5Y 5/2) intercala regularmente con niveles (1 a 2cm) de arena fina a muy fina limosa gris.

CLAY: Arcilla marrón-oscura (5YR 3/4).

NO RECUPERADO

CLAY: Arcilla gris-verdosa oscura (5Y 5/2) con muy escasos niveles aislados (?1cm) de arena fina limosa y rastros irregulares de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6).

CLAY Interbeded SAND: Arcilla gris-verdosa oscura (5Y 3/2) con nivel (35cm) arena muy fina limo arcillosa (5Y 3/2).

CLAYEY SAND: Arena media a fina limo-arcillosa gris (N4) con abundnates fragmentos rosado-blanquecinos (2 a 10mm) carbonáticos (Intraclastos?).

CLAY: Arcilla rojiza-pálida (10R 5/4) a ligeramente gris con muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla marrón-pálida (5YR 5/2) muy escasos y finos niveles irregulares de arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla rojiza-oscura (10R 4/2) con nivel (32cm) de arcilla gris-verdosa (5Y 5/2).

CLAY: Arcilla verde a gris (5G 5/2) con escasos e irregulares rastros de arcilla negra.

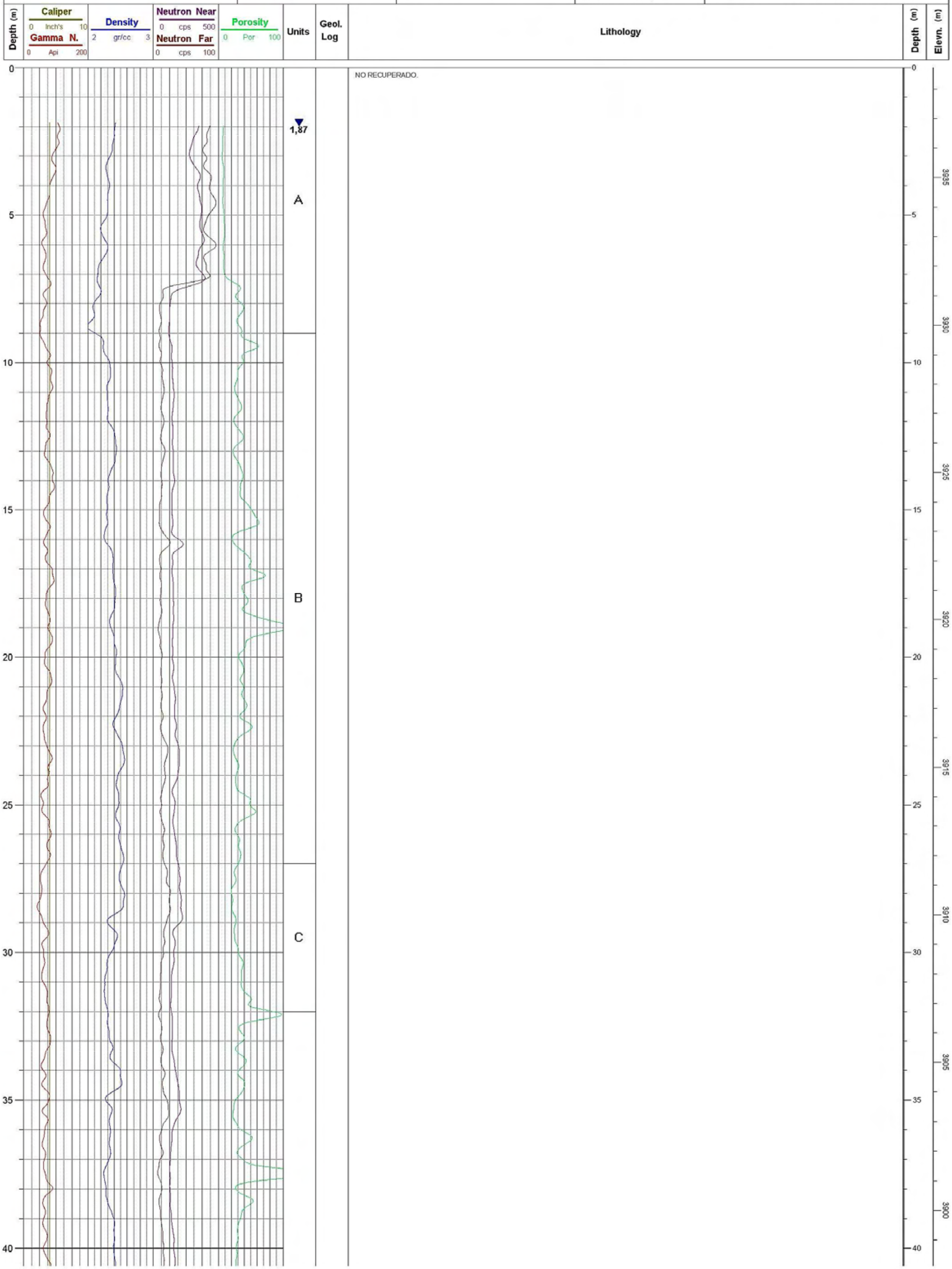
CLAY: Arcilla rojiza (10R 4/6) con muy escasas manchas irregulares de arcilla negra.

SILTY SAND: Arena fina a muy fina limosa en distintos tonos de grises a negro. Nivel (1cm) lenticular de arcilla marrón.

NO RECUPERADO

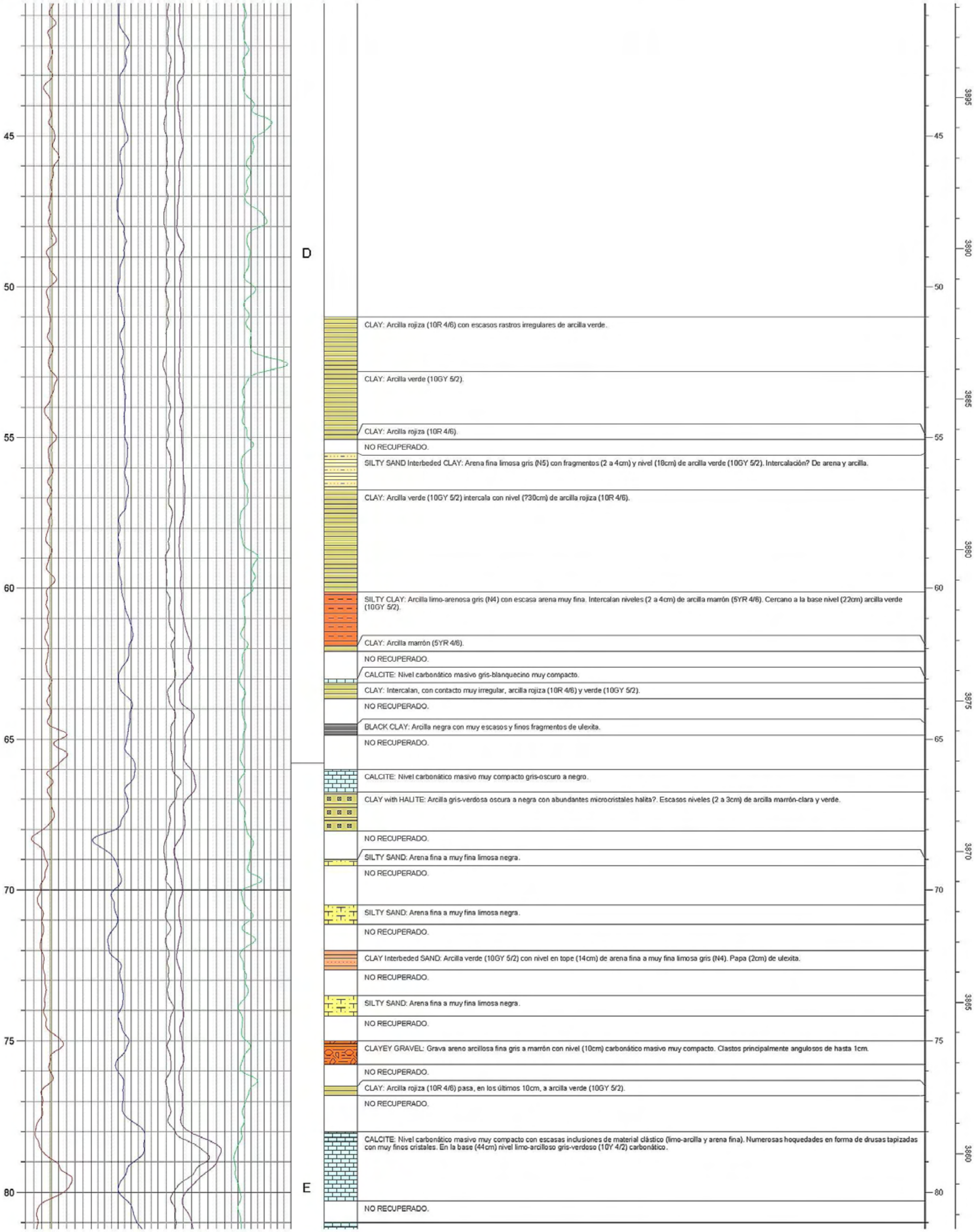
CLAY Interbeded SAND: Intercala arcilla marrón (5YR 5/2) con niveles (1 a 3cm) de arena media a fina limosa gris. Muy escasos rastros de arcilla negra.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE:	22-11-2010	COORDINATES (POSGAR 94 Zone 3) E: 3423998	WELL REFERENCE: **CD-02**
		DRILL RIG: UDR 200	END DATE:	08-12-2010	N: 7410903	Page 1 of 5
RESOURCE EVALUATION PROGRAM		METHOD: CORE BARREL	DEPTH:	199,70m	Elevn: 3938,727	LOGED BY: Geol. FERNANDO A. MARTÍN



OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: MAJOR	START DATE: 22-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: **CD-02**
	DRILL RIG: UDR 200	END DATE: 08-12-2010	E: 3423998	Page 2 of 5
	METHOD: CORE BARREL	DEPTH: 199,70m	N: 7410903	
			Elevn: 3938,727	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla rojiza (10R 4/6) con escasos rastros irregulares de arcilla verde.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla rojiza (10R 4/6).

NO RECUPERADO.

SILTY SAND Interbeded CLAY: Arena fina limosa gris (N5) con fragmentos (2 a 4cm) y nivel (18cm) de arcilla verde (10GY 5/2). Intercalación? De arena y arcilla.

CLAY: Arcilla verde (10GY 5/2) intercala con nivel (?30cm) de arcilla rojiza (10R 4/6).

SILTY CLAY: Arcilla limo-arenosa gris (N4) con escasa arena muy fina. Intercalan niveles (2 a 4cm) de arcilla marrón (5YR 4/6). Cercano a la base nivel (22cm) arcilla verde (10GY 5/2).

CLAY: Arcilla marrón (5YR 4/6).

NO RECUPERADO.

CALCITE: Nivel carbonático masivo gris-blanquecino muy compacto.

CLAY: Intercalan, con contacto muy irregular, arcilla rojiza (10R 4/6) y verde (10GY 5/2).

NO RECUPERADO.

BLACK CLAY: Arcilla negra con muy escasos y finos fragmentos de ulexita.

NO RECUPERADO.

CALCITE: Nivel carbonático masivo muy compacto gris-oscuro a negro.

CLAY with HALITE: Arcilla gris-verdosa oscura a negra con abundantes microcristales halita?. Escasos niveles (2 a 3cm) de arcilla marrón-clara y verde.

NO RECUPERADO.

SILTY SAND: Arena fina a muy fina limosa negra.

NO RECUPERADO.

SILTY SAND: Arena fina a muy fina limosa negra.

NO RECUPERADO.

CLAY Interbeded SAND: Arcilla verde (10GY 5/2) con nivel en tope (14cm) de arena fina a muy fina limosa gris (N4). Papa (2cm) de ulexita.

NO RECUPERADO.

SILTY SAND: Arena fina a muy fina limosa negra.

NO RECUPERADO.

CLAYEY GRAVEL: Grava areno arcillosa fina gris a marrón con nivel (10cm) carbonático masivo muy compacto. Clastos principalmente angulosos de hasta 1cm.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) pasa, en los últimos 10cm, a arcilla verde (10GY 5/2).

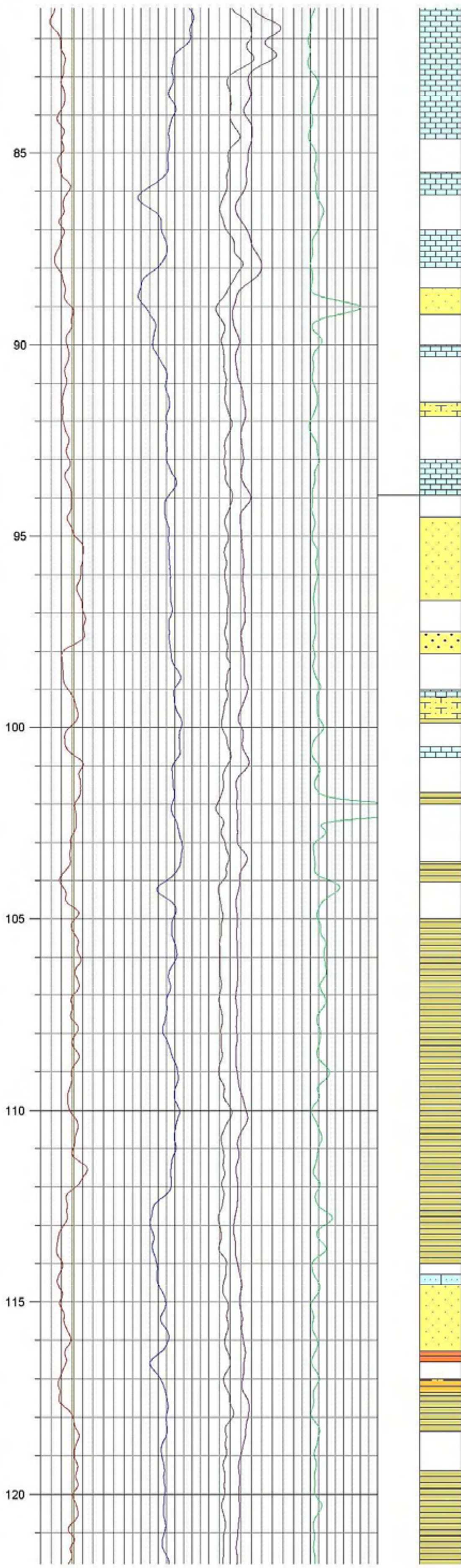
NO RECUPERADO.

CALCITE: Nivel carbonático masivo muy compacto con escasas inclusiones de material clástico (limo-arcilla y arena fina). Numerosas hoquedades en forma de drusas tapizadas con muy finos cristales. En la base (44cm) nivel limo-arcilloso gris-verdoso (10Y 4/2) carbonático.

NO RECUPERADO.

ORDCOBRE — OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 22-11-2010	COORDINATES (POSGAR 94 Zone 3) E: 3423998	WELL REFERENCE: **CD-02**
	DRILL RIG: UDR 200	END DATE: 08-12-2010	N: 7410903	Page 3 of 5
RESOURCE EVALUATION PROGRAM	METHOD: CORE BARREL	DEPTH: 199,70m	Elevn: 3938,727	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CALCITE: Nivel carbonático masivo hoqueroso con muy escasas inclusiones de material clástico. Bandeamientos en material cristalino (TRAVERTINO?).

NO RECUPERADO.

CALCITE: Nivel carbonático fracturado. Hacia la base (14cm) arena muy fina limo-arcillosa marrón (5YR 5/2).

NO RECUPERADO.

CALCITE: Nivel carbonático masivo con escasas inclusiones de material clástico. Numerosas y finas hoquedades tapizadas con carbonatos de estructura botroidal.

NO RECUPERADO.

SAND: Arena fina a muy fina gris (N4) limosa con fuerte presencia de carbonatos.

NO RECUPERADO.

CALCITE: Nivel carbonático muy fracturado con hoquedades tapizadas con carbonatos de etructura botroidal. Últimos 10cm cona rena fina muy fina limosa con fuerte presencia de carbonatos.

NO RECUPERADO.

SILTY SAND: Arena fina limosa gris (N4) con fuerte presencia de carbonatos y fragmento carbonático (7cm) nodulo?.

NO RECUPERADO.

CALCITE: Nivel carbonático masivo gris-blanquecino con hoquedades tapizadas con carbonatos de eestructura botroidal, Nivel central (20cm) de arena muy fina limosa gris (N3) con fuerte presencia de carbonatos.

NO RECUPERADO.

SAND: Arena fina con escaso limo gris (N4).

NO RECUPERADO.

COARSE SAND: Arena gruesa con escasa arena fina y limo gris (N4). Abundantes granos blanquecino. En la base (últimos 3cm) arcilla rojiza (10R 4/6).

NO RECUPERADO.

CALCITE: Nivel carbonático masivo en la base (3cm) arcilla rojiza (10R 4/6).

SILTY SAND: Arena fina a muy fina limosa gris (N4).

CLAY: Arcilla rojiza (10R 4/6) sector basal fuertemente cementado con carbonatos.

NO RECUPERADO.

CALCITE: Nivel carbonático gris-blanquecino hoqueroso con nivel (2cm) de arcilla rojiza (10R 4/6).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) contaminada(?) con arena del nivel superior.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con dos niveles (5 y 8cm) de carbonato masivo fragmentado gris-blanquecino.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos ratsros irregulares de arcilla verde (10GY 5/2) y finas papas (?1cm) de ulexita.

NO RECUPERADO.

SAND Cemente CARBONATES: Arena muy fina gris (N3) intercala con niveles (?2cm) de arcilla rojiza (10R 4/6). Todo cementado con carbonatos. Nivel (2cm) de arcilla rojiza no cementada.

SAND: Arena media a fina gris (N5) con escaso limo.

SILTY CLAY: Arcilla marrón limo-arenosa (5YR 5/2) ligeramente rojiza. Nivel (4cm) de arena media a fina con nodulo? Carbonático de arena cementada.

NO RECUPERADO.

CLAYEY SILT: Nivel limo-areno arcilloso marrón a gris verdoso oscuro (10YR 4/2).

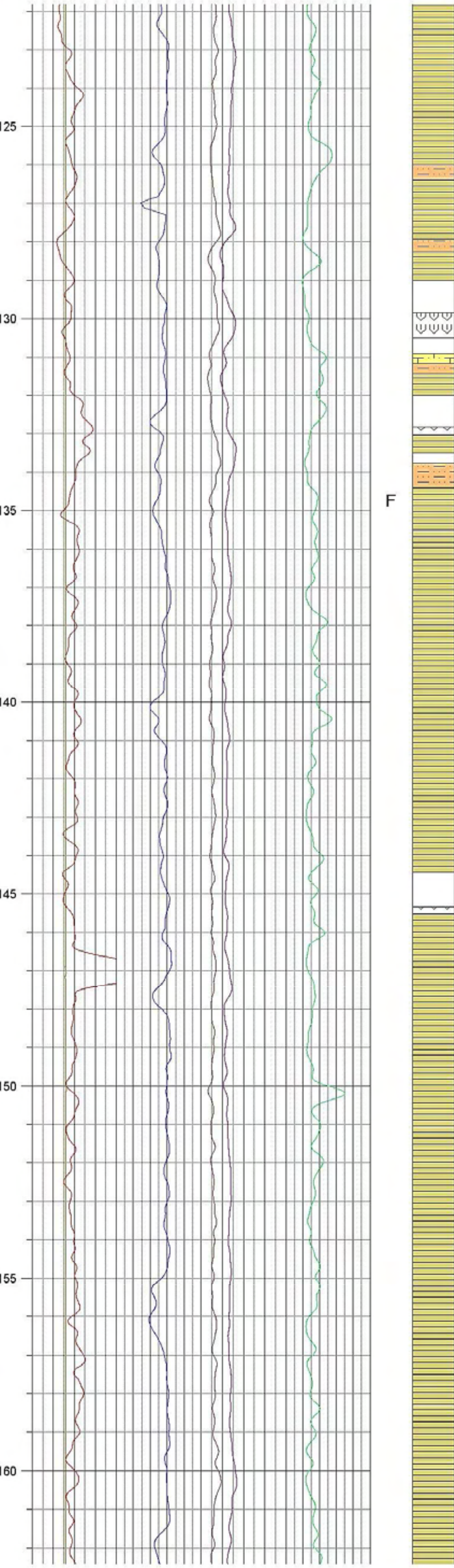
CLAY: Arcilla rojiza (10R 4/6) con nivel (3cm) limoso marrón.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos niveles (?1cm) de arcilla verde. Nivel (23cm) de arena media a fina limosa gris.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 22-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-02
RESOURCE EVALUATION PROGRAM		DRILL RIG: UDR 200	END DATE: 08-12-2010	E: 3423998 / N: 7410903	Page 4 of 5
		METHOD: CORE BARREL	DEPTH: 199,70m	Elevn: 3938,727	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAYEY SAND: Arena fina limo-arcillosa marrón. Abudnante presencia de fluido de inyacción.

CLAY: Arcilla rojiza (10R 4/6).

CLAYEY SAND: Arena fina limo-arcillosa gris (N4).

CLAY: Mix de arcilla marrón-oscura (5YR 3/4) a ligeramnete rojiza y arcilla gris-verdosa oscura (5Y 3/2) con abundantes papas (2 a 3cm) de ulexita. Nivel (3cm) con abundantes agregados cristalinos cónicos maclados. Algunos ejemplares aciculares y fuerte reaccion al HCl (ARAGONITO?).

NO RECUPERADO.

ULEXITE: Nivel de ulexita(?) con abundante material limo-arcilloso rojizo intersticial. En sectores masivo y muy compacto.

NO RECUPERADO.

SILTY SAND: Arena fina limosa gris (N4) con finas papas de ulexita (?2cm).

CLAYEY SAND: Arena muy fina limo-arcillosa marrón a gris-verdosa oscura.

CLAY: Arcilla marrón-oscura a gris-verdosa (5YR 3/2).

NO RECUPERADO.

ULEXITE: Nivel de ulexita.

CLAY: Arcilla verde (10GY 5/2) con papas (hasta 5cm) de ulexita.

NO RECUPERADO.

CLAYEY SAND: Arena gruesa a muy gruesa con abundantes clastos blanquecinos carbonáticos y escasa arcilla verde de distribución irregular. Arena gruesa arcillosa?.

CLAY: Arcilla verde (10GY 5/2). Con nivel (19cm) de arena muy fina limosa gris.

CLAY: Arcilla rojiza (10R 4/6) con muy escasas y aisladas papas (?1cm) de ulexita. Dos niveles (3 y 5cm) de arena gruesa arcillosa cementada con carbonatos.

NO RECUPERADO.

ULEXITE: Nivel de ulexita con inclusiones de arcilla marrón-rojiza.

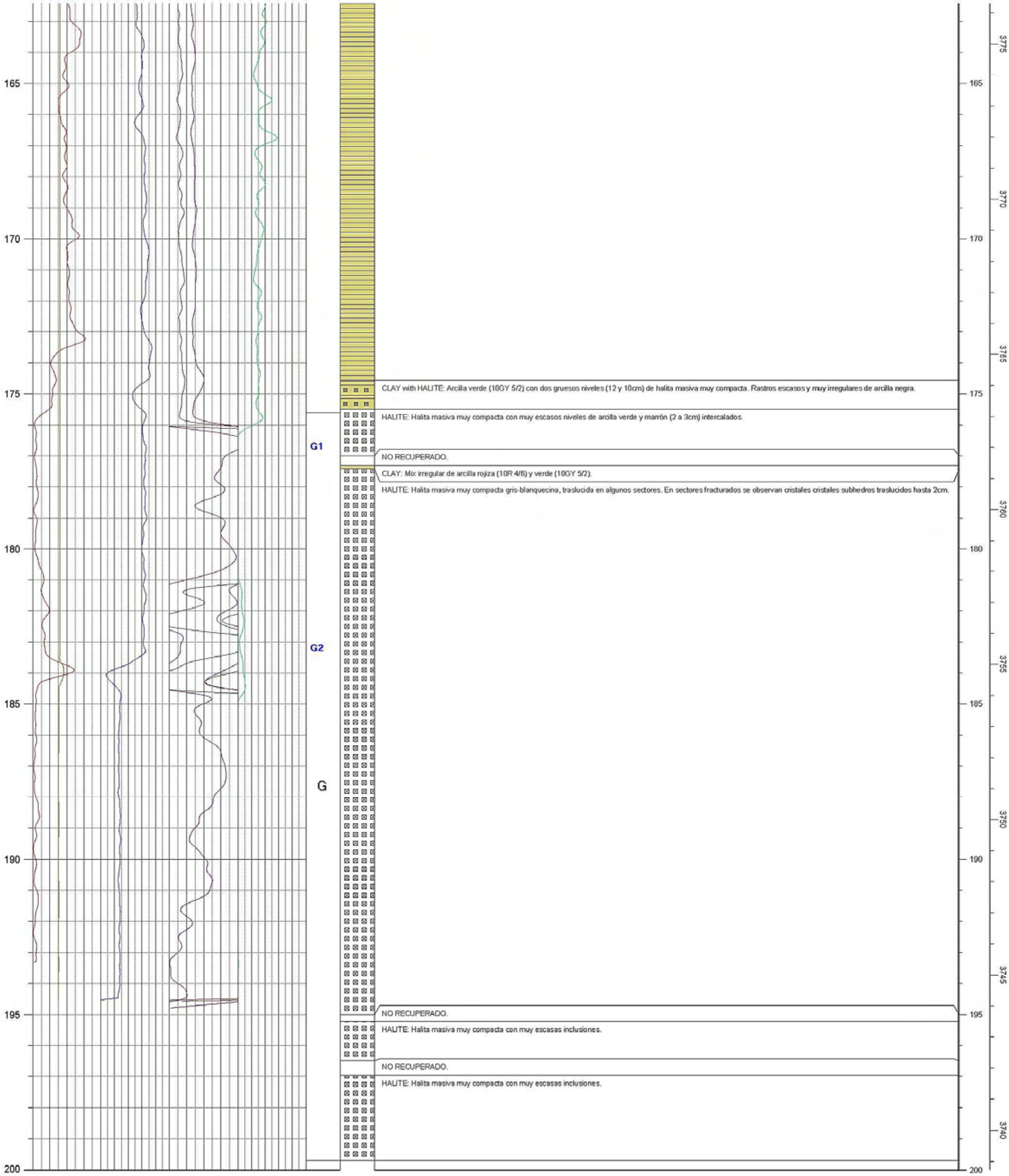
CLAY: Arcilla rojiza (10R 4/6) intercala con niveles (10 y 30cm) de arcilla verde (10GY 5/2). Escasas y aisladas papas (?1cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con niveles intercalados (3 a 7cm) de arcilla verde (10GY 5/2) y nivel (2cm) con cristales de selenita. Nivel (2cm) en tope con cristales euhedros traslucidos de halita.

Depth (m)	Elevn. (m)
125	3815
130	3810
135	3805
140	3800
145	3795
150	3790
155	3785
160	3780

OROCOBRE — RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 22-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-02
		DRILL RIG: UDR 200	END DATE: 08-12-2010	E: 3423998	Page 5 of 5
		METHOD: CORE BARREL	DEPTH: 199,70m	N: 7410903	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 3938,727	

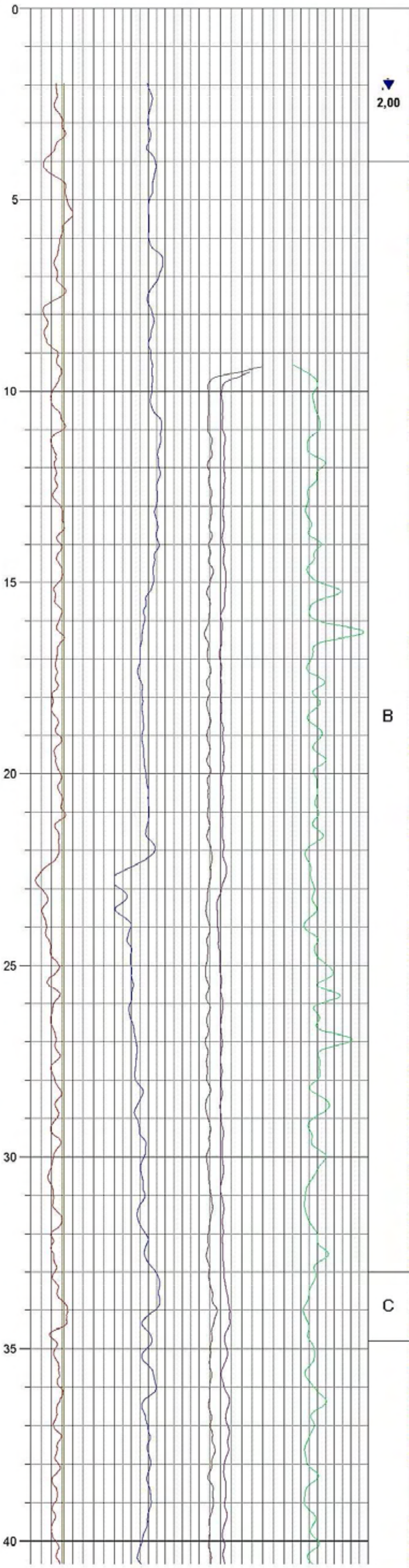
Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology
CLAY with HALITE: Arcilla verde (10GY 5/2) con dos gruesos niveles (12 y 10cm) de halita masiva muy compacta. Rastros escasos y muy irregulares de arcilla negra.
HALITE: Halita masiva muy compacta con muy escasos niveles de arcilla verde y marrón (2 a 3cm) intercalados.
NO RECUPERADO.
CLAY: Mix irregular de arcilla rojiza (10R 4/6) y verde (10GY 5/2).
HALITE: Halita masiva muy compacta gris-blanquecina, traslucida en algunos sectores. En sectores fracturados se observan cristales cristales subhedros traslucidos hasta 2cm.
NO RECUPERADO.
HALITE: Halita masiva muy compacta con muy escasas inclusiones.
NO RECUPERADO.
HALITE: Halita masiva muy compacta con muy escasas inclusiones.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY/MAJOR	START DATE: 02-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC/DIAMOND	END DATE: 21-11-2010	E: 3428000	**CD-03**
		METHOD: SONIC/DIAMOND	DEPTH: 199,50m	N: 7408000	Page 1 of 5
				Elevn: 3938,940	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology:

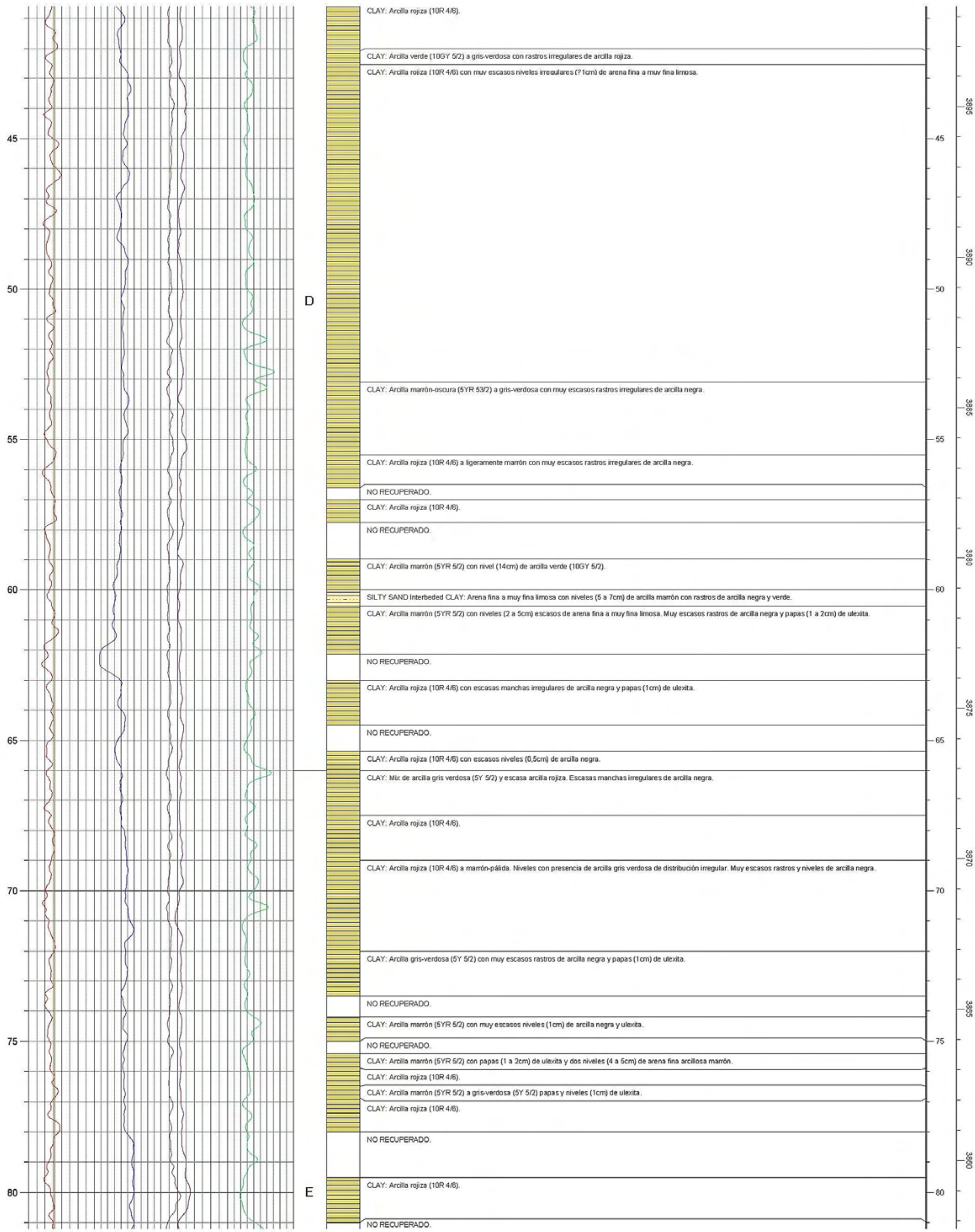
- HALITE: Halita masiva con escasas inclusiones de material clástico (limo-arcilloso marrón). Cristales subhedros traslucidos a blanco-lechoso en tope (?5mm). Alta porosidad.
- NO RECUPERADO.
- CLAY: Arcilla marrón-pálida (10YR 6/2) con abundantes cristales (2 a 10mm) de selenita.
- NO RECUPERADO.
- CLAY with HALITE: Arcilla marrón-pálida (10YR 6/2) con abundantes microcristales de halita y muy escasos rastros de arcilla negra.
- HALITE: Halita masiva con inclusiones de material clástico marrón y gris-verdoso.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 4/4).
- NO RECUPERADO.
- SANDY CLAY: Arcilla-arenosa marrón-oscura (10YR 4/2) con niveles y papas (2 a 3cm) de ulexita.
- CLAY: Arcilla marrón-oscura (10YR 4/2) intercala con niveles (5mm) de arcilla negra y niveles y papas (1 a 2cm) de ulexita.
- NO RECUPERADO.
- HALITE: Halita masiva con inclusiones de material clástico marrón y gris-oscuro. Papa (1cm) de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con dos niveles de arcilla verde (10GY 5/2). Muy escasas y finas manchas de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6).
- CLAY with HALITE: Arcilla gris-verdosa (5Y 5/2) con nivel (1cm) de ulexita y abundantes microcristales de halita en el tope.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) con papas (1 a 3cm) de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) mix con arcilla gris-verdosa (5Y 5/2). Papas (1 a 2cm) de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla verde (10GY 5/2).
- BLACK CLAY: Arcilla negra con dos niveles (2 y 1cm) de arcilla marrón en tope.
- NO RECUPERADO.
- BLACK CLAY: Arcilla negra, hacia la base intercala con finos niveles (0,5 a 1cm) de arcilla marrón.
- CLAY: Arcilla marrón (5YR 4/4) con muy escasos niveles (1cm) de arcilla negra.
- NO RECUPERADO.
- BLACK CLAY: Arcilla negra con muy escasos rastros de arcilla marrón.
- NO RECUPERADO.
- CLAY: Arcilla marrón-pálida (10YR 6/2) escasos rastros de arcilla negra y verde.
- NO RECUPERADO.
- CLAY Interbeded ORGANICS: Arcilla marrón (5YR 5/2) con niveles intercalados de contacto irregular (3 a 5cm) de arcilla negra y escasos de arcilla verde (10GY 5/2).
- CLAY: Arcilla marrón (5YR 5/2) con niveles deformados escasos de arcilla verde y gris-verdosa. Nivel (15cm) de arcilla negra y escasos rastros aislados.
- CLAY: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra.
- BLACK CLAY: Arcilla negra.
- CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasas manchas irregulares de arcilla negra y nivel (2cm) de arena muy fina limosa.
- CLAY: Arcilla marrón-pálida (10YR 6/2) con escasos rastros irregulares de arcilla negra.
- CLAY: Arcilla verde (10GY 5/2) muy escasas y finas manchas irregulares de arcilla negra.
- CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasos rastros irregulares de arcilla gris-verdosa.
- BLACK CLAY: Arcilla negra con finos niveles lenticulares (?5mm) de arena muy fina marrón y gris verdosa. Presencia de FeOx.
- CLAY: Arcilla gris-verdosa (5Y 5/2) con rastros irregulares de arcilla negra.
- CLAY: Arcilla marrón (5YR 5/2) a rojiza con escasos niveles en la base (?1cm) de arena muy fina limosa.
- CLAY Interbeded ORGANICS: Arcilla gris-verdosa con rastros irregulares de arcilla marrón y negra. Nivel (20cm) de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla gris-verdosa oscura (5Y 3/2) con escasos niveles (1 a 2cm) de arena fina muy fina gris y arena muy fina limo arcillosa.
- CLAY Interbeded SAND: Arcilla marrón (5YR 5/2) con niveles deformados de arena fina arcillosa.
- NO RECUPERADO.
- CLAY: Arcilla marrón-oscura (5YR 3/2) con escasos y muy finos niveles (?0,5cm) de arena muy fina limosa y escasos rastros de arcilla negra.
- CLAY Interbeded SAND: Arcilla gris-verdosa oscura (5Y 3/2) con muy escasos rastros de arcilla negra. Intercalan dos niveles (6 y 8cm) de arena fina a muy fina limosa gris (N4).
- CLAY Interbeded SAND: Arcilla marrón (5YR 5/2) a ligeramente rojiza con finos niveles intercalados (?0,5 a 1cm) de arena muy fina limosa gris.
- NO RECUPERADO.
- CLAY with HALITE: Arcilla gris-verdosa oscura (5Y 3/2) con nivel (3cm) con abundantes microcristales de halita y arena fina a muy fina.
- CLAY: Arcilla marrón (5YR 5/2) con rastros irregulares de arcilla gris-verdosa y finos niveles (2 a 3cm) lenticulares? De arena fina a muy fina.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) con manchas y niveles irregulares de arcilla negra y rastros de arcilla verde.

Depth (m): 0, 5, 10, 15, 20, 25, 30, 35, 40

Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910, 3905, 3900

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY/MAJOR	START DATE: 02-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: **CD-03**
	DRILL RIG: SONIC/DIAMOND	END DATE: 21-11-2010	E: 3428000	
	METHOD: SONIC/DIAMOND	DEPTH: 199,50m	N: 7408000	LOGED BY: Geol. FERNANDO A. MARTÍN
			Elevn: 3938,940	

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla verde (10GY 5/2) a gris-verdosa con rastros irregulares de arcilla rojiza.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos niveles irregulares (?1cm) de arena fina a muy fina limosa.

CLAY: Arcilla marrón-oscura (5YR 53/2) a gris-verdosa con muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) a ligeramente marrón con muy escasos rastros irregulares de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6).

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con nivel (14cm) de arcilla verde (10GY 5/2).

SILTY SAND Interbeded CLAY: Arena fina a muy fina limosa con niveles (5 a 7cm) de arcilla marrón con rastros de arcilla negra y verde.

CLAY: Arcilla marrón (5YR 5/2) con niveles (2 a 5cm) escasos de arena fina a muy fina limosa. Muy escasos rastros de arcilla negra y papas (1 a 2cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con escasas manchas irregulares de arcilla negra y papas (1cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con escasos niveles (0,5cm) de arcilla negra.

CLAY: Mix de arcilla gris verdosa (5Y 5/2) y escasa arcilla rojiza. Escasas manchas irregulares de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla rojiza (10R 4/6) a marrón-pálida. Niveles con presencia de arcilla gris verdosa de distribución irregular. Muy escasos rastros y niveles de arcilla negra.

CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasos rastros de arcilla negra y papas (1cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos niveles (1cm) de arcilla negra y ulexita.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con papas (1 a 2cm) de ulexita y dos niveles (4 a 5cm) de arena fina arcillosa marrón.

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla marrón (5YR 5/2) a gris-verdosa (5Y 5/2) papas y niveles (1cm) de ulexita.

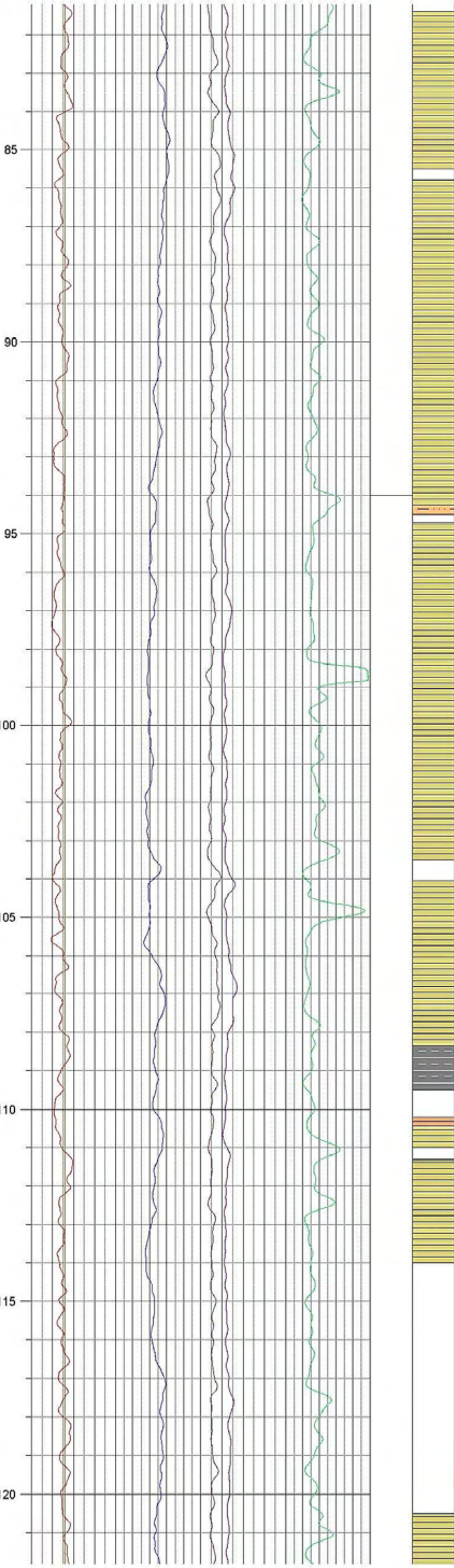
CLAY: Arcilla rojiza (10R 4/6).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6).

NO RECUPERADO.

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla marrón (5YR 5/2) con muy escasas manchas irregulares de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla marrón-oscura (5YR 3/4) a ligeramente gris-verdosa con manchas escasas y aisladas de arcilla negra. Muy escasas papas (1 a 2cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con muy escasas y finas manchas irregulares de arcilla negra. Muy escasos niveles lenticulares de arena fina a muy fina limosa (1cm).

CLAY: Arcilla verde (10GY 5/2) a gris-verdosa con papa (1cm) de ulexita y muy escasos rastros de arcilla negra y rojiza.

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasas papas (1 a 2cm) de ulexita y nivel (4cm) de arcilla arenosa fina a muy fina.

CLAYEY SAND: Arena fina a muy fina limo-arcillosa gris (N4) con papas (2 a 3cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla rojiza-pálida (10R 5/4) a ligeramente marrón. Escasas manchas irregulares de arcilla negra y niveles que gradan a colores gris-verdosos.

CLAY: Arcilla gris-verdosa (5Y 5/2) a marrón (5YR 5/2) con escasas manchas irregulares de arcilla negra.

CLAY: Arcilla marrón-oscura (5YR 3/4) a gris-verdosa oscura con papas (2 a 4cm) y niveles (1cm) de ulexita. Muy escasas manchas aisladas de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) con niveles (1 a 2cm) y manchas aisladas de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros aislados de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con rastros escasos y niveles (1cm) de arcilla negra.

CLAY Interbeded ORGANICS: Arcilla rojiza (10R 4/6) intercala con niveles (1 a 4cm) de arcilla negra.

NO RECUPERADO.

CLAY Interbeded SAND: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra y nivel basal (6cm) de arena media a fina gris (N4) con escaso limo.

CLAY: Arcilla rojiza (10R 4/6) a marrón con niveles (1 a 2cm) de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con nivel (32cm) gris verdoso (5Y 5/2) intercalan escasos niveles (2 a 4cm) de arena fina a muy fina limosa y escasos niveles (2cm) de arcilla negra. Muy escasas papas (1 a 2cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla rojiza-pálida (10R 5/4).

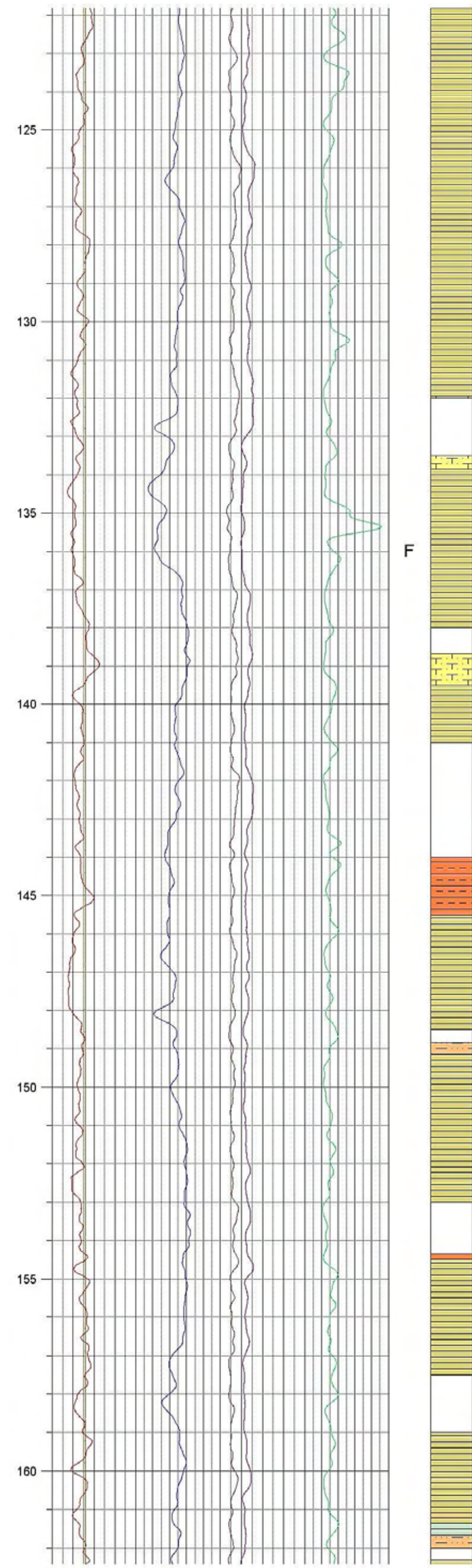
CLAY: Arcilla rojiza (10R 4/6) en escasos sectores ligeramente marrón, con muy escasos rastros irregulares de arcilla negra y escasas manchas anaranjadas

OROCOBRE — OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR: BLY/MAJOR	START DATE: 02-11-2010	COORDINATES (POSGAR 94 Zone 3) E: 3428000	WELL REFERENCE: **CD-03**
DRILL RIG: SONIC/DIAMOND	END DATE: 21-11-2010	N: 7408000	
METHOD: SONIC/DIAMOND	DEPTH: 199,50m	Elevn: 3938,940	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



(rejalgar/oropimente?).

SILTY SAND: Arena muy fina limosa con muy baja proporción de arcilla.

NO RECUPERADO.

SILTY SAND: Arena fina a muy fina limosa gris (N4) con escasa proporción de arcilla. Escasas papas (1cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con niveles y papas (1cm) de ulexita. Muy escasos rastros de arcilla negra y niveles lenticulares (1cm?) de arena fina a muy fina.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros aislados de arcilla negra.

NO RECUPERADO.

SILTY SAND: Arena fina a media limosa gris (N4). Muy escasa presencia de arcilla marrón de distribucón irregular y papas (1cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) a gris-verdosa en el tope. Papas (2 a 3cm) de ulexita y muy escasos rastros irregulares de arcilla negra.

NO RECUPERADO.

SILTY CLAY: Arcilla gris-verdosa (5Y 5/2) limosa con muy escasas papas (1 a 2cm) de ulexita y rastros irregulares de arcilla negra.

SILTY CLAY: Arcilla limosa marrón (5YR 5/2) con escasas y finas papas de ulexita y muy escasos niveles (?1cm) de arena muy fina limosa gris (N4).

CLAY: Arcilla verde (10GY 5/2) hacia la base grada a gris-verdosa y marrón transicional con el nivel inferior. Nivel irregular (2cm) de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) escasos rastros irregulares de arcilla gris-verdosa y negra. Hacia la base (20cm) intercala con niveles deformados (?1cm) de arena fina limo arcillosa.

CLAY: Arcilla verde (10GY 5/2) con nivel (9cm) de arcilla marrón-pálida. Muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) muy escasas manchas de arcilla negra y niveles (1 a 3cm) de arena fina limo-arcillosa. Papa (4cm) de ulexita.

NO RECUPERADO.

CLAYEY SAND: Arena fina a muy fina arcillosa marrón con papas (1 a 2cm) de ulexita y muy escasos rastros de arcilla negra.

CLAY: Arcilla marrón (5YR 4/4) con niveles aislados (?10cm) de arcilla gris-verdosa (5Y 5/2) y niveles escasos irregulares de (2 a 10mm) de arcilla negra. Muy escasas papas (?0,5cm) de ulexita.

NO RECUPERADO.

SANDY CLAY: Arcilla arenosa marrón (5YR 5/4) con abundantes papas (2 a 4cm) de ulexita.

CLAY: Intercalan arcilla marrón-pálida (10YR 6/2) y arcilla verde (10GY 5/2) a gris-verdosa. Muy escasos e irregulares niveles (1 a 3cm) de arcilla negra.

CLAY: Arcilla marrón (5YR 4/4) con escasos niveles (1cm) de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) muy escasas y muy finas manchas de arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropimente?). Nivel (0,5cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con escasos y finos niveles irregulares de arcilla negra.

CLAYEY SAND: Arena fina arcillosa gris con niveles (2 a 3cm) de ulexita.

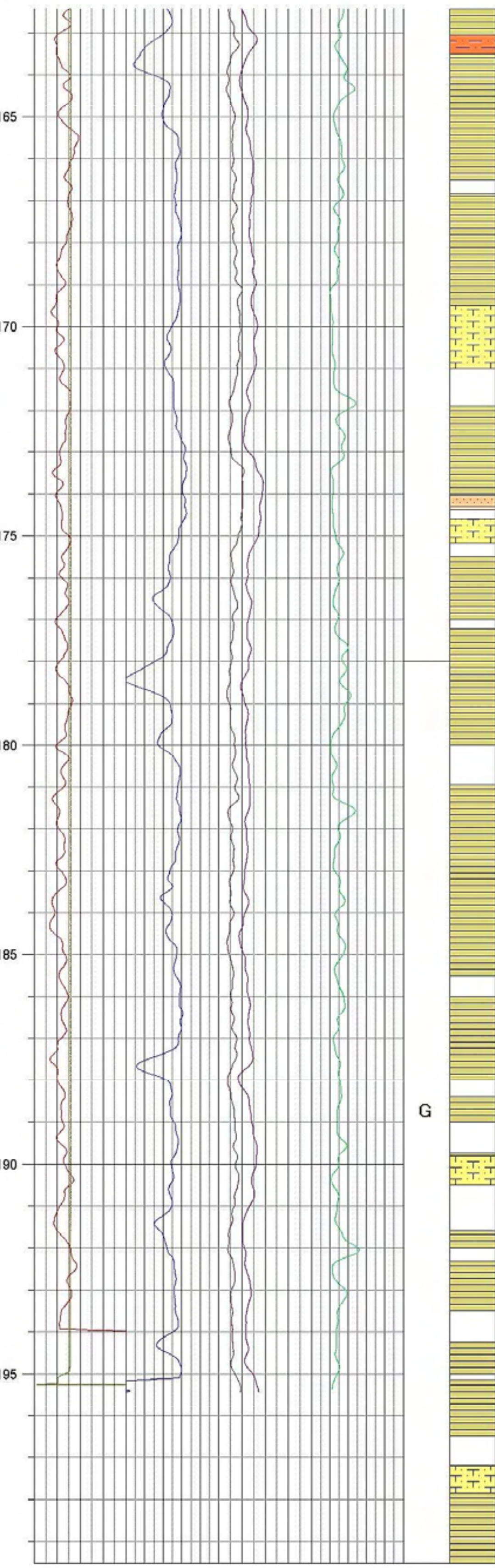
CLAY: Arcilla marrón-pálida (10YR 6/2) con manchas anaranjadas (FeOx?).

CLAY cemented CARBONATE: Nivel de arcilla marrón fuertemente cementado con carbonatos y papas (1 a 2cm) de ulexita. Nivel intercalado (6cm) de arena muy fina limo-

Depth (m)	Elevn. (m)
125	3815
130	3810
135	3805
140	3800
145	3795
150	3790
155	3785
160	3780

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY/MAJOR	START DATE: 02-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC/DIAMOND	END DATE: 21-11-2010	E: 3428000	**CD-03**
		METHOD: SONIC/DIAMOND	DEPTH: 199,50m	N: 7408000	
				Elevn: 3938,940	LOGED BY: Geol. FERNANDO A. MARTÍN

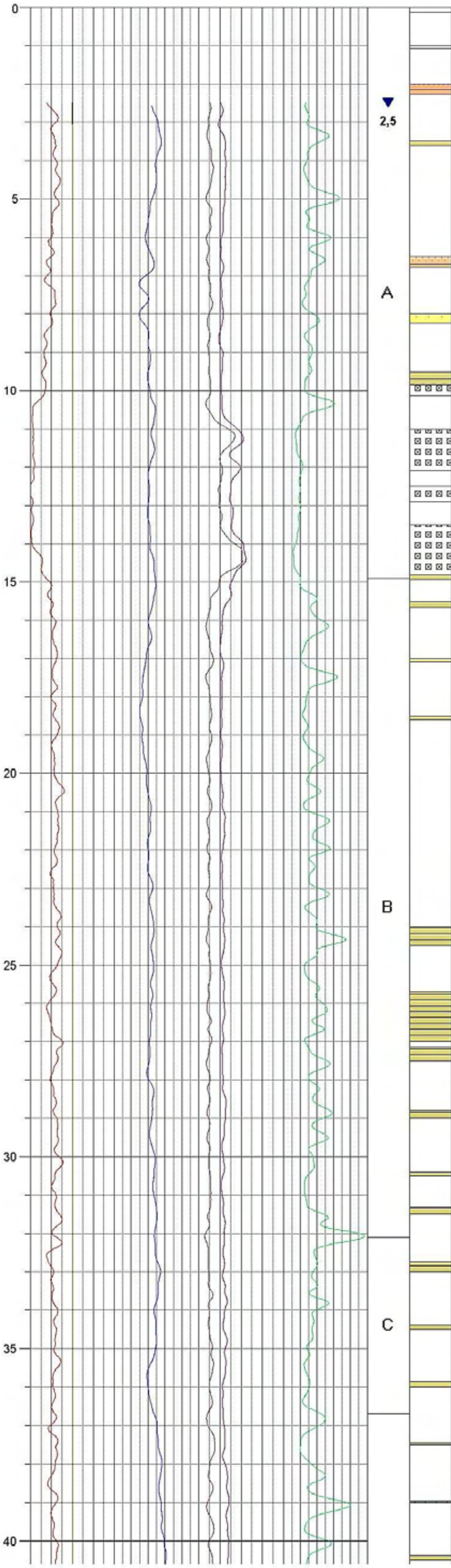
Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



- arcillosa gris (N4).
- CLAYEY SAND: Arena fina a muy fina limo-arcillosa marrón (5YR 5/2) con muy escasas papas (1cm) de ulexita y rastros de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente gris-verdosa (5Y 5/2). Muy escasas papas (0,5 a 1cm) de ulexita.
- CLAY: Arcilla marrón (5YR 4/4) a ligeramente rojiza con muy escasas papas (0,5 a 1cm) de ulexita.
- SANDY CLAY: Arcilla arenosa (arena fina a muy fina) gris-oscura (N3).
- CLAY: Arcilla gris-verdosa (5Y 5/2). Muy escasos rastros de arcilla negra. Nivel (30cm) de arcilla marrón (5YR 5/2) con nivel (1cm) de ulexita. Dos niveles (5 y 3cm) de arcilla arenosa y arcilla limo-arenosa gris y gris-oscura respectivamente.
- CLAY: Arcilla rojiza (10R 4/6) a marrón con niveles escasos (0,5 a 2cm) de arcilla negra y escasas papas y niveles (1 a 2cm) de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) intercala en niveles regulares (50cm) con arcilla gris-verdosa (5Y 5/2) con muy escasos rastros de arcilla negra.
- CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros irregulares de arcilla negra y papas (1cm) de ulexita.
- SILTY SAND: Arena fina a muy fina limosa gris (N5). Escasas papas (1 a 2 cm) de ulexita y dos niveles (3 y 2cm) de arcilla marrón.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) con nivel (16cm) de ulexita intercalada con arena fina y arcilla rojiza (fuerte deformación).
- SAND Interbeded CLAY: Intercalan arena media a fina gris (N4) con niveles (3 a 5cm) de arcilla rojiza (10R 4/6). Papa (3cm) en arena de ulexita.
- NO RECUPERADO.
- SILTY SAND: Arena fina a muy fina limosa gris (N4).
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2).
- NO RECUPERADO.
- CLAY: Arcilla gris-verdosa oscura (5Y 3/2) con papa (4cm) de ulexita.
- CLAY: Arcilla marrón (5YR 4/4) con escasos niveles (0,5 a 1cm) de arcilla negra.
- CLAY: Arcilla marrón-oscura con abundantes papas (1 a 2cm) de ulexita.
- CLAY: Arcilla marrón (5YR 4/4) con papas (1 a 3cm) de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) con aisladas papas (1 a 3cm) de ulexita.
- CLAY: Arcilla gris-verdosa (5Y 5/2) muy escasos rastros de arcilla negra y papa (3cm) de ulexita.
- CLAY: Arcilla marrón (5YR 5/2) con niveles lenticulares? (?0,5cm) de arena arcillosa y muy escasas papas de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla marrón-pálida (10YR 6/2) a ligeramente gris-verdosa (5Y 5/2).
- CLAY: Arcilla rojiza (10R 4/6) con abundantes papas (1 a 3cm) y nivel (7cm) de ulexita.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) con nivel (1cm) de arena muy fina limosa gris.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6).
- SILTY SAND: Arena fina a muy fina limosa gris-clara (N6).
- NO RECUPERADO.
- CLAY: Arcilla gris verdosa (5Y 5/2) con muy escasos y finos niveles (?0,5cm) deformados de arena fina a muy fina limosa gris-clara (N6).
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasos y finos rastros de arcilla negra y ulexita.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasos rastros de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con muy escasos y finos rastros de arcilla negra y ulexita.
- NO RECUPERADO.
- SILTY SAND: Arena fina a muy fina limosa gris (N4) con escasa proporción de arcilla.
- CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasos rastros de arcilla negra y ulexita.
- CLAY: Arcilla marrón (5YR 5/2) con muy escasos e irregulares rastros de arcilla negra. Finas y aisladas papas (?1cm) de ulexita y nivel central (7cm) de arcilla gris-verdosa oscura (5Y 3/2). Hacia el tope (25cm) de color rojizo (10R 4/6)

OROCOBRE — RESOURCE EVALUATION PROGRAM	OLAROZ PROJECT			COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-04
		CONTRACTOR: MAJOR	START DATE: 28-11-2010	E: 3424000	Page 1 of 5
		DRILL RIG: DIAMON BIT	END DATE: 18-12-2010	N: 7404000	
		METHOD: DIAMON BIT	DEPTH: 200m	Elevn: 3939,199	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)

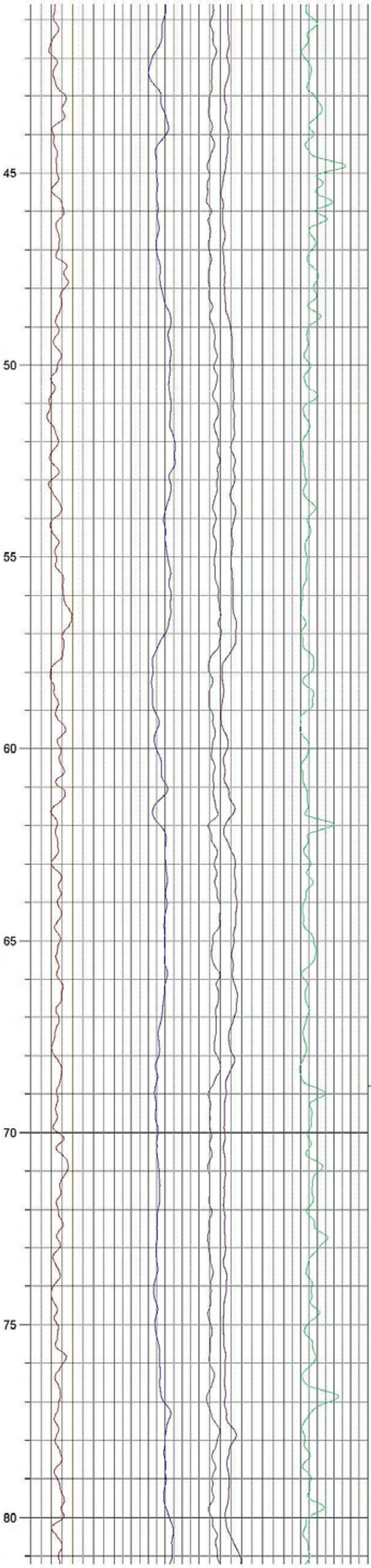


- HALITE: Halita masiva porosa blanquecina con finos niveles (?1cm) con inclusiones de material clástico.
- NO RECUPERADO
- HALITE: Halita masiva blanquecina porosa con niveles finos con inclusiones de material clástico.
- NO RECUPERADO
- CLAY Interbeded SAND: Arcilla marrón-pálida (10YR 6/2) con niveles (?1cm) deformados de arena fina a muy fina limosa. Y nivel en tope (4cm) de halita masiva muy compacta.
- NO RECUPERADO
- CLAY: Arcilla marrón-pálida.
- NO RECUPERADO
- SAND Interbeded CLAY: Intercalan arena fina a muy fina limosa gris con niveles (5 a 6cm) de arcilla marrón (5YR 4/4).
- NO RECUPERADO
- SAND: Arena fina a muy fina gris (N5) ligeramente arcillosa.
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6).
- HALITE: Halita masiva muy compacta con muy escasos rastros de ulexita.
- NO RECUPERADO
- HALITE: Halita masiva muy compacta blanquecina a traslucida con papas (3 a 4cm) de ulexita.
- NO RECUPERADO
- HALITE: Halita masiva, muy compacta gris-blanquecina con escasas papas (1 a 2cm) de ulexita.
- NO RECUPERADO
- HALITE: Halita masiva, muy compacta gris-blanquecina con muy escasas papas (?1cm) de ulexita.
- CLAY: Arcilla rojiza (10R 4/6).
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6) con nivel (5mm) de arena muy fina limo-arcillosa gris.
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6).
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6).
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2).
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2) intercala con niveles de arcilla rojiza (10R 4/6).
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6) con nivel (5cm) de arcilla verde (10GY 5/2) y muy escasos rastros irregulares de arcilla negra.
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2) a gris-verdosa con rastros de arcilla negra y niveles de formados (?2mm) de arena muy fina gris.
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2) con escasos rastros de arcilla negra.
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2) con escasos rastros irregulares de arcilla marrón.
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6) con escasos rastros de arcilla verde (10GY 5/2).
- NO RECUPERADO
- CLAY: Arcilla rojiza (10R 4/6).
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2).
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2).
- NO RECUPERADO
- CLAY: Arcilla marrón (5YR 4/4).
- CALCITE: Nivel carbonático masivo.
- NO RECUPERADO
- CLAY: Arcilla verde (10GY 5/2).

Depth (m)	Elevn. (m)
0	
5	3935
10	3930
15	3925
20	3920
25	3915
30	3910
35	3905
40	3900

ORDCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 28-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:	CD-04
		DRILL RIG: DIAMON BIT	END DATE: 18-12-2010	E: 3424000		Page 2 of 5
RESOURCE EVALUATION PROGRAM		METHOD: DIAMON BIT	DEPTH: 200m	N: 7404000		
				Elevn: 3939,199	LOGED BY:	Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Units: D

NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) con nivel (21cm) y escasas manchas irregulares de arcilla negra.

NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) con escasos rastros de arcilla negra. Hacia la base arcilla arenosa con escasa presencia de arena fina.

NO RECUPERADO

CLAY: Arcilla verde (10GY 5/2) con nivel (?5mm) de arcilla marrón. Muy escasos rastros de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles irregulares de arcilla verde y muy escasas manchas irregulares de arcilla negra.

NO RECUPERADO

CLAY: Arcilla marrón (5YR 4/4) intercala con arcilla verde (!0GY 5/2). Escasos rastros de arcilla negra.

NO RECUPERADO

SAND: Arena fina a muy fina gris (N4) con escaso limo.

CLAY Interbeded SAND: Arcilla verde (10GY 5/2) intercalan niveles (2 a 5cm) de arena fina a muy fina limosa gris (N4).

SAND: Arena media a fina gris (N5) con escaso limo intercala con niveles (1 a 3cm) aislados de arcilla marrón (10YR 4/2).

CLAYEY SAND: Arena media a fina gris con escaso limo a ligeramente arcillosa marrón. Intercala con niveles de arcilla rojiza (10R 4/6) a ligeramente marrón (0,5 a 5cm).

CLAY: Arcilla rojiza (10R 4/6) muy escasos rastros de arcilla gris-verdosa.

SAND: Arena media a fin a gris (N4) con escaso limo y niveles (1 a 2 cm) de arcilla marrón.

NO RECUPERADO

CLAY: Arcilla marrón-oscura (10YR 4/2) a gris-verdosa (5Y 5/2) con manchas irregulares de arcilla negra.

CLAY: Mix de contacto muy irregular entre arcilla marrón (10YR 5/2) y verde (10GY 5/2).

CLAY: Arcilla gris-verdosa (5Y 5/2) con manchas irregulares de arcilla negra y escasos niveles muy deformados de arena fina limosa y arena fina arcillosa negra a gris-verdosa.

SAND: Arena media a fina gris (N4).

CLAY Interbeded SAND: Arcilla gris-verdosa (5Y 5/2) a ligeramente marrón. Intercalan abundantes niveles lenticulares? Deformados (1 a 2cm) de arena fina gris a negra. Muy escasos rastros aislados de arcilla negra.

SAND: Arena media a fina gris (N4) muy escasas manchas, en tope, anaranjadas (feOx?).

CLAY: Arcilla rojiza-pálida (5R 6/2) con muy escasos y finos niveles (?0,5cm) de arcilla negra.

SAND: Arena media a fina gris (N4) a gris-oscura (N3) hacia la base, últimos 6cm, ligeramente arcillosa, transicional con el nivel inferior.

CLAY: Arcilla marrón (5YR 5/2).

CLAY: Arcilla marrón-oscura (10YR 4/2) muy escasos niveles deformados de arcilla negra y arena fina.

SAND: Arena media a fina gris (N4) con escaso limo.

CLAY: Arcilla marrón (5YR 5/2) niveles muy deformados y escasas manchas aisladas (1 a 2cm) de arcilla negra. Muy escasas y finas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

CLAY: Arcilla rojiza (10R 4/6) con finos (?0,5cm) y escasos niveles de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) intercala con niveles (5 a 15cm) de arcilla gris verdosa (5Y 5/2) y niveles escasos (?0,5cm) de arcilla negra.

NO RECUPERADO

CLAY: Arcilla gris-verdosa (5Y 5/2) intercala con niveles (5 a 10cm) de arcilla marrón y niveles (?1cm) de contacto irregular con arcilla negra.

NO RECUPERADO

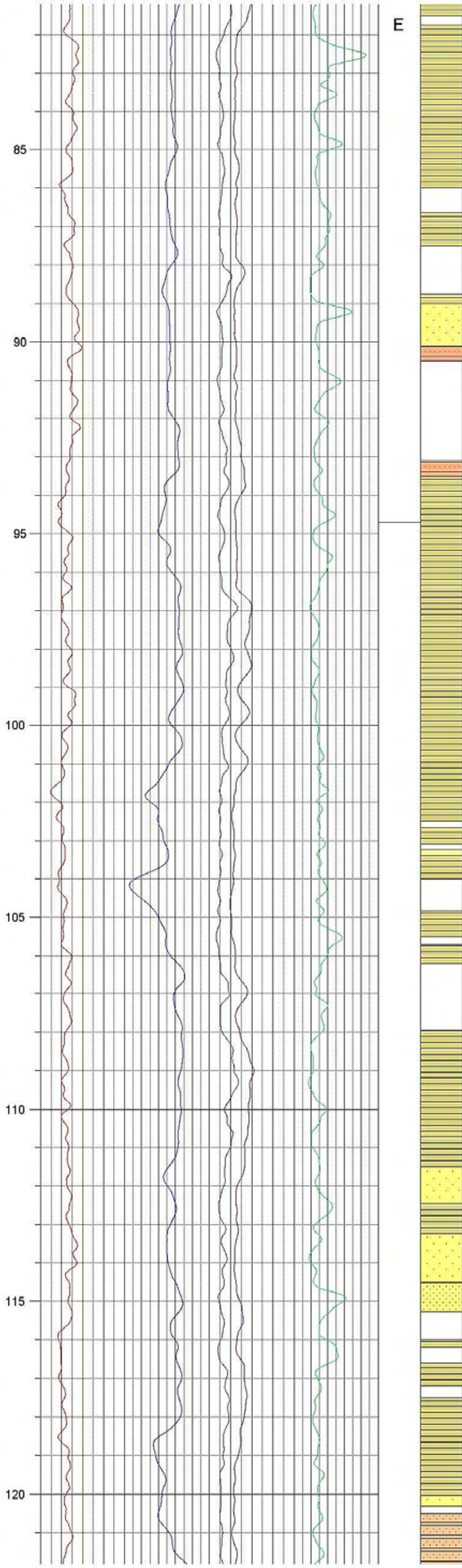
CLAY: Arcilla marrón (5YR 5/2) escasas y aisladas manchas de arcilla negra. Muy escasos rastros irregulares de acrilla gris-verdosa.

NO RECUPERADO

CLAY: Arcilla marrón (5YR 5/2) a marrón-oscura (10YR 4/2) con niveles (?5cm) de arcilla gris-verdosa (5Y 5/2). Muy escasos rastros de arcilla negra.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 28-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: **CD-04**
RESOURCE EVALUATION PROGRAM		DRILL RIG: DIAMON BIT	END DATE: 18-12-2010	E: 3424000	Page 3 of 5
		METHOD: DIAMON BIT	DEPTH: 200m	N: 7404000	
				Elevn: 3939,199	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) con niveles aislados (?1cm) y manchas irregulares de arcilla negra.

NO RECUPERADO

CLAY: Arcilla marrón (5YR 5/2). Nivel (4cm) de arena fina limosa marrón con rastros de arcilla negra.

NO RECUPERADO

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles (2 a 4cm) de arena fina limosa con escasa presencia de arcilla gris-oscura a negra.

SAND: Arena fina a muy fina gris (N4).

CLAY Interbeded SAND: Intercalan arcilla marrón (5YR 5/2) con niveles (5 a 10cm) de arena fina a muy fina gris.

NO RECUPERADO

CLAY Interbeded SAND: Arcilla rojiza (10R 4/6) con nivel central (9cm) de arena fina a muy fina gris (N4).

CLAY: Arcilla rojiza (10YR 4/6). Escasos y finos niveles deformados (lenticulares? ?0,5cm) de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros irregulares de arcilla negra.

CLAY: Arena fina a muy fina gris (N4).

CLAY: Arcilla gris-verdosa (5Y 5/2) con niveles (2cm) deformados de arcilla negra.

NO RECUPERADO

CLAY: Arcilla gris-verdosa (5Y 5/2) con escasos rastros de arcilla negra y marrón.

NO RECUPERADO

SAND: Arena media a fina gris (N4) con lente de arena arcillosa negra (1cm).

CLAY: Arcilla marrón (5YR 5/2) con nivel (1cm) de arcilla negra.

NO RECUPERADO

CLAY: Arcilla marrón-oscura (10YR 4/2) con nivel (8cm) de arcilla gris-verdosa (5Y 5/2) y escasos rastros irregulares de arcilla negra.

NO RECUPERADO

CLAY: Arcilla marrón-oscura (10YR 6/2) con rastros irregulares de arcilla gris-verdosa (5Y 5/2) y negra.

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla marrón-pálida (10YR 6/2) con muy escasos rastros irregulares de arcilla verde y negra.

CLAY: Mix de arcilla marrón (5YR 5/2) y gris-verdosa (5Y 5/2) escasos y finos niveles (1cm) de arcilla negra y nivel (3cm) de arena media a fina gris.

SAND: Arena media a fina gris (N4).

CLAY: Arcilla rojiza con escasas manchas irregulares de arcilla negra.

CLAY: Arcilla marrón-oscura (5YR 3/4) con nivel (1cm) limoso gris.

SAND: Arena media a fina gris (N4) con escaso limo. Nivel (7cm) de arcilla marrón-pálida.

FINE SAND: Arena fina a muy fina gris (N3) con nivel (11cm) en la base, de arcilla rojiza.

NO RECUPERADO

CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasos rastros de arcilla negra.

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros de arcilla negra y nivel en tope (5cm) de arcilla gris-verdosa.

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) con escasos rastros de arcilla negra.

CLAY: Arcilla gris-verdosa (5Y 5/2) con rastros irregulares de arcilla rojiza y negra.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) con niveles intercalados (2 a 3cm) en tope de arena muy fina arcillosa.

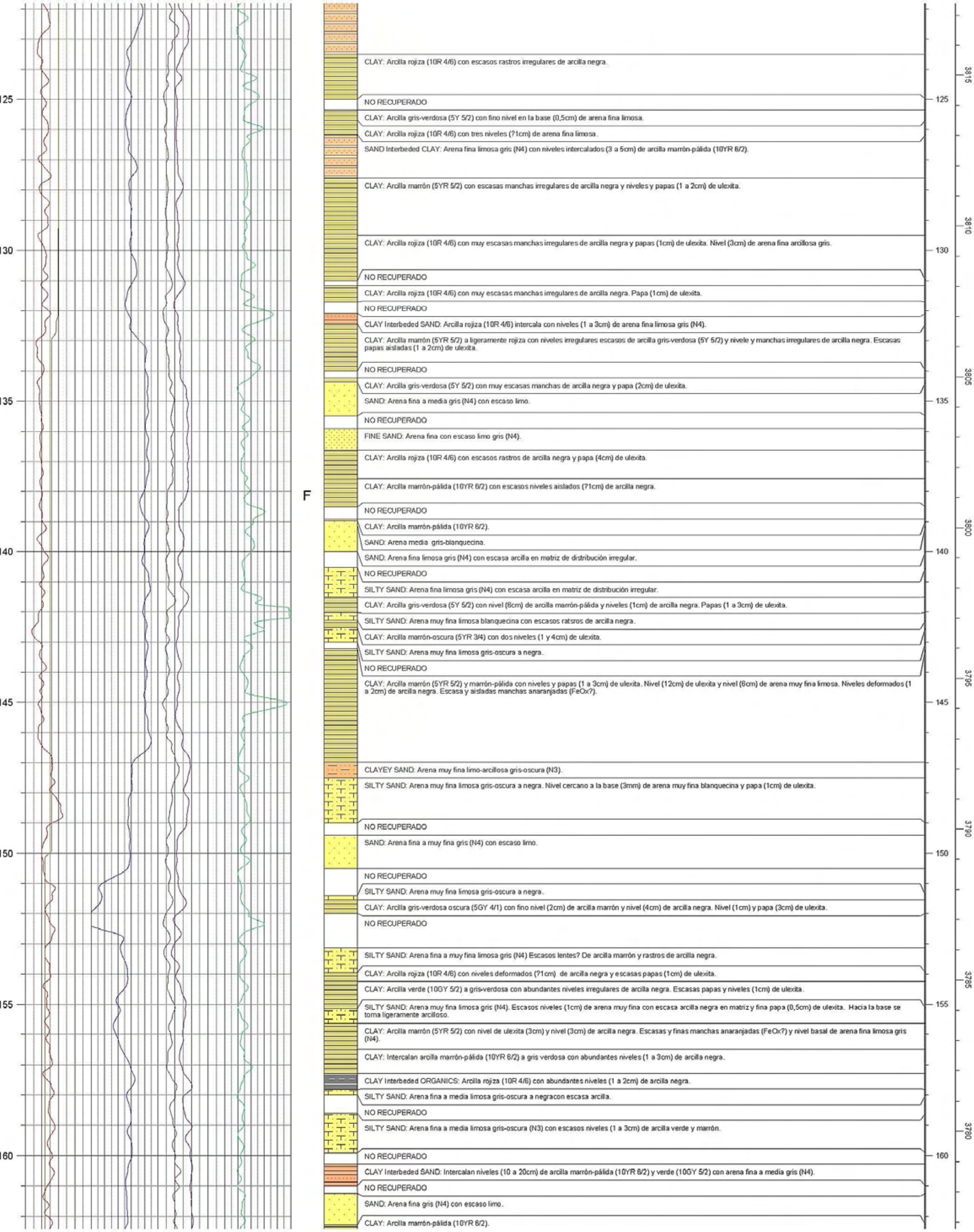
SAND: Arena media a fina gris (N4) con escaso limo.

NO RECUPERADO

SAND Interbeded CLAY: Intercalan arena fina limosa gris (N3) con arcilla marrón-pálida (10R 6/2) en niveles de 10 a 20cm.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 28-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG: DIAMON BIT	END DATE: 18-12-2010	E: 3424000	**CD-04**
		METHOD: DIAMON BIT	DEPTH: 200m	N: 7404000	Page 4 of 5
				Elevn: 3939,199	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla rojiza (10R 4/6) con escasos rastros irregulares de arcilla negra.

NO RECUPERADO

CLAY: Arcilla gris-verdosa (5Y 5/2) con fino nivel en la base (0,5cm) de arena fina limosa.

CLAY: Arcilla rojiza (10R 4/6) con tres niveles (?1cm) de arena fina limosa.

SAND Interbeded CLAY: Arena fina limosa gris (N4) con niveles intercalados (3 a 5cm) de arcilla marrón-pálida (10YR 6/2).

CLAY: Arcilla marrón (5YR 5/2) con escasas manchas irregulares de arcilla negra y niveles y papas (1 a 2cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con muy escasas manchas irregulares de arcilla negra y papas (1cm) de ulexita. Nivel (3cm) de arena fina arcillosa gris.

NO RECUPERADO

CLAY: Arcilla rojiza (10R 4/6) con muy escasas manchas irregulares de arcilla negra. Papa (1cm) de ulexita.

NO RECUPERADO

CLAY Interbeded SAND: Arcilla rojiza (10R 4/6) intercala con niveles (1 a 3cm) de arena fina limosa gris (N4).

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza con niveles irregulares escasos de arcilla gris-verdosa (5Y 5/2) y nivele y manchas irregulares de arcilla negra. Escasas papas aisladas (1 a 2cm) de ulexita.

NO RECUPERADO

CLAY: Arcilla gris-verdosa (5Y 5/2) con muy escasas manchas de arcilla negra y papa (2cm) de ulexita.

SAND: Arena fina a media gris (N4) con escaso limo.

NO RECUPERADO

FINE SAND: Arena fina con escaso limo gris (N4).

CLAY: Arcilla rojiza (10R 4/6) con escasos rastros de arcilla negra y papa (4cm) de ulexita.

CLAY: Arcilla marrón-pálida (10YR 6/2) con escasos niveles aislados (?1cm) de arcilla negra.

NO RECUPERADO

CLAY: Arcilla marrón-pálida (10YR 6/2).

SAND: Arena media gris-blanquecina.

SAND: Arena fina limosa gris (N4) con escasa arcilla en matriz de distribución irregular.

NO RECUPERADO

SILTY SAND: Arena fina limosa gris (N4) con escasa arcilla en matriz de distribución irregular.

CLAY: Arcilla gris-verdosa (5Y 5/2) con nivel (8cm) de arcilla marrón-pálida y niveles (1cm) de arcilla negra. Papas (1 a 3cm) de ulexita.

SILTY SAND: Arena muy fina limosa blanquecina con escasos ratsros de arcilla negra.

CLAY: Arcilla marrón-oscura (5YR 3/4) con dos niveles (1 y 4cm) de ulexita.

SILTY SAND: Arena muy fina limosa gris-oscura a negra.

NO RECUPERADO

CLAY: Arcilla marrón (5YR 5/2) y marrón-pálida con niveles y papas (1 a 3cm) de ulexita. Nivel (12cm) de ulexita y nivel (8cm) de arena muy fina limosa. Niveles deformados (1 a 2cm) de arcilla negra. Escasa y aisladas manchas anaranjadas (FeOx?).

CLAYEY SAND: Arena muy fina limo-arcillosa gris-oscura (N3).

SILTY SAND: Arena muy fina limosa gris-oscura a negra. Nivel cercano a la base (3mm) de arena muy fina blanquecina y papa (1cm) de ulexita.

NO RECUPERADO

SAND: Arena fina a muy fina gris (N4) con escaso limo.

NO RECUPERADO

SILTY SAND: Arena muy fina limosa gris-oscura a negra.

CLAY: Arcilla gris-verdosa oscura (5GY 4/1) con fino nivel (2cm) de arcilla marrón y nivel (4cm) de arcilla negra. Nivel (1cm) y papa (3cm) de ulexita.

NO RECUPERADO

SILTY SAND: Arena fina a muy fina limosa gris (N4) Escasos lentes? De arcilla marrón y rastros de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) con niveles deformados (?1cm) de arcilla negra y escasas papas (1cm) de ulexita.

CLAY: Arcilla verde (10GY 5/2) a gris-verdosa con abundantes niveles irregulares de arcilla negra. Escasas papas y niveles (1cm) de ulexita.

SILTY SAND: Arena muy fina limosa gris (N4). Escasos niveles (1cm) de arena muy fina con escasa arcilla negra en matriz y fina papa (0,5cm) de ulexita. Hacia la base se torna ligeramente arcilloso.

CLAY: Arcilla marrón (5YR 5/2) con nivel de ulexita (3cm) y nivel (3cm) de arcilla negra. Escasas y finas manchas anaranjadas (FeOx?) y nivel basal de arena fina limosa gris (N4).

CLAY: Intercalan arcilla marrón-pálida (10YR 6/2) a gris verdosa con abundantes niveles (1 a 3cm) de arcilla negra.

CLAY Interbeded ORGANICS: Arcilla rojiza (10R 4/6) con abundantes niveles (1 a 2cm) de arcilla negra.

SILTY SAND: Arena fina a media limosa gris-oscura a negracon escasa arcilla.

NO RECUPERADO

SILTY SAND: Arena fina a media limosa gris-oscura (N3) con escasos niveles (1 a 3cm) de arcilla verde y marrón.

NO RECUPERADO

CLAY Interbeded SAND: Intercalan niveles (10 a 20cm) de arcilla marrón-pálida (10YR 6/2) y verde (10GY 5/2) con arena fina a media gris (N4).

NO RECUPERADO

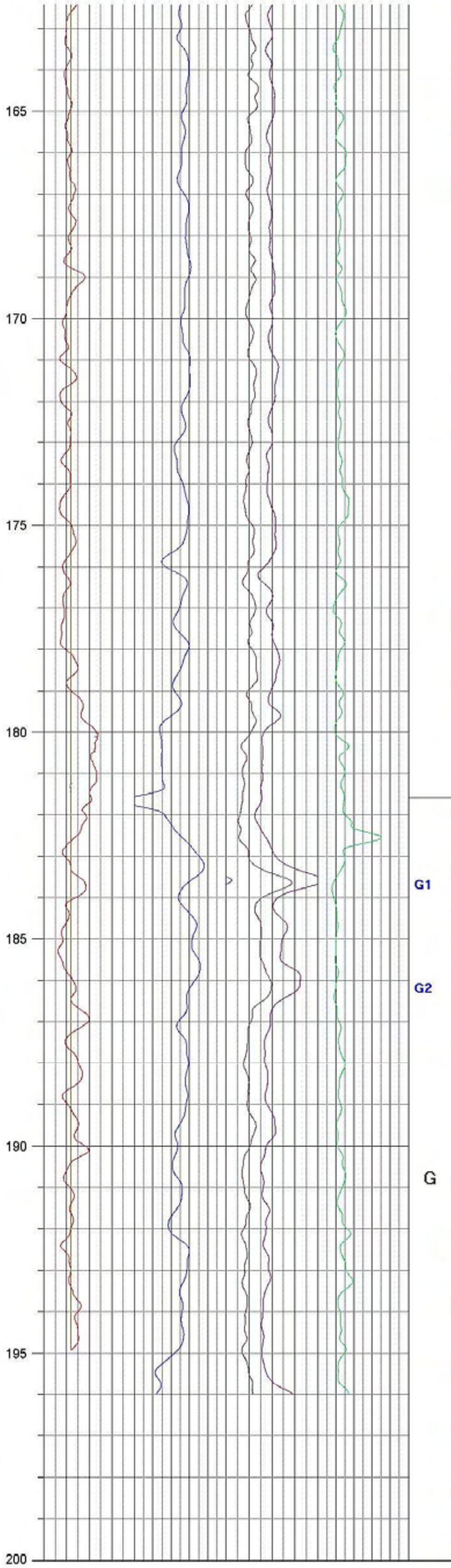
SAND: Arena fina gris (N4) con escaso limo.

CLAY: Arcilla marrón-pálida (10YR 6/2).

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM

CONTRACTOR: MAJOR	START DATE: 28-11-2010	COORDINATES (POSGAR 94 Zone 3) E: 3424000	WELL REFERENCE: **CD-04**
DRILL RIG: DIAMON BIT	END DATE: 18-12-2010	N: 7404000	Page 5 of 5
METHOD: DIAMON BIT	DEPTH: 200m	Elevn: 3939,199	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)

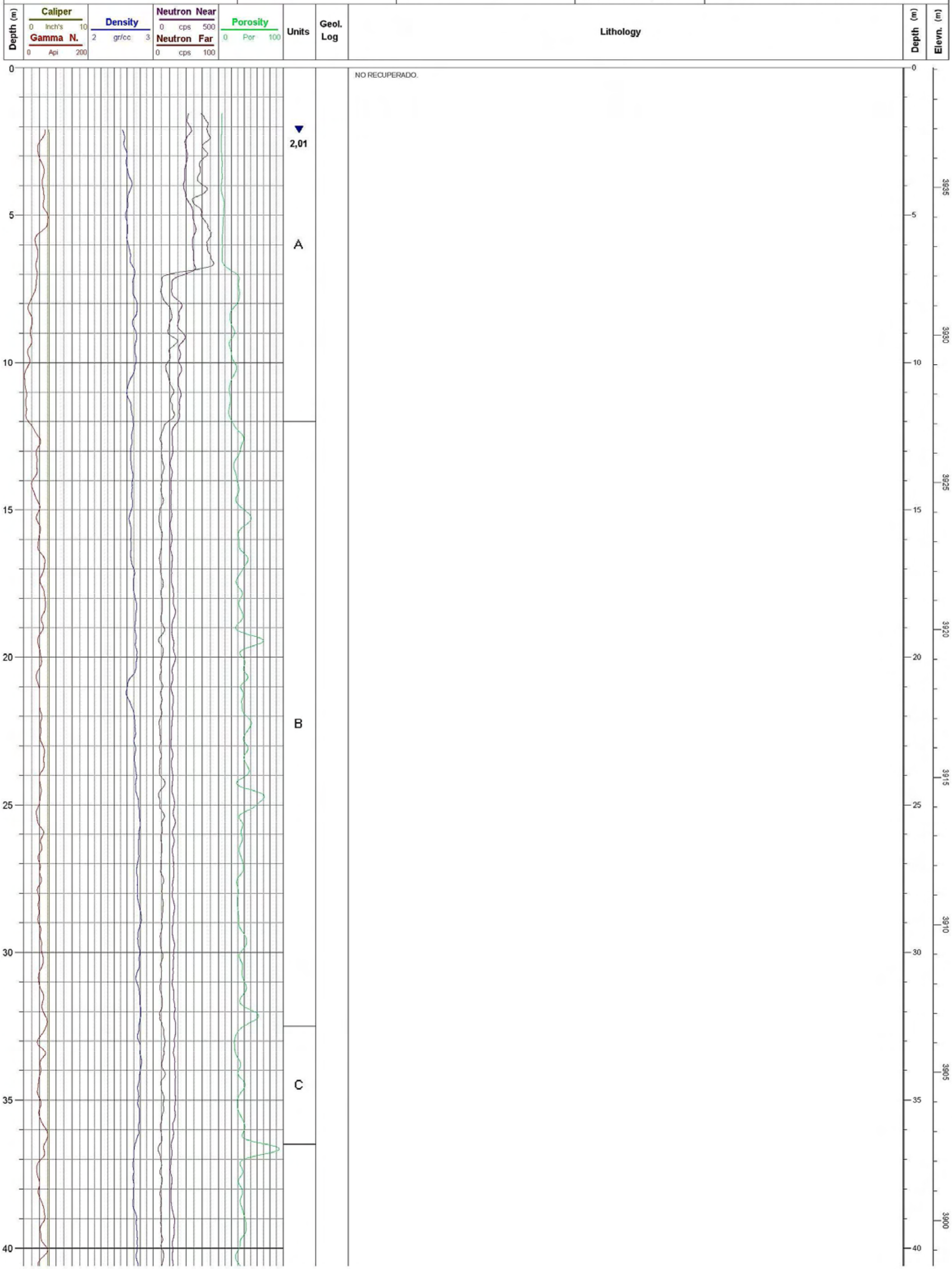


- CLAYEY SAND: Arena fina a media gris (N4) con muy escasa arcilla en matriz. Nivel de arcilla marrón-pálida (5cm) y rojiza-pálida (3cm).
- CLAY: Arcilla gris-verdosa oscura (5Y 3/2) con nivel de arena muy fina arcillosa (4cm) y arcilla rojiza (2cm).
- NO RECUPERADO
- SAND: Arena fina a media gris (N4) con muy escaso limo.
- CLAY: Arcilla gris-verdosa oscura (5Y 3/2) con muy finos y escasos rastros de arcilla negra.
- NO RECUPERADO
- SILTY SAND: Arena muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- CLAYEY SAND: Arena fina a muy fina limo arcillosa gris oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- FINE SAND: Arena fina a muy fina gris-oscura (N3) con escaso limo.
- NO RECUPERADO
- FINE SAND: Arena fina a muy fina gris-oscura (N3) con escaso limo.
- NO RECUPERADO
- FINE SAND: Arena fina a muy fina gris (N4) con escaso limo.
- NO RECUPERADO
- FINE SAND: Arena fina a muy fina gris (N4) con escaso limo.
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3) con escasa proporción de arcilla en matriz.
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).
- NO RECUPERADO
- SILTY SAND: Arena fina a muy fina limosa gris-oscura (N3).

Depth (m): 165, 170, 175, 180, 185, 190, 195, 200

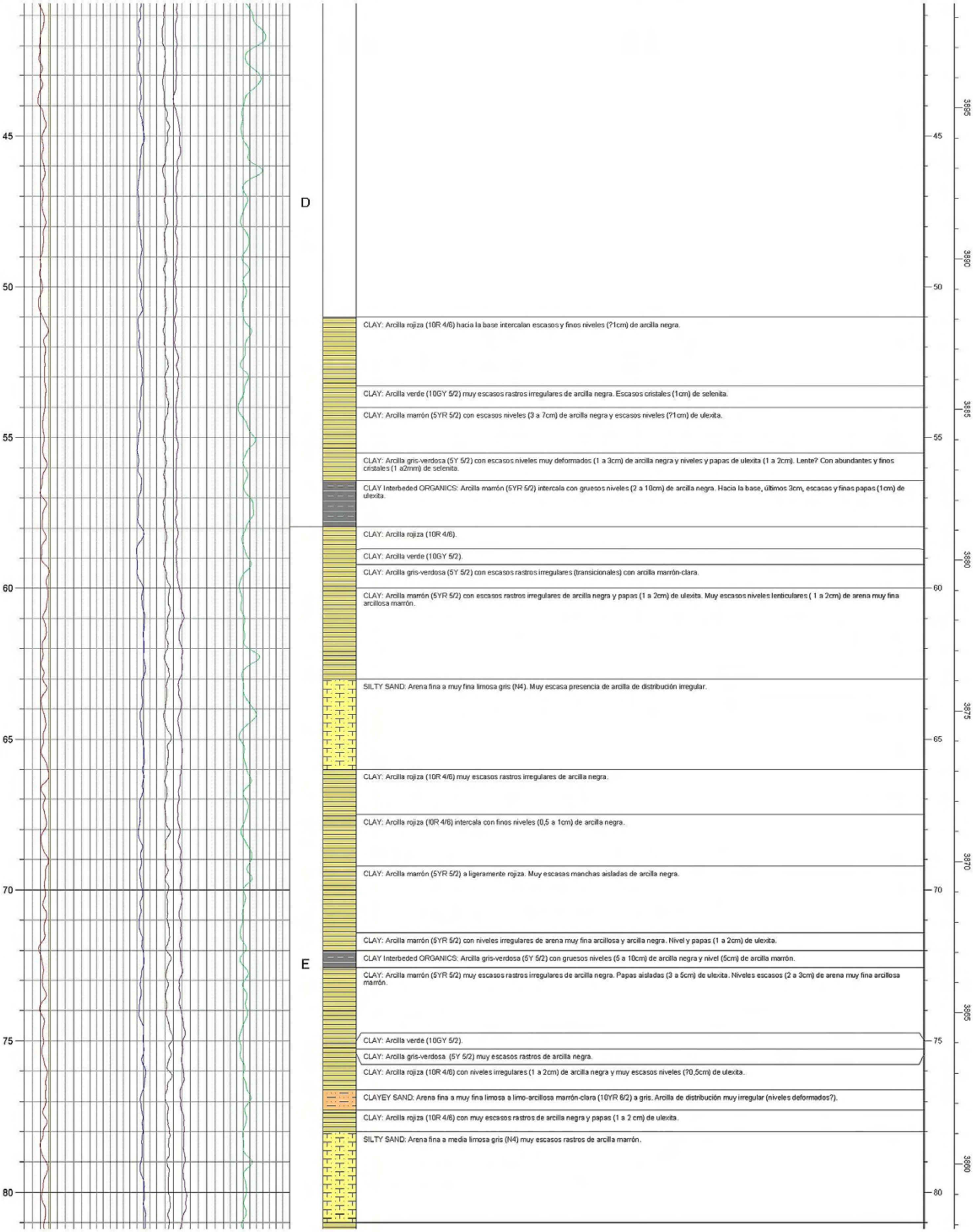
Elevn. (m): 3775, 3770, 3765, 3760, 3755, 3750, 3745, 3740

OROCOBRE	OLAROZ PROJECT	CONTRACTOR:	BLY/MAJOR	START DATE:	28-11-2010	COORDINATES (POSGAR 94 Zone 3) E: 3428999	WELL REFERENCE: **CD-05**
		DRILL RIG:	SONIC/DIAMOND	END DATE:	07-12-2010	N: 7403999	Page 1 of 5
RESOURCE EVALUATION PROGRAM		METHOD:	SONIC/DIAMOND	DEPTH:	200m	Elevn: 3939,069	LOGED BY: Geol. FERNANDO A. MARTÍN



OROCOBRE OLAROZ PROJECT	CONTRACTOR: BLY/MAJOR	START DATE: 28-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: **CD-05**
RESOURCE EVALUATION PROGRAM	DRILL RIG: SONIC/DIAMOND	END DATE: 07-12-2010	E: 3428999 / N: 7403999	Page 2 of 5
	METHOD: SONIC/DIAMOND	DEPTH: 200m	Elevn: 3939,069	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla rojiza (10R 4/6) hacia la base intercalan escasos y finos niveles (?1cm) de arcilla negra.

CLAY: Arcilla verde (10GY 5/2) muy escasos rastros irregulares de arcilla negra. Escasos cristales (1cm) de selenita.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles (3 a 7cm) de arcilla negra y escasos niveles (?1cm) de ulexita.

CLAY: Arcilla gris-verdosa (5Y 5/2) con escasos niveles muy deformados (1 a 3cm) de arcilla negra y niveles y papas de ulexita (1 a 2cm). Lente? Con abundantes y finos cristales (1 a2mm) de selenita.

CLAY Interbeded ORGANICS: Arcilla marrón (5YR 5/2) intercala con gruesos niveles (2 a 10cm) de arcilla negra. Hacia la base, últimos 3cm, escasas y finas papas (1cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6).

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla gris-verdosa (5Y 5/2) con escasos rastros irregulares (transicionales) con arcilla marrón-clara.

CLAY: Arcilla marrón (5YR 5/2) con escasos rastros irregulares de arcilla negra y papas (1 a 2cm) de ulexita. Muy escasos niveles lenticulares (1 a 2cm) de arena muy fina arcillosa marrón.

SILTY SAND: Arena fina a muy fina limosa gris (N4). Muy escasa presencia de arcilla de distribución irregular.

CLAY: Arcilla rojiza (10R 4/6) muy escasos rastros irregulares de arcilla negra.

CLAY: Arcilla rojiza (I0R 4/6) intercala con finos niveles (0,5 a 1cm) de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) a ligeramente rojiza. Muy escasas manchas aisladas de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) con niveles irregulares de arena muy fina arcillosa y arcilla negra. Nivel y papas (1 a 2cm) de ulexita.

CLAY Interbeded ORGANICS: Arcilla gris-verdosa (5Y 5/2) con gruesos niveles (5 a 10cm) de arcilla negra y nivel (5cm) de arcilla marrón.

CLAY: Arcilla marrón (5YR 5/2) muy escasos rastros irregulares de arcilla negra. Papas aisladas (3 a 5cm) de ulexita. Niveles escasos (2 a 3cm) de arena muy fina arcillosa marrón.

CLAY: Arcilla verde (10GY 5/2).

CLAY: Arcilla gris-verdosa (5Y 5/2) muy escasos rastros de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) con niveles irregulares (1 a 2cm) de arcilla negra y muy escasos niveles (?0,5cm) de ulexita.

CLAYEY SAND: Arena fina a muy fina limosa a limo-arcillosa marrón-clara (10YR 6/2) a gris. Arcilla de distribución muy irregular (niveles deformados?).

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros de arcilla negra y papas (1 a 2 cm) de ulexita.

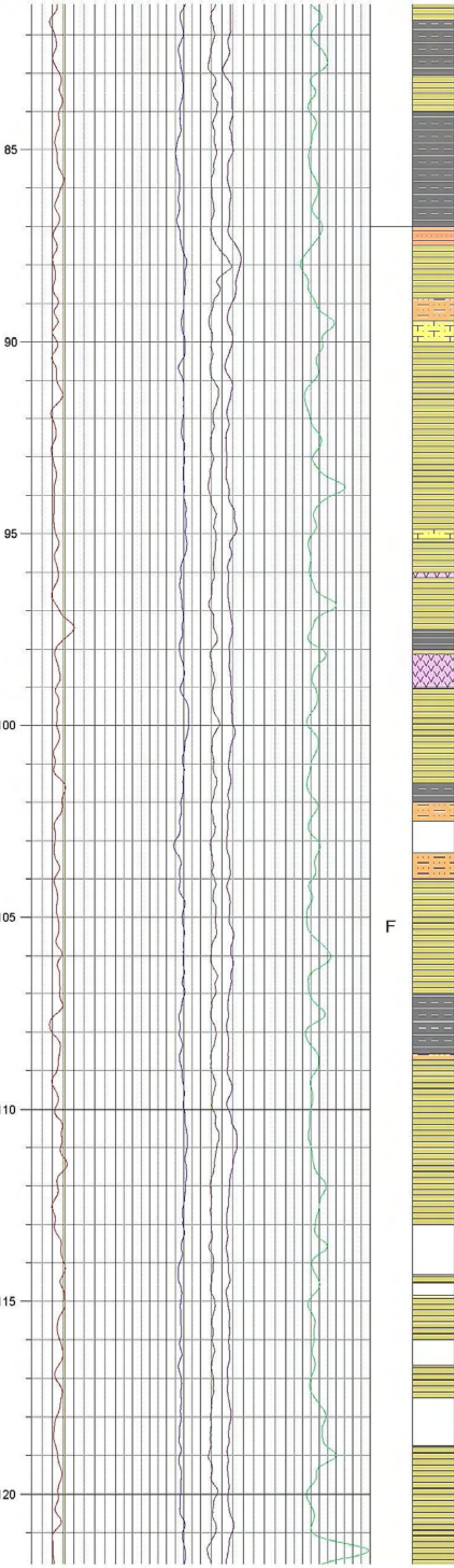
SILTY SAND: Arena fina a media limosa gris (N4) muy escasos rastros de arcilla marrón.

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY/MAJOR DRILL RIG: SONIC/DIAMOND METHOD: SONIC/DIAMOND	START DATE: 28-11-2010 END DATE: 07-12-2010 DEPTH: 200m	COORDINATES (POSGAR 94 Zone 3) E: 3428999 N: 7403999 Elevn: 3939,069

WELL REFERENCE: CD-05

LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla marrón-oscura (5YR 3/4) a rojiza con muy escasos rastros de arcilla negra y papa (5cm) de ulexita.

CLAY Interbeded ORGANICS: Arcilla gris-verdosa (5Y 5/2) con niveles gruesos irregulares (5 a 7cm) de arcilla negra. Escasas papas (1 a 2cm) y nivel (3cm) de ulexita.

CLAY Interbeded ORGANICS: Arcilla marrón (5YR 5/2) con abundantes y gruesos niveles muy irregulares de arcilla negra. Escasas papas (1 a 2cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con papas (2 a 5cm) y nivel (14cm) de ulexita. Muy escasas manchas irregulares de arcilla negra.

CLAY Interbeded ORGANICS: Arcilla rojiza (10R 4/6) intercala, rítmicamente, con abundantes niveles (1 a 3cm) de arcilla negra.

CLAY Interbeded SAND: Arcilla marrón-oscura (10YR 4/2) con dos niveles (2 y 4cm) de arena muy fina limosa gris.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos niveles (0,5 a 2cm) de arcilla negra.

CLAYEY SAND: Arena muy fina limo arcillosa marrón-clara con muy escasas papas (1cm) de ulexita.

SILTY SAND: Arena fina a muy fina limosa con lentes (1cm) muy escasos de arcilla marrón arenosa.

CLAY: Arcilla rojiza (10R 4/2) muy escasos rastros de arcilla negra y cristales aislados (?1cm) de selenita.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos y finos niveles (?1cm) deformados de arcilla negra.

CLAY: Arcilla marrón (5YR 4/4) a ligeramente rojiza intercala con dos niveles (4 y 18cm) de arcilla gris-verdosa (5Y 5/2) y niveles en tope (2 a 3cm) de arena media a fina limo arcillosa gris (N4) Muy escasos rastros de arcilla negra y papas (1 a 2cm) de ulexita.

CLAY: Arcilla verde (10GY 5/2).

SILTY SAND: arena media a fina limosa gris (N4) con muy escasa arcilla en matriz de distribución irregular.

CLAY: Arcilla rojiza (10R 4/6).

VOLCANIC ASH: Nivel blanquecino limoso (ceniza volcánica?).

CLAY: Arcilla gris-verdosa (5Y 5/2) pasa transicionalmente a arcilla verde (10GY 5/2). Intercalan finos niveles (?0,5 a 1cm) de arcilla negra. Muy escasos cristales (0,5cm) de selenita.

BLACK CLAY: Arcilla negra con nivel (3cm) limoso blanquecino.

CLAY: Arcilla marrón (5YR 5/2) intercala con niveles blanquecinos (3 a 5cm).

VOLCANIC ASH: Nivel limo-arcilloso gris-blanquecino (ceniza volcánica?).

CLAY: Arcilla marrón (5YR 5/2) muy escasos niveles (1cm) de arcilla negra.

CLAY Interbeded ORGANICS: Intercalan arcilla marrón (5YR 5/2) con niveles (2 a 10cm) de arcilla negra.

CLAYEY SAND: Arena fina a muy fina limo-arcillosa gris-oscura (N3) con niveles marrones de ídem textura.

NO RECUPERADO.

CLAYEY SAND: Arena fina a muy fina limo-arcillosa gris-oscura con nivel (10cm) de arcilla marrón (5YR 5/2) y nivel (13cm) de arcilla negra.

CLAY: Arcilla rojiza (10R 4/6) a ligeramente marrón. Muy escasos rastros irregulares de arcilla negra. Intercala nivel (24cm) de arcilla gris-verdosa (5Y 5/2) y niveles deformados (3 a 6cm) de arcilla verde (10GY 5/2).

CLAY Interbeded ORGANICS: Arcilla negra con escasos niveles irregulares (2 a 15cm) de arcilla marrón (5YR 5/2).

CLAYEY SAND: Arena muy fina arcillosa marrón (5YR 5/2) con papas (1 a 2cm) de ulexita.

CLAY: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra y papas (1cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6).

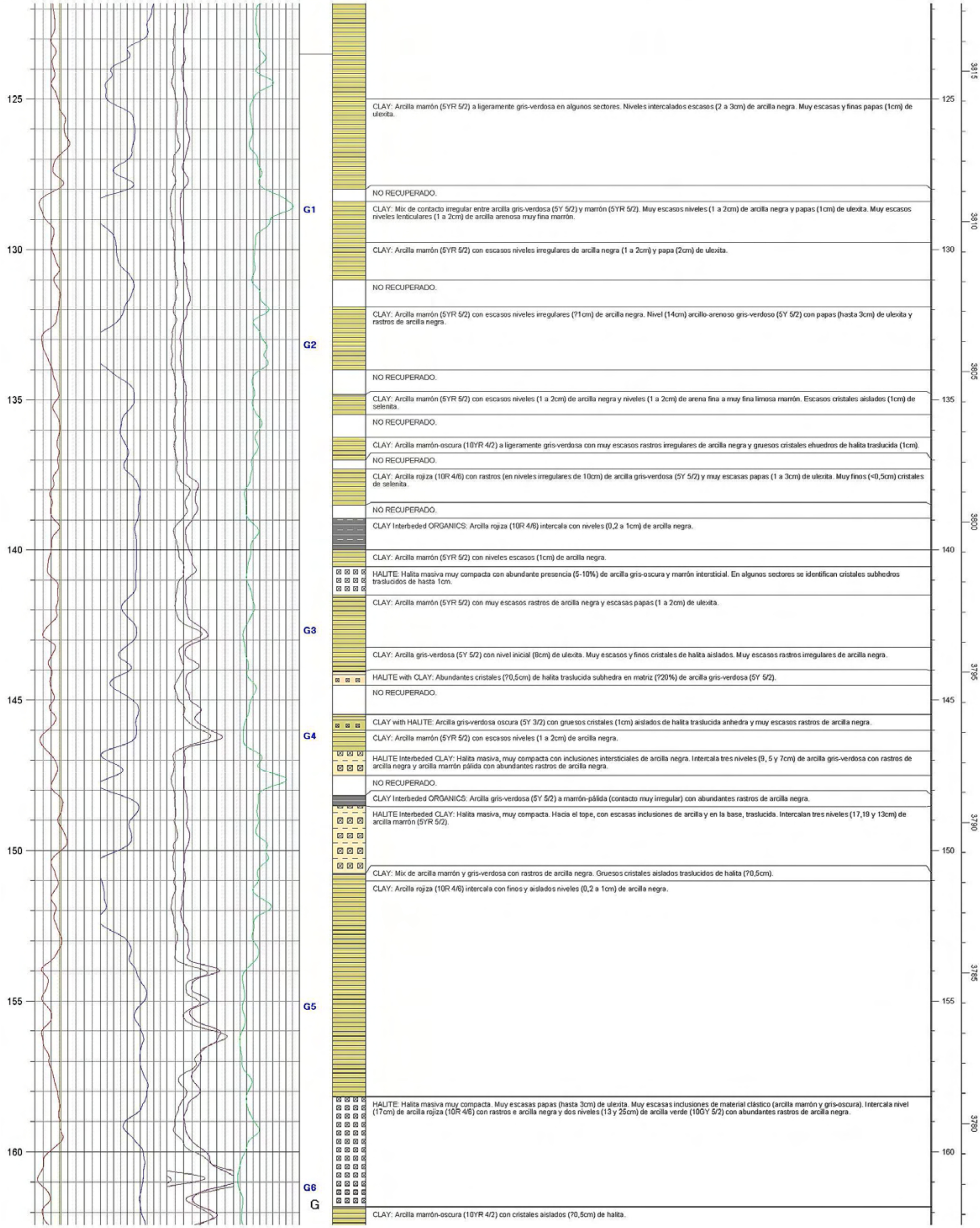
NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros irregulares de arcilla negra y gris-verdosa.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos y finos niveles (1 a 3mm) de arcilla negra.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: BLY/MAJOR	START DATE: 28-11-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-05
RESOURCE EVALUATION PROGRAM		DRILL RIG: SONIC/DIAMOND	END DATE: 07-12-2010	E: 3428999	Page 4 of 5
		METHOD: SONIC/DIAMOND	DEPTH: 200m	N: 7403999	
				Elevn: 3939,069	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla marrón (5YR 5/2) a ligeramente gris-verdosa en algunos sectores. Niveles intercalados escasos (2 a 3cm) de arcilla negra. Muy escasas y finas papas (1cm) de ulexita.

NO RECUPERADO.

CLAY: Mix de contacto irregular entre arcilla gris-verdosa (5Y 5/2) y marrón (5YR 5/2). Muy escasos niveles (1 a 2cm) de arcilla negra y papas (1cm) de ulexita. Muy escasos niveles lenticulares (1 a 2cm) de arcilla arenosa muy fina marrón.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles irregulares de arcilla negra (1 a 2cm) y papa (2cm) de ulexita.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles irregulares (?1cm) de arcilla negra. Nivel (14cm) arcillo-arenoso gris-verdoso (5Y 5/2) con papas (hasta 3cm) de ulexita y rastros de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles (1 a 2cm) de arcilla negra y niveles (1 a 2cm) de arena fina a muy fina limosa marrón. Escasos cristales aislados (1cm) de selenita.

NO RECUPERADO.

CLAY: Arcilla marrón-oscura (10YR 4/2) a ligeramente gris-verdosa con muy escasos rastros irregulares de arcilla negra y gruesos cristales ehuedros de halita traslucida (1cm).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con rastros (en niveles irregulares de 10cm) de arcilla gris-verdosa (5Y 5/2) y muy escasas papas (1 a 3cm) de ulexita. Muy finos (<0,5cm) cristales de selenita.

NO RECUPERADO.

CLAY Interbeded ORGANICS: Arcilla rojiza (10R 4/6) intercala con niveles (0,2 a 1cm) de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) con niveles escasos (1cm) de arcilla negra.

HALITE: Halita masiva muy compacta con abundante presencia (5-10%) de arcilla gris-oscura y marrón intersticial. En algunos sectores se identifican cristales subhedros traslucidos de hasta 1cm.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros de arcilla negra y escasas papas (1 a 2cm) de ulexita.

CLAY: Arcilla gris-verdosa (5Y 5/2) con nivel inicial (8cm) de ulexita. Muy escasos y finos cristales de halita aislados. Muy escasos rastros irregulares de arcilla negra.

HALITE with CLAY: Abundantes cristales (?0,5cm) de halita traslucida subhedra en matriz (?20%) de arcilla gris-verdosa (5Y 5/2).

NO RECUPERADO.

CLAY with HALITE: Arcilla gris-verdosa oscura (5Y 3/2) con gruesos cristales (1cm) aislados de halita traslucida anhedra y muy escasos rastros de arcilla negra.

CLAY: Arcilla marrón (5YR 5/2) con escasos niveles (1 a 2cm) de arcilla negra.

HALITE Interbeded CLAY: Halita masiva, muy compacta con inclusiones intersticiales de arcilla negra. Intercala tres niveles (9, 5 y 7cm) de arcilla gris-verdosa con rastros de arcilla negra y arcilla marrón pálida con abundantes rastros de arcilla negra.

NO RECUPERADO.

CLAY Interbeded ORGANICS: Arcilla gris-verdosa (5Y 5/2) a marrón-pálida (contacto muy irregular) con abundantes rastros de arcilla negra.

HALITE Interbeded CLAY: Halita masiva, muy compacta. Hacia el tope, con escasas inclusiones de arcilla y en la base, traslucida. Intercalan tres niveles (17,19 y 13cm) de arcilla marrón (5YR 5/2).

CLAY: Mix de arcilla marrón y gris-verdosa con rastros de arcilla negra. Gruesos cristales aislados traslucidos de halita (?0,5cm).

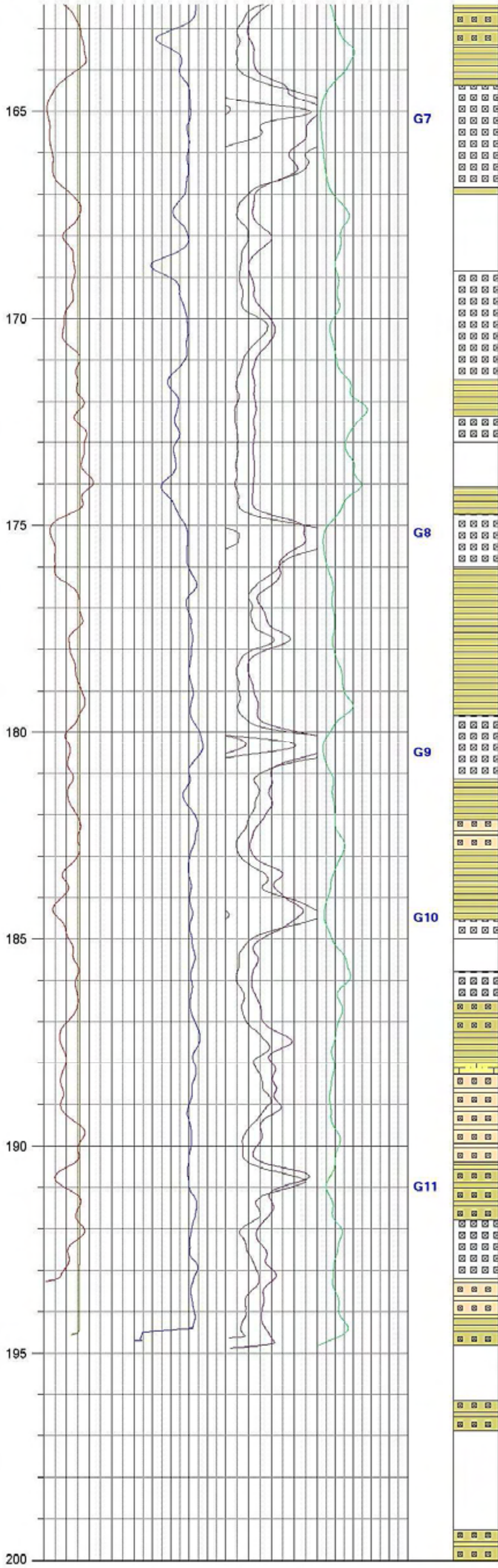
CLAY: Arcilla rojiza (10R 4/6) intercala con finos y aislados niveles (0,2 a 1cm) de arcilla negra.

HALITE: Halita masiva muy compacta. Muy escasas papas (hasta 3cm) de ulexita. Muy escasas inclusiones de material clástico (arcilla marrón y gris-oscura). Intercala nivel (17cm) de arcilla rojiza (10R 4/6) con rastros e arcilla negra y dos niveles (13 y 25cm) de arcilla verde (10GY 5/2) con abundantes rastros de arcilla negra.

CLAY: Arcilla marrón-oscura (10YR 4/2) con cristales aislados (?0,5cm) de halita.

OROCOBRE — OLAROZ PROJECT — RESOURCE EVALUATION PROGRAM	CONTRACTOR: BLY/MAJOR DRILL RIG: SONIC/DIAMOND METHOD: SONIC/DIAMOND	START DATE: 28-11-2010 END DATE: 07-12-2010 DEPTH: 200m	COORDINATES (POSGAR 94 Zone 3) E: 3428999 N: 7403999 Elevn: 3939,069	WELL REFERENCE: **CD-05** Page 5 of 5 LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



Lithology

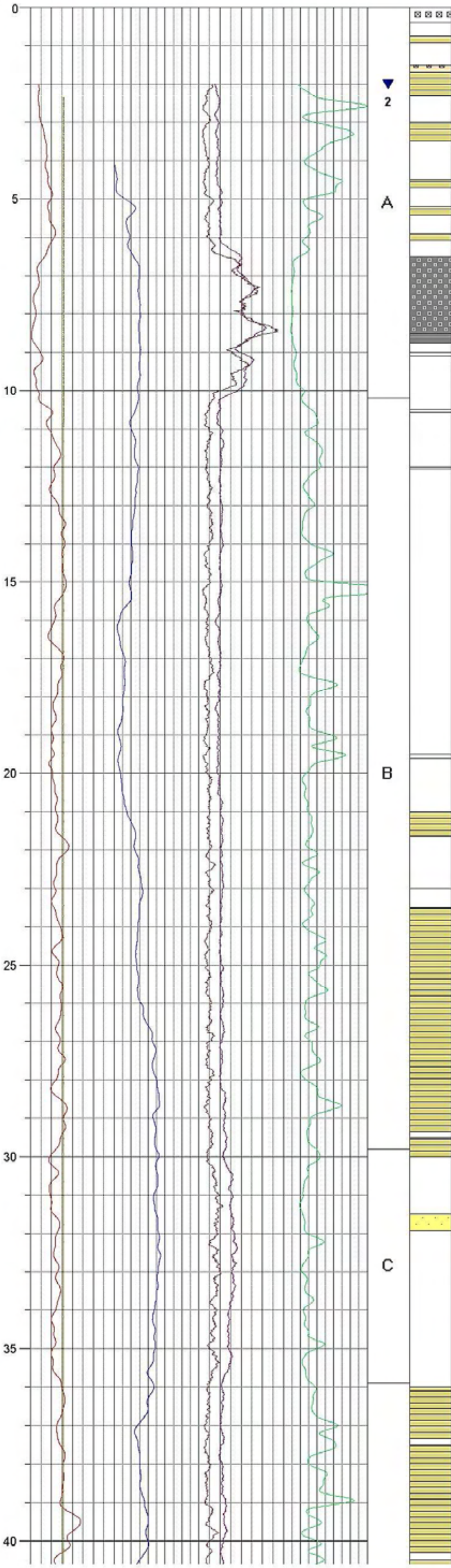
- CLAY with HALITE: Arcilla rojiza-pálida (10R 5/4) con nivel, en tope, (32cm) cementado con halita?.
- CLAY: Arcilla gris-verdosa (5Y 5/2) a verde (10GY 5/2) con muy escasos rastros irregulares de arcilla negra y papa (2cm) de ulexita.
- HALITE: Halita masiva, muy compacta con escasas inclusiones de material clástico (arcilla marrón-oscura) y nivel (12cm) de arcilla gris-verdosa (5Y 5/2). Muy escasas y finas papas (0,5 a 1cm) de ulexita.
- CLAY: Arcilla marrón-oscura (5YR 3/4) con escasos cristales (?0,5cm) de halita subhedros traslucidos.
- CLAY Interbeded HALITE: Arcilla rojiza (10R 4/6) con muy escasos niveles (1cm) de arcilla negra. Dos niveles (22 y 3cm) de halita masiva muy compacta. Muy escasos cristales traslucidos subhedros de halita dispersos (0,5 a 2cm).
- HALITE: Halita masiva muy compacta con muy escasas inclusiones de arcilla. Nivel (1cm) de arcilla marrón. Muy escasas papas (?1cm) de ulexita.
- CLAY: Arcilla marrón (5YR 5/2) con nivel (12cm) irregular de arcilla gris-verdosa (5Y 5/2) muy escasos rastros de arcilla negra y finas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- HALITE: Halita masiva muy compacta con muy escasas inclusiones de material clástico (arcilla marrón y gris-oscura).
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros de arcilla negra.
- HALITE: Halita masiva muy compacta con muy escasas inclusiones de material clástico.
- CLAY: Arcilla rojiza (10R 4/6) intercala con muy escasos niveles (2 a 3mm) de arcilla negra.
- HALITE: Halita masiva, muy compacta intercala con dos niveles (3 y 2cm) de arcilla marrón.
- CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros de arcilla negra.
- HALITE with CLAY: Halita masiva muy compacta. Hacia el tope mix con arcilla gris verdosa.
- CLAY: Arcilla rojiza (10R 4/6) muy escasos rastros de arcilla negra.
- HALITE: Halita masiva muy compacta con muy escasas inclusiones de material clástico.
- NO RECUPERADO.
- HALITE: Halita masiva muy compacta con papas (1 a 3cm) de ulexita y escasas inclusiones de material clástico (arcilla marrón).
- CLAY with HALITE: Arcilla marrón (5YR 5/2) a rojiza fuertemente cementada con halita. Escasas papas (1 a 3cm) de ulexita.
- CLAY: Arcilla rojiza (10R 4/6) con muy finas y escasas manchas de arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- SILTY SAND: Arena fina a muy fina limosa gris (N5).
- HALITE with CLAY: Halita masiva, muy compacta con inclusiones de material clástico. Nivel (51cm) con abundantes cristales de halita traslucida euhedra con matriz de arcilla marrón (5YR 3/4) con escasos rastros de arcilla negra.
- CLAY with HALITE: Arcilla marrón (5YR 5/2) fuertemente cementada con halita. Escasos y finos niveles y papas (1cm) de ulexita.
- HALITE: Halita masiva muy compacta con muy escasas inclusiones de material clástico.
- HALITE with CLAY: Halita masiva muy compacta con abundante presencia (15-20%) de arcilla verde (10GY 5/2) y escasas papas (1 a 2cm) de ulexita.
- CLAY: Arcilla verde(10GY 5/2).
- CLAY with HALITE: Arcilla gris-verdosa (5Y 5/2) hacia la base, fuertemente cementada con halita. Muy escasos rastros de arcilla negra.
- CLAY Interbeded HALITE: Arcilla verde (10GY 5/2) con gruesos (1 a 2cm) y aislados cristales de halita. Intercala nivel (29cm) de halita masiva con inclusiones de arcilla verde.
- CLAY with HALITE: Arcilla gris-verdosa (5Y 5/2) con escasas manchas de arcilla negra y escasas papas (1 a 3cm) de ulexita. Por sectores, fuertemente cementada con halita.
- CLAY Interbeded HALITE: Arcilla verde (10GY 5/2) a ligeramente gris-verdosa. Nivel de halita masiva (30cm) con inclusiones de arcilla verde y nivel contiguo (10cm) de halita masiva traslucida. Gruesos cristales aislados (2cm) de halita y escasas papas (1cm) de ulexita.
- CLAY with HALITE: Arcilla gris-verdosa oscura (5Y 3/2) cementada con halita.

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 24-09-2010	COORDINATES (POSGAR 94 Zone 3) E: 3426985
RESOURCE EVALUATION PROGRAM	DRILL RIG: DIAMON BIT	END DATE: 14-10-2010	N: 7398997,54
	METHOD: CORE BARREL	DEPTH: 199,5m	Elevn: 7398998

WELL REFERENCE: CD-06

LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)

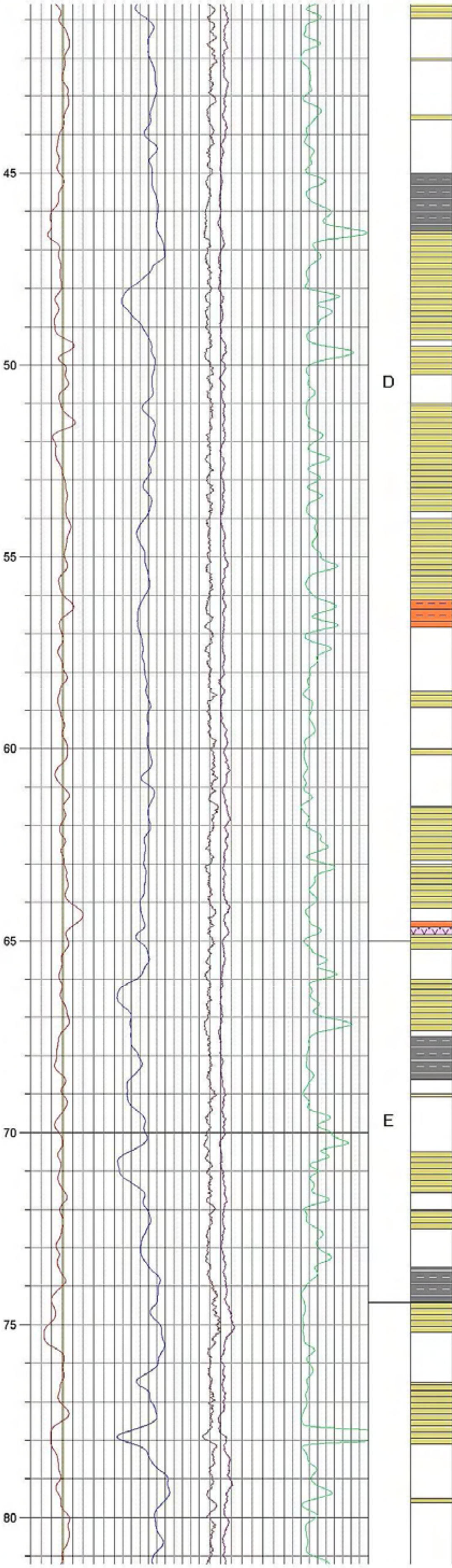


Lithology

- HALITE: Halita compacta blanqucina conformada por cristals euhedros (hasta 3mm) traslucidos de tamaño uniforme.
- NO RECUPERADO.
- CLAY: Arcilla limosa marrón-anaranjada (5YR 5/6) escasos microcristales de halita y ulexita en finas papas.
- NO RECUPERADO.
- HALITE with CLAY: Abundantes cristales de halita (<0,5mm) con arcilla marrón-anaranjada (5YR 5/6) a marrón (5YR 5/2).
- CLAY: Arcilla marrón (10YR 4/2) con escasas papas (?1cm) de ulexita y aislados cristales de selenita (0,5mm), algunos ejemplares intercrecidos (rosas del desierto). Muy escasos rastros de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2) con niveles (1 a 2cm) y ulexita intercalada.
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2) con muy escasos cristales (5mm) de selenita.
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2) con abundantes papas (hasta 2cm) de ulexita y escasos rastros de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2) con finos (0,2 a 0,5cm) niveles intercalados de ulexita y menor arcilla negra.
- NO RECUPERADO.
- BLACK HALITE: Halita masiva muy compacta con cristales hasta 3mm traslucidos euhedros. Alternan niveles de arcilla negra (10cm aprox.).
- BLACK CLAY: Arcilla negra.
- NO RECUPERADO.
- HALITE: Halita masiva muy compacta.
- NO RECUPERADO.
- HALITE: Halita masiva muy compacta.
- NO RECUPERADO.
- HALITE: Halita masiva muy compacta.
- NO RECUPERADO.
- HALITE: Halita masiva muy compacta.
- NO RECUPERADO.
- CLAY: Arcilla marrón-rojiza (10R 4/6) intercala con escasos niveles (o,5 a 1cm) de arcilla negra.
- CLAY: Arcilla gris-verdosa (10Y 4/2) intercala con niveles (?1cm) de ulexita y muy escasos de materia orgánica. Nivel (4cm) de arcilla verde (10GY 5/2).
- NO RECUPERADO.
- CLAY intrbeded SAND: REC=0,62m. Arcilla gris-verdosa (10Y 4/2) intercala con niveles (0,5 a 2cm) de arena fina a muy fina limosa marrón. Hacia la base grada a color verde (10GY 5/2).
- CLAY: REC=1,87m. Arcilla verde (10GY 5/2). En tope intercala con escasos niveles deformados de arcilla arenosa marrón (gruesa a fina). Cristales aislados de selenita (hasta 1cm). En la base, finos (1cm) y escasos niveles de arcilla marrón-rojiza.
- CLAY: REC=1,18. Arcilla marrón-rojiza (10R 4/6) con aislados cristales de selenita (1cm) escasas rosas del desierto. Hacia la base (últimos 20cm), Arcilla gris-verdosa con cristales aislados de selenita (2cm).
- CLAY: REC= 0,70m. Arcilla gris-verdosa (5Y 5/2) con muy escasos rastros de arcilla negra y arcilla marrón clara (10Y 6/2).
- CLAY: REC=0,85m. Arcilla marrón (5YR 5/2) con escasas y finas papas de ulexita (0,5 a 1cm). Muy escasos rastros de arcilla negra y cristales aislados de selenita.
- CLAY: REC=2,42m. Arcilla marrón (5YR 5/2) intercala con niveles (2 a 4cm) de arcilla negra y papas de ulexita (1 a 2cm). Escasos cristales de selenita (1cm).
- CLAY: Arcilla verdosa (5Y 5/2) a ligeramente marrón con rastros irregulares de arcilla negra.
- CLAY: Arcilla marrón (10YR 4/2).
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2) muy escasos rastros de arcilla negra. Papas de ulexita (1 a 2cm).
- NO RECUPERADO.
- SAND: Arena media a fina gris (N4) con muy escaso a nulo limo.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) con niveles (2cm) intercalados de ulexita y menor arcilla negra (0,5 a 1cm). Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- CLAY: Arcilla verde (10GY 5/2) con muy escasa presencia irregular de arcilla marrón y abundantes agregados policristalinos de selenita en el tope.
- NO RECUPERADO.
- CLAY: Arcilla verde (10GY 5/2) con escasos cristales de selenita (0,5 a 1cm).
- CLAY: Arcilla rojiza (10R 4/6) con escasos rastros de arcilla verde y cristales de selenita (0,5 a 1cm) escasos forman rosas del desierto.
- CLAY: Arcilla verde (10GY 5/2) con escasos y aislados cristales de selenita.
- CLAY: Arcilla marrón (10YR 4/2) hacia el tope (10cm) rojiza a verde transicional con nivel superior. Intercalan escasos niveles de ulexita (1 a 2cm). Muy escasos rastros de arcilla negra. Manchas anaranjadas pulverulentas (rejalgar/oropimente?) localizadas en zonas de fractura.
- NO RECUPERADO.

Elevn. (m): 3935, 3930, 3925, 3920, 3915, 3910, 3905, 3900

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



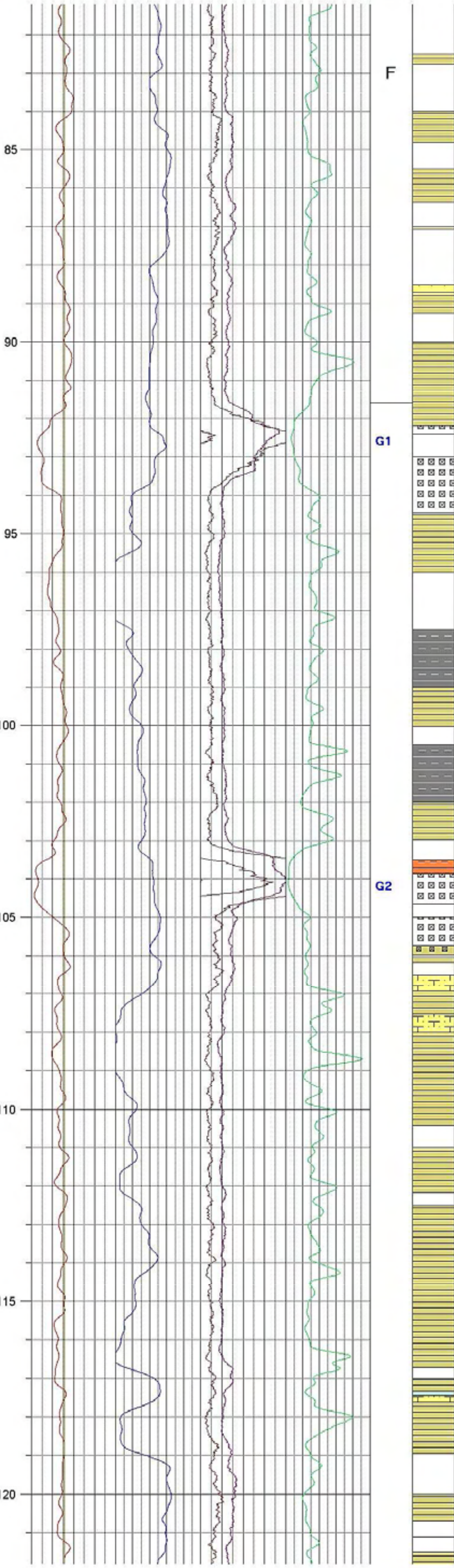
Lithology

- CLAY: Arcilla marrón (10YR 4/2). Muy escasos niveles de ulexita (1 a 2cm) y rastros de arcilla negra. Escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2). Muy escasa ulexita y rastros de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 4/2). Muy escasa ulexita y rastros de arcilla negra.
- NO RECUPERADO.
- CLAY interbeded ORGANICS: REC=1,62m. Arcilla marrón (10YR 4/2) con abundantes rastros irreguares y niveles (4cm) de arcilla negra. Nivel en tope de ulexita (4cm), en la base niveles de 0,5 a 1cm. Abundnantes manchas anaranjadas pulverulentas (rejalgar/oropimente?) concentradas en planos de debilidad (fracturas?). En los últimos centimetros se torna rojiza transición con nivel inferior.
- CLAY: Arcilla rojiza (10R 4/6). Abundantes papas de ulexita (1 a 3cm) disminuye proporcón hacia la base.
- CLAY: Arcilla verde (5GY 5/2) con escasos y finos niveles (0,5cm) de ulexita y muy escasos y aislados cristales de selenita (1cm). En la bas color gris verdoso (10Y 4/2).
- NO RECUPERADO.
- CLAY: Arcilla marrón (10R 4/2) escasos niveles y papas de ulexita y rastros de arcilla negra irregulares. Cristales aislados de selenita y muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 5/2). Niveles y papas de ulexita (1 a 3cm) y muy escasos rastros de arcilla negra. Muy escasas manchas anaranjadas pulverulentas (rejalgar/orpimente?).
- CLAY: Arcilla rojiza (10R 4/6) con muy escasos cristales de selenita (1cm).
- CLAY: Arcilla verde (10GY 5/2). En los últimos 10cm se torna, transicionalmente, marrón. Muy escasos y aislados cristales de selenita (1cm).
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) muy escasos rastros de arcilla negra y cristales (1 a 2cm) de selenita algunos forman rosas del desierto. En todo el perfil finas manchas anaranjadas pulverulentas (rejalgar/oropimente?). Nivel (4cm) de arcilla gris verdosa (5Y 5/4).
- SILTY CLAY: Arcilla limosa marrón-clara (10YR 6/2) intercala con abundantes niveles (2 a 4cm) de arcilla negra. Escasa manchas amarillentas (FeOx?). Escasos cristales de selenita (1 a 2cm).
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) intercala con niveles de ulexita (?). Elevada dureza de todo el nivel (seco/cementado?). Manchas irregulares y niveles (1m) de arcilla negra.
- NO RECUPERADO.
- CLAY: Elevada dureza (seco). Arcilla rojiza (10R 4/6) intercala con niveles de ulexita (?). Manchas irregulares y niveles (1m) de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) hacia la base (últimos 14cm) se torna ligeramente limosa.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) intercala con muy escasos niveles (0,5 a 1cm) arcillo limosos.
- CLAY: Intercalación rítmica de arcilla rojiza (10R 4/6) y niveles (0,5 a 1cm) de arcilla negra. Nivel (9cm) de arcilla verde (10GY 5/2). Escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- NO RECUPERADO.
- SILTY CLAY: Arcilla rojiza (10R 4/6) con escaso limo.
- VOLCANIC ASH: Nivel limosos blanquecino con escasos rastros de materia orgánica en tope (arcilla negra). Ceniza Volcánica?.
- CLAY: Arcilla rojiza (10R 4/6) muy escasos rastros de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) con muy escasos y finos lentes (0,5cm) de arcilla negra. Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- NO RECUPERADO.
- CLAY interbeded ORGANICS: Arcilla rojiza (10R 4/6) con abundantes manchas (2 a 3cm) y niveles (0,5cm) de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 6/2).
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10YR 4/6) con muy escasos rastros irregulares de arcilla negra. Y manchas anarajadas pulverulentas (rejalgar/oropimente?).
- NO RECUPERADO.
- CLAY: Arcilla marrón (5YR 5/2) con rastros irregulares de arcilla negra.
- CLAY: Arcilla verde (5GY 5/2) con niveles (2 a 4cm) de arcilla negra. Finas y aisladas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- NO RECUPERADO.
- CLAY interbeded ORGANICS: Arcilla marrón-clara (10YR 6/2) intercala rítmicamente con niveles de arcilla negra (0,5 a 1cm). Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- CLAY interbeded ORGANICS: Arcilla verde-clara (5G 6/1) intercala con abundantes y gruesos niveles (1 a 7cm) de arcilla negra. Abundantes manchas anaranjadas pulverulentas (rejalgar/oropimente?).
- CLAY: Arcilla marrón (5YR 5/2) con abundantes y finas papas (1cm) de ulexita. Muy escasos rastros irregulares de arcilla negra.
- NO RECUPERADO.
- CLAY: Arcilla rojiza (10R 4/6) con escasos rastros de arcilla negra y ulexita en papas (1 a 3cm). En tope, escasos cristales de selenita (1cm).
- NO RECUPERADO.
- CLAY: Arcilla marrón (10YR 6/2) a rojiza con abundantes papas (2cm) de ulexita y menor cristales (1cm) de selenita.
- NO RECUPERADO.

Depth (m): 45, 50, 55, 60, 65, 70, 75, 80 — Elevn.: 3895, 3890, 3885, 3880, 3875, 3870, 3865, 3860

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 24-09-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
RESOURCE EVALUATION PROGRAM		DRILL RIG: DIAMON BIT	END DATE: 14-10-2010	E: 3426985	**CD-06**
		METHOD: CORE BARREL	DEPTH: 199,5m	N: 7398997,54	
				Elevn: 7398998	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Caliper (0 Inch's 10) / Gamma N. (0 Api 200)	Density (2 gr/cc 3)	Neutron Near (0 cps 500) / Neutron Far (0 cps 100)	Porosity (0 Por 100)	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla marrón (10YR 6/2) con abundantes papas (2cm) de ulexita y menor cristales (1cm) de selenita.

CLAY: Arcilla verde (5GY 5/2) con muy escasas y finas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con fino nivel (2cm) de arcilla verde (5GY 5/2) y finos y escasos niveles, en tope, (1cm) de arcilla negra y ulexita. Escasos y aislados cristales (1cm) de selenita.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2). Abundantes y finas papas (1 a 2cm) de ulexita. Muy escasos rastros de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2).

NO RECUPERADO.

SAND: Arena fina a muy fina gris con granos blanquecinos.

CLAY: Arcilla marrón-oscura (5YR 3/4) con lentes (1cm) arcilla arenosa marrones y niveles (2cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos rastros de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) intercala irregularmente (cada 10 a 7cm) con niveles irregulares (1cm) de arcilla negra y niveles (<0,5cm) de ulexita.

HALITE: Halita masiva muy compacta blanquecina.

NO RECUPERADO.

HALITE: Halita muy compacta blanquecina se observan cristales subhedros (2mm) traslucidos.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con escasos y gruesos (2cm) cristales de halita. Muy escasos ratsros de arcilla negra y finas papas de ulexita.

CLAY: Arcilla verde (10GY 5/2) transicional con nivel superior (5cm). Muy escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?) y cristales de selenita (2cm).

NO RECUPERADO.

CLAY interbeded ORGANICS: REC=1,64m. Arcilla marrón-rojiza (10R 4/2) con niveles y abundantes manchas irregulares (1 a 3cm) de arcilla negra. Muy escasas manchas amarillentas (FeOx?).

CLAY: Arcilla rojiza (10R 4/6) con muy escasas papas (0,5cm) de ulexita.

NO RECUPERADO.

CLAY interbeded ORGANICS: REC=1,65m. Arcilla rojiza-pálida (10R 5/4) con niveles alternados de arcilla negra (0,3 a 4cm). Escasos y finos niveles (?0,5cm) con abundantes FeOx?. En la base nivel arcillo limoso con rastros de arcilla negra.

CLAY: Arcilla rojiza-pálida (10R 5/4) intercala con niveles aislados (0,5 a 1cm) de arcilla negra y muy escasos (1 a 2cm) niveles areno-arcillosos.

NO RECUPERADO.

SILTY CLAY: Arcilla limosa marrón-oscura (5YR 3/2).

HALITE: Halita masiva muy compacta. Gruesos cristales (2 a 4mm) subhedros. Muy escasos rastros de arcilla negra.

NO RECUPERADO.

HALITE: Halita masiva muy compacta con muy escasos rastros de arcilla negra. Hacia la base (últimos 15cm) microcristales con nivel (2cm) arenoso (arena muy fina) con microcristales de halita.

CLAY with HALITE: Arcilla marrón (10R 5/4) en la base con abundnates microcristales de halita.

HALITE: Nivel masivo de halita microcristalina gris (N5).

CLAY: Arcilla marrón (5YR 5/2). Últimos 3cm arcilla limosa.

NO RECUPERADO.

SILTY SAND: Arena limosa gris con escasa arcilla marrón oscura (5YR 3/2).

CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros de arcilla negra y papas (2cm) de ulexita.

SILTY SAND: Arena media a fina limosa gris (N5) con escasa arcilla.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos y aislados niveles (0,5cm) de ulexita y arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropimente?).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos y aislados niveles (0,2 a 0,5cm) de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos y aislados niveles (0,5cm) de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla marrón-rojiza (5YR 3/4) escasas manchas (?1cm) aisladas de arcilla negra.

SANDY CLAY cemented CARBONATE: Arcilla arenosa marrón cementada con carbonatos. Nivel (2cm) de ulexita.

SILTY SAND: Arena media a fina limosa gris.

CLAY: Arcilla marrón-rojiza (5YR 5/2) con escasas manchas irregulares de arcilla negra.

NO RECUPERADO.

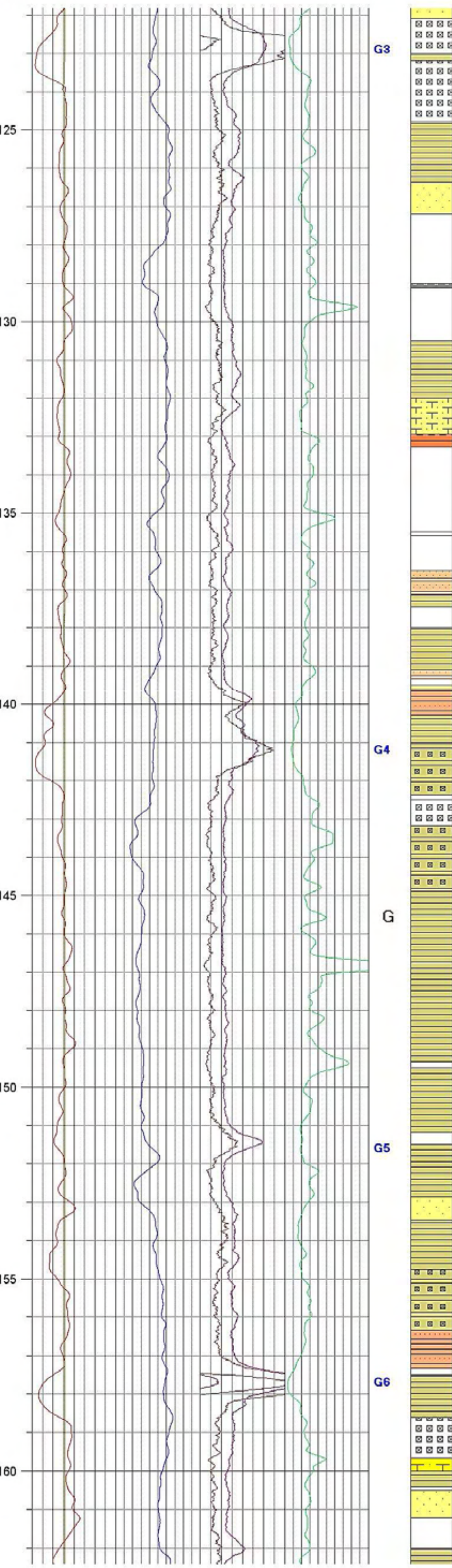
CLAY: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra y ulexita. Nivel intrcalado de arena fina a muy fina limosa gris (N5).

SAND : Nivel de arena media a fina con escaso limo. Escasas y finas papas (1 a 2cm) de ulexita. Nivel intrcalado (3cm) de arcilla gris verdosa-oscura.

NO RECUPERADO.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 24-09-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-06
RESOURCE EVALUATION PROGRAM		DRILL RIG: DIAMON BIT	END DATE: 14-10-2010	E: 3426985	Page 4 of 5
		METHOD: CORE BARREL	DEPTH: 199,5m	N: 7398997,54	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 7398998	

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



CLAY: Arcilla marrón (5YR 5/2) con escasos rastros de arcilla negra, ulexita y manchas anaranjadas (rejalgar/oropimente?).

SAND: Arena media a fina limos a gris (N5) con muy escaos rastros de arcilla.

HALITE: Halita gris oscura a negra transición de textura microcristalina en tope a cristales euhedros (hasta 3mm) masivo muy compacto. En los últimos 20cm microcristales sueltos de halita con muy escasa arena fina a muy fina.

HALITE: Halita en gruesos cristales euhedros (2 a 20mm) con escasos rastros de arcilla negra. Nivel masivo muy compacto.

CLAY: Arcilla marrón (5YR 5/2) muy escasos rastros de arcilla negra.

HALITE: Nivel de halita masiva muy compacta con muy escasos rastros de arcilla negra. Cristales euhedros de 0,5 a 2cm.

CLAY: Arcilla rojiza-pálida (10R 5/4) muy escasos rastros irregulares de arcilla verde (10GY 5/2).

CLAY: Arcilla marrón-oscura (5YR 3/2) muy escasos y finos rastros de ulexita.

SAND: Nivel de arena media a fina limosa gris (N6).

NO RECUPERADO.

BLACK HALITE: Halita microcristalina gris-oscura a negra y gruesas papas de ulexita (7cm).

NO RECUPERADO.

CLAY: Arcilla marrón-rojiza (10R 3/4) con papas (1 a 2cm) alternadas de ulexita.

SILTY SAND: Arena media a fina limosa gris con 3 niveles de 17, 7 y 10cm cementados con halita?.

SILTY CLAY: Arcilla limosa marrón (5YR 5/2) con escasas papas (1 a 2cm) de ulexita.

NO RECUPERADO.

HALITE: Halita masiva muy compacta con cristales euhedros traslucidos (3a 10mm) y escasas papas (1cm) de ulexita.

NO RECUPERADO.

SAND Interbeded CLAY: Arena muy fina limosa gris intercala con dos niveles (14, 3 y 5cm) de arcilla limosa marrón (5YR 3/4).

CLAY: Arcilla marrón (5YR 3/4) con escasos niveles de ulexita (2cm) con finos (0,5cm) y aislados crsitales de selenita, algunos forman rosas del desierto.

NO RECUPERADO.

CLAY: Arcilla marrón-oscura (5YR 3/4) intercala con niveles (1 y 4cm) de arcilla marrón-clara (5YR 7/2) muy escasos cristales (0,5 a 1cm) de halita euhedra diseminada.

CLAY: Arcilla marrón-clara (5YR 7/2) con abundantes cristales euhedros traslucidos de halita (hasta 1cm) en finos niveles y diseminados. Escasas manchas anaranjadas pulverulentas (rejalgar/oropimente?).

SAND Interbeded CLAY: Arena muy fina limosa (seca) gris (N6). Últimos 6cm de arcilla limosa marrón (5YR 3/4) con abundantes papas (hasta 3cm) de ulexita.

NO RECUPERADO.

SAND: Arena muy fina cementada con halita?. Escasas papas (<1cm) de ulexita.

CLAY Interbeded SAND: Arcilla marrón-oscura (5YR 3/4) con ulexita en papas (1 a 3cm) y nivel (11cm) central de arena muy fina limosa gris. Muy escasos rastros de arcilla negra.

CLAY: Arcilla rojiza-pálida (10R 5/4) con escasas papas de ulexita (2cm) y manchas aisladas de arcilla negra. Muy escasas manchas amarillentas (FeOx?).

CLAY with HALITE: Arcilla marrón-clara (5YR 6/4) con abundantes cristales de halita euhedra traslucida (hasta 1cm) disminados. Intercalan niveles masivos de halita masiva irregular (1 a 10cm) conformados por cristales euhedros traslucidos (0,5 a 2cm) y muy escasos rastros de arcilla negra.

NO RECUPERADO.

HALITE: Halita masiva muy compacta con escasa presencia de arcilla marrón clara con escasa arcilla negra. Finas papas (0,5cm) de ulexita. Cristales traslucido euhedros (0,5 a 1cm). Escasas y aisladas manchas anaranjadas (FeOx?).

CLAY with HALITE: Arcilla marrón-clara (5YR 6/4) con abundantes y gruesos cristales (0,5 a 2cm) de halita traslucida subhedra a euhedra diseminada y en nivel de 4cm y nivel incial cementado con halita?.

CLAY: Arcilla rojiza-pálida (10R 5/4) con gruesos y muy escasos cristales de halita anhedra (3cm). Ratsros de arcilla negra y escasa manchas anaranjadas (FeOx?). EN los últimos 19cm pasa a arcilla marrón-pálida (10YR 6/2).

CLAY: Arcilla rojiza-pálida (10R 5/4). Muy escasos rastros de arcilla negra y FeOx?.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6). Abundantes papas de ulexita (1 a 3cm) disminuye proporcón hacia la base. Muy escasos niveles (1 a 2mm) de arcilla negra.

NO RECUPERADO.

CLAY: Arcilla rojiza-pálida (10R 5/4) con muy escasos rastros de arcilla negra y manchas de FeOx?.

SAND: Arena media a fina fuertemente cementada (halita?). Nivel intermedio (13cm) no cementado con muy escasa arcilla.

CLAY: Arcilla marrón-pálida (10YR 6/2) con muy escasos rastros de arcilla negra y manchas aisladas FeOx?. Nivel intermedio de arcilla gris-verdosa (5Y 5/2). Escasos cristales de halita traslúcida (2 a 5mm) diseminados.

CLAY with HALITE: Arcilla marrón con abundantes y gruesos cristales de (0,5 a 2cm) halita euhedros a asubhedros diseminados y en escasos niveles (2 a 3cm) de halita masiva. Muy escasas manchas anaranjadas (FeOx?).

CLAY Interbeded SAND: Arcilla rojiza-pálida (10R 5/4). Nivel basal (10cm) de arena media a fina fuertemente cementada (halita?).

CLAY Interbeded SAND: Arcilla marrón (5YR 6/4) con nivel basal (4cm) de arena fuertemente cementada (halita?).

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con muy escasos rastros de arcilla negra. Nivel (15cm) limo-arcilloso cementado (halita?). Muy escasa ulexita y finos cristales de halita.

HALITE: Halita masiva muy compacta conformada por gruesos cristales euhedros (1 a 2cm) traslucidos. Muy escasoa rastros de material arcillo-limoso.

SILT: Limo-arcilla(?) gris clara a marrón cementada con halita? Y papas de ulexita (3cm). Hacia la base (19cm) limo-arena muy fina marrón (5YR 3/4).

CLAY: Arcilla rojiza (10R 4/6).

NO RECUPERADO.

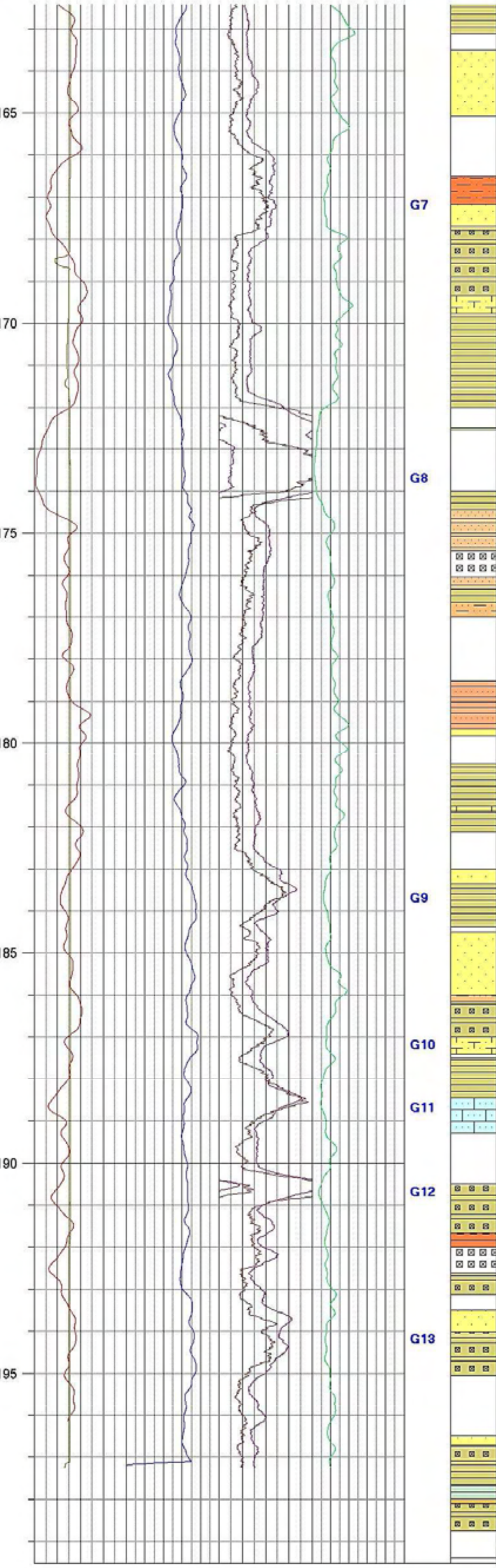
SAND: Arena media a fina gris (N5) con muy escasos rastros irregulares de limo y arcilla.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos niveles (0,5 a 1cm) de arcilla negra.

OROCOBRE	OLAROZ PROJECT	CONTRACTOR: MAJOR	START DATE: 24-09-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: CD-06
RESOURCE EVALUATION PROGRAM		DRILL RIG: DIAMON BIT	END DATE: 14-10-2010	E: 3426985	Page 5 of 5
		METHOD: CORE BARREL	DEPTH: 199,5m	N: 7398997,54	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 7398998	

Depth (m)	Caliper 0 Inch's 10 / Gamma N. 0 Api 200	Density 2 gr/cc 3	Neutron Near 0 cps 500 / Neutron Far 0 cps 100	Porosity 0 Por 100	Units	Geol. Log	Lithology	Depth (m)	Elevn. (m)



NO RECUPERADO.

SAND: Arena media a fina gris (N4) muy escaso limo.

NO RECUPERADO.

SANDY CLAY: Mix de arcilla marrón (5YR 4/4) con arena fina arcillosa gris-oscura (intercalación deformada?).

SAND: Arena media a fina gris (N4) con muy escaso a nulo limo.

CLAY: Arcilla marrón-oscura (5YR 3/4) con escasos rastros de arcilla negra.

CLAY with HALITE: Arcilla marrón (5YR 4/4) con abundantes cristales de halita (0,5 a 1cm) euhedros traslúcidos diseminados y escasos niveles (1 a 3cm) de halita masiva. Papas de ulexita (1 a 3cm) en todo el nivel.

SILTY SAND: Arena fina limosa? Fuertemente cementada con halita? Y escasas papas (3cm) de ulexita.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos y finos (2 a 5mm) niveles de arcilla negra.

NO RECUPERADO.

SAND: Arena muy fina limosa gris (seca).

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos de arcilla negra.

CLAY: Arcilla marrón-oscura (5YR 3/4) con muy escasos niveles (2 a 3mm) de arcilla negra.

SAND Interbeded CLAY: Sedienento muy alterado. Intercalación (?) de arena media a fina gris con escaso limo y arcilla marrón (5YR 3/4) con escasos rastros de arcilla negra.

HALITE: Halita masiva muy compacta conformada por cristales (0,5 a 1cm) euhedros traslúcidos con muy escasos rastros de arcilla limosa marrón-rojiza intersticial. Finas (0,5cm) y muy escasas ulexita.

SAND Interbeded CLAY: Arena muy fina limosa cementada con halita (?). Abundantes niveles (1cm) y muy escasos rastros de arcilla negra.

CLAY: Arcilla rojiza-pálida (10R 6/2).

CLAYEY SAND: Arena muy fina limosa con escasa arcilla. Color del conjunto marrón-pálido (10YR 6/2) a gris. Muy escasas y finas (0,5cm) papas de ulexita.

NO RECUPERADO.

CLAY Interbeded SAND: Sediemento fuertemente alterado. Arcilla rojiza (10R 4/6) con escasas papas (1cm) de ulexita. Muy escasos raastros de arcilla negra y arcilla arenosa gris-oscura. En la base (últimos 8cm) arena muy fina a fina limosa.

SAND: Arena media a fina fuertemente cementada con halita?.

NO RECUPERADO.

CLAY: Arcilla rojiza (10R 4/6) con muy escasos ratstros de arcilla negra. Hacia el tope (19cm) arcilla limosa marrón-oscura (5YR 3/4) muy escasos rastros de arcilla negra.

SILTY SAND: Arena muy fina limosa marrón.

CLAY: Arcilla rojiza-pálida (10R 5/4) muy escasos rastros irregulares de arcilla negra y manchas anaranjadas pulverulentas (rejalgar/oropoimente?).

NO RECUPERADO.

SAND: Arena fina a muy fina marrón (10YR 6/2) a gris con muy escaso limo.

CLAY: Arcilla rojiza-pálida (10R 5/6) con muy escasas y aisladas papas de ulexita (1cm), menor rastros irregulares de arcilla negra.

NO RECUPERADO.

SAND: Arena media a fina limosa gris-oscura (N3) con papa (3cm) de ulexita. Intercala con niveles (3 y 5cm) de arcilla marrón-oscura con rastros irregulares de arcilla negra. Nivel basal (6cm) de halita masiva con cristales euhedros traslúcidos (0,5 a 1cm). Muy escasa y fina ulexita intersticial.

SAND: Arena media a fina fuertemente cementada con halita?. Abundantes y gruesos cristales de halita diseminada y nivel (5cm) masivo. Cristales euhedros traslúcidos (0,5 a 1cm). Abundantes y finas papas (0,5 a 2cm) de ulexita diseminada.

CLAYEY SAND: Arena arcillosa? Fuertemente cementada con halita?. Muy escasos y gruesos critales (2cm) de halita.

CLAY with HALITE: Arcilla marrón-pálida (10YR 6/2) con abundantes cristales de halita traslúcidos euhedros (0,5cm) diseminados. Muestra muy seca (cementada?). Muy escasa y fina ulexita.

SILTY SAND: Arena media a fina limosa fuertemente cementada con halita? (N7).

NO RECUPERADO.

CLAY: Arcilla marrón (5YR 5/2) con muy escasas y aisladas papas (1 a 2cm) de ulexita. Hacia la base se toma ligeramente gris-verdosa.

SAND cemented CARBONATE: Arena media a fina limosa fuertemente cementada con halita? Gris (N7). Nivel (5cm) con fuerte presencia de carbonatos. Escasos cristales (0,5cm) diseminados de halita.

NO RECUPERADO.

CLAY with HALITE: Arcilla verde-clara (5GY 7/2) limosa? (muy seca) cementada con halita?. Abundantes cristales de halita diseminados y y en niveles (3 a 5cm) Cristales euhedros traslúcidos (0,5 a 1cm) con escasas inclusiones de arcilla verde.

SILTY CLAY: Arcilla rojiza muy clara (rosada 5R 8/2) limosa?. Con escasos cristales aislados de halita euhedra traslúcida (1cm). Muy seca/cementada con halita?.

HALITE: Halita masiva muy compacta. Cristales traslucidos euhedros (0,5 a 1cm). Abundnates rastros de arena muy fina intersticial.

CLAY with HALITE: Arcilla marrón-pálida (10YR 6/2) y escasa verde-clara (5GY 7/2) cementada con halita?. Abundantes y gruesos cristales (hasta 2cm) de halita euhedra a subhedra traslúcida diseminada.

NO RECUPERADO.

SAND: Arena fina a muy fina gris a marrón con escaso limo. Abundantes cristales e halita (0,5 a 1cm) diseminados.

CLAY with HALITE: Arcilla rosada (limosa?) fuertemente cementada con halita? (5R 8/2) con abundantes cristales de halita diseminados (0,5 a 1cm) traslucidos. Nivel (1cm) de halita masiva muy compacta y nivel basal (6cm) de arcilla rojiza-pálida (10R 5/4).

NO RECUPERADO.

SAND: Arena muy fina fuertemente cementada con halita?.

CLAY with HALITE: Arcilla marrón-pálida (10YR 5/4) cementada con halita? Nivel (2cm) de halita cristalina (?). Escasa presencia de carbonatos.

CLAY: Arcilla marrón (10YR 6/2) con muy escasos rastros de arcilla negra.

CLAY cemented CARBONATE: Arcilla limosa marrón muy clara a blanquecina cementada con carbonatos.

CLAYEY SILT: Limo arcilla blanquecina muy friable.

CLAY with HALITE: Arcilla verdosa-clara (5GY 7/2) con cristales (0,5 a 1cm) de halita traslúcida euhedra diseminada. Intercala nivel de arcilla marrón-clara (5cm).

SAND : Arena muy fina limosa cementada con halita (?).Muy escasa presencia de carbonatos.

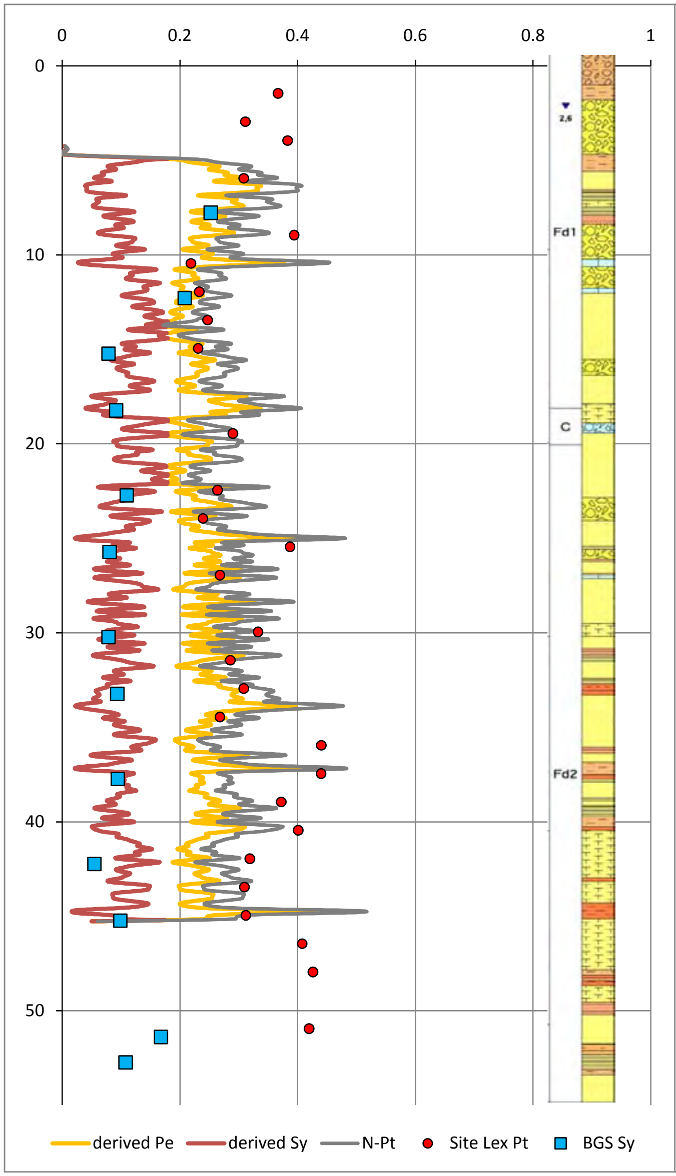
SAND: Arena muy fina limosa marrón a ligeramente gris con abundantes niveles y papas de ulexita (2cm). Nivel (3cm) fuertemente cementado con halita?. Escasa presencia de carbonatos.

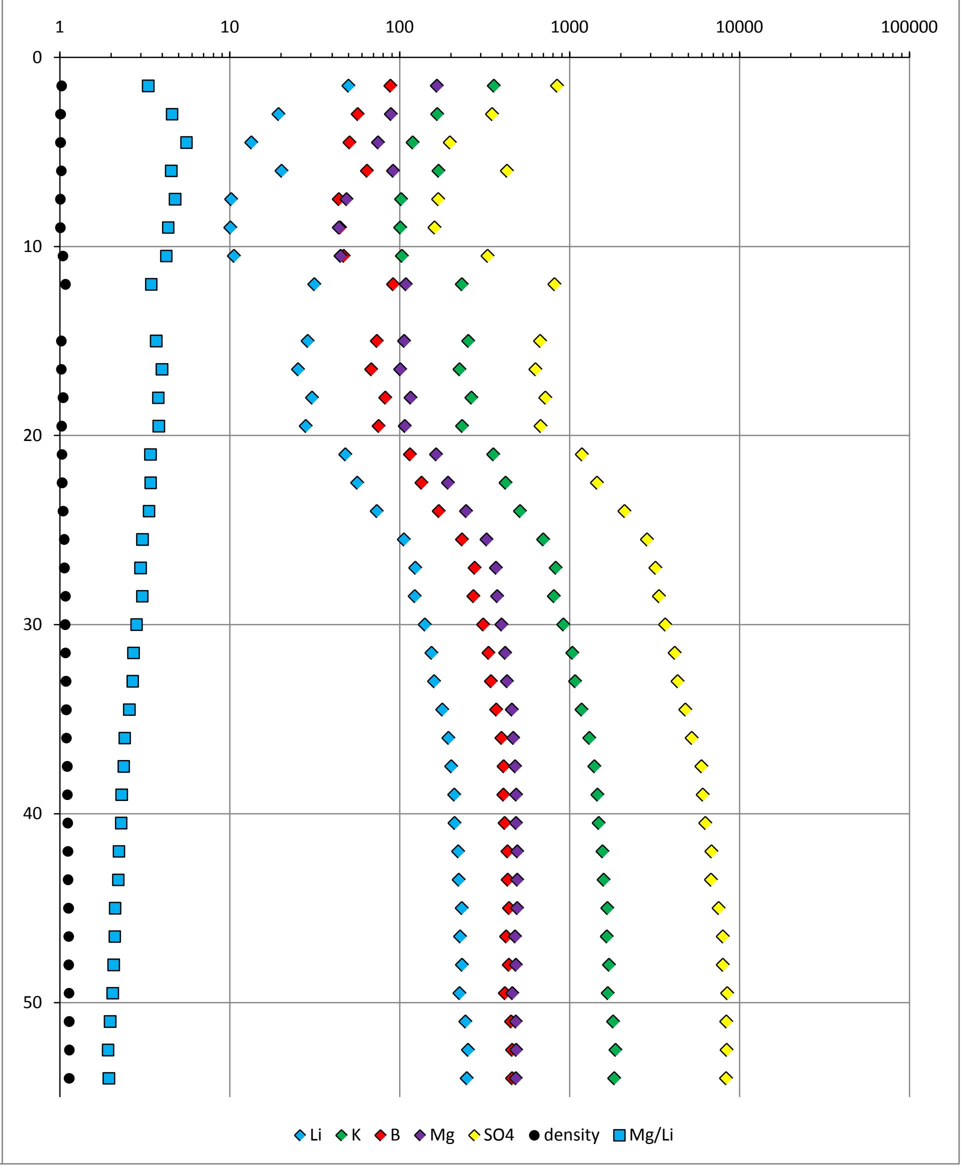
NO RECUPERADO.

APPENDIX B

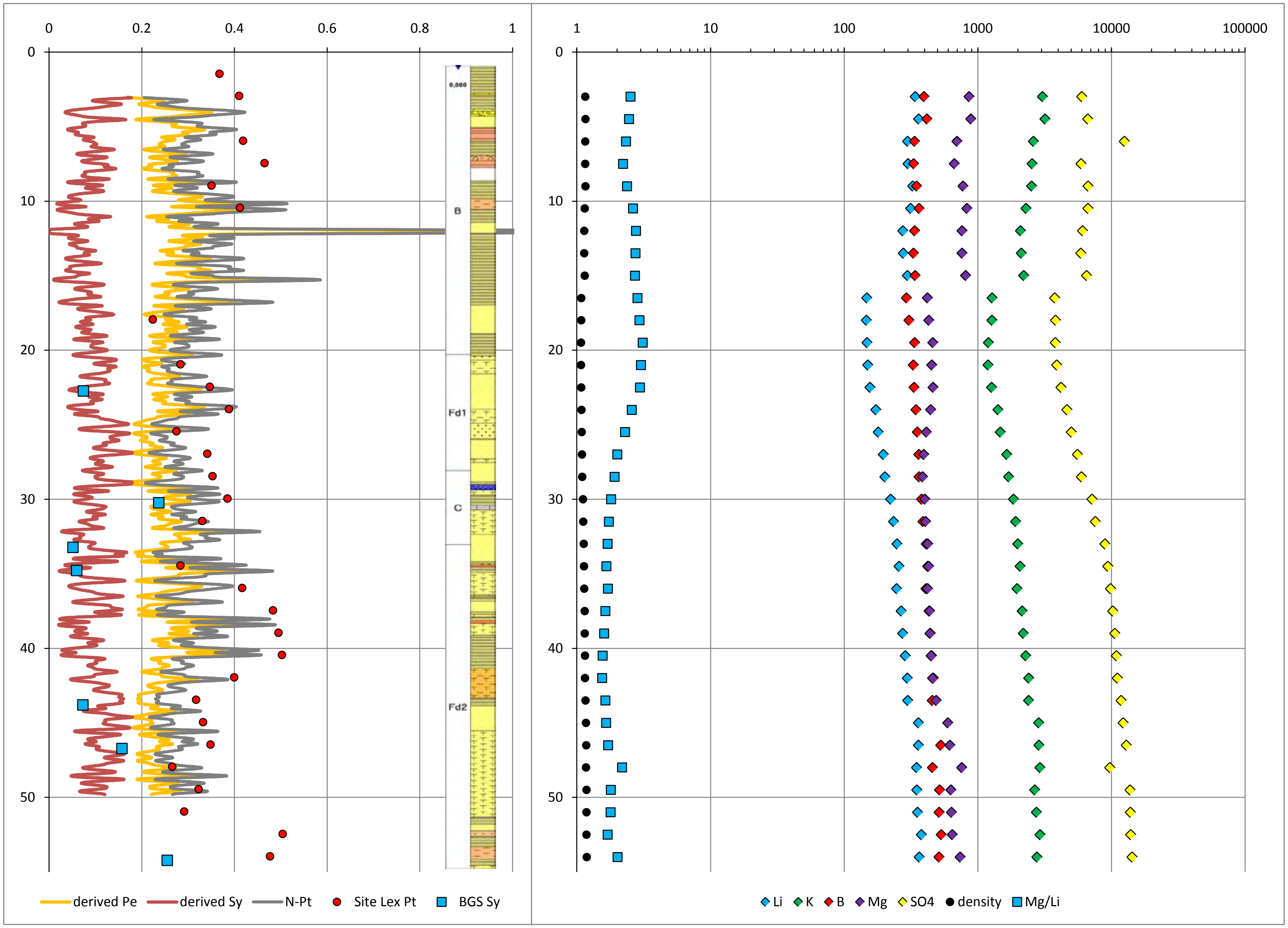
COMPOSITE WELL DATA

OROCOBRE: OLAROZ PROJECT **WELL REF: C00**

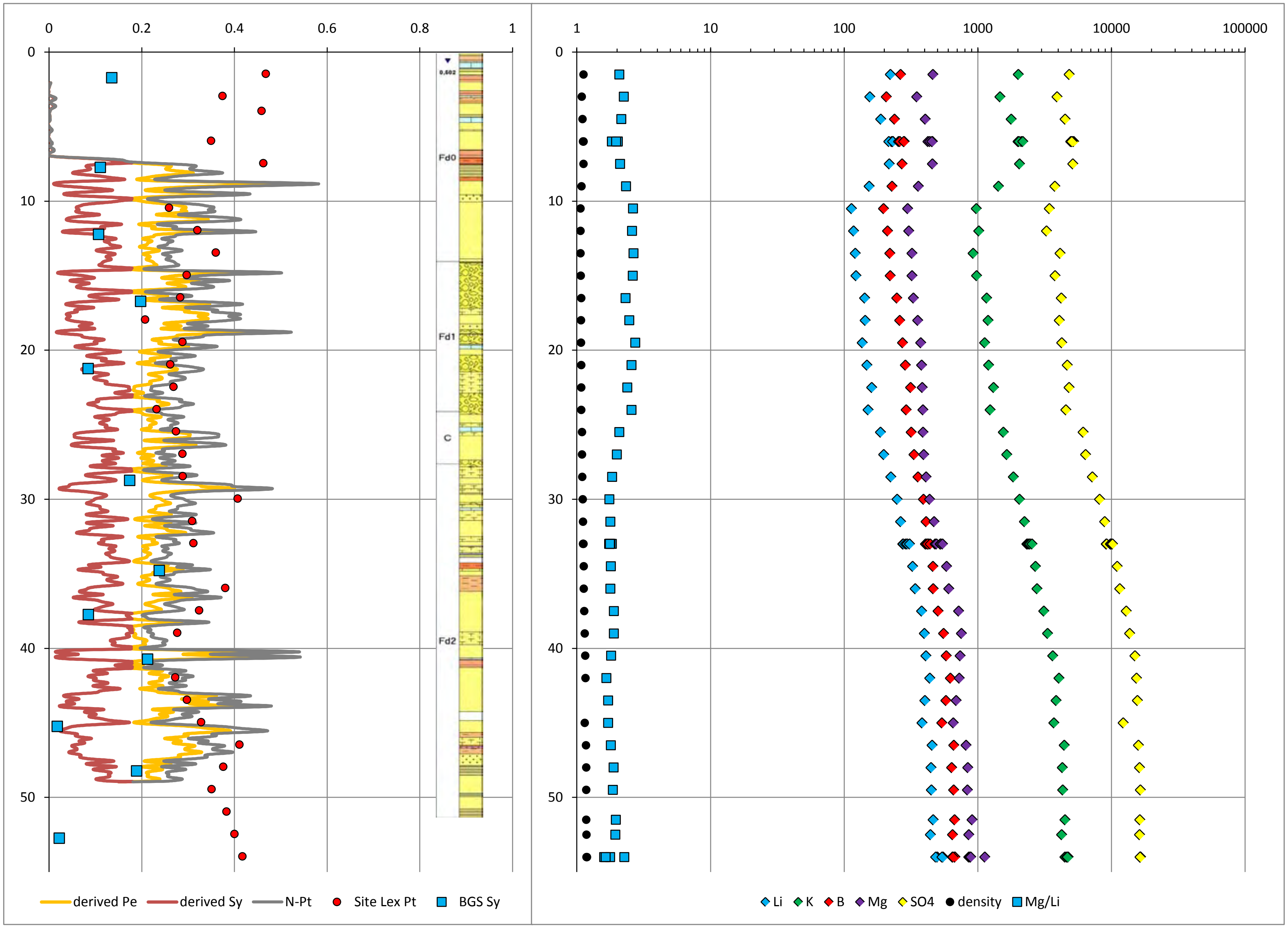




OROCOBRE: OLAROZ PROJECT **WELL REF: C01**

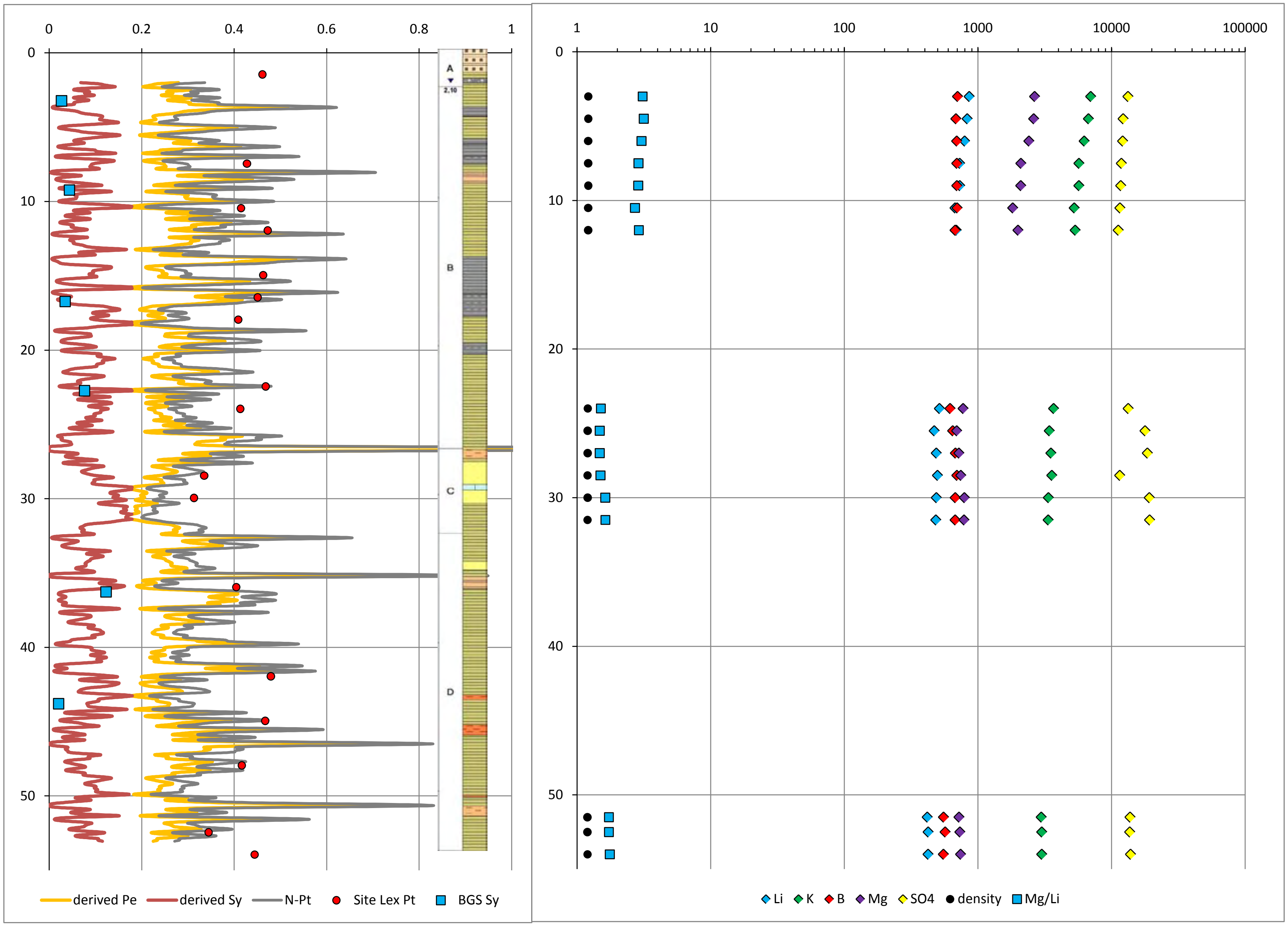


OROCOBRE: OLAROZ PROJECT **WELL REF: C02**



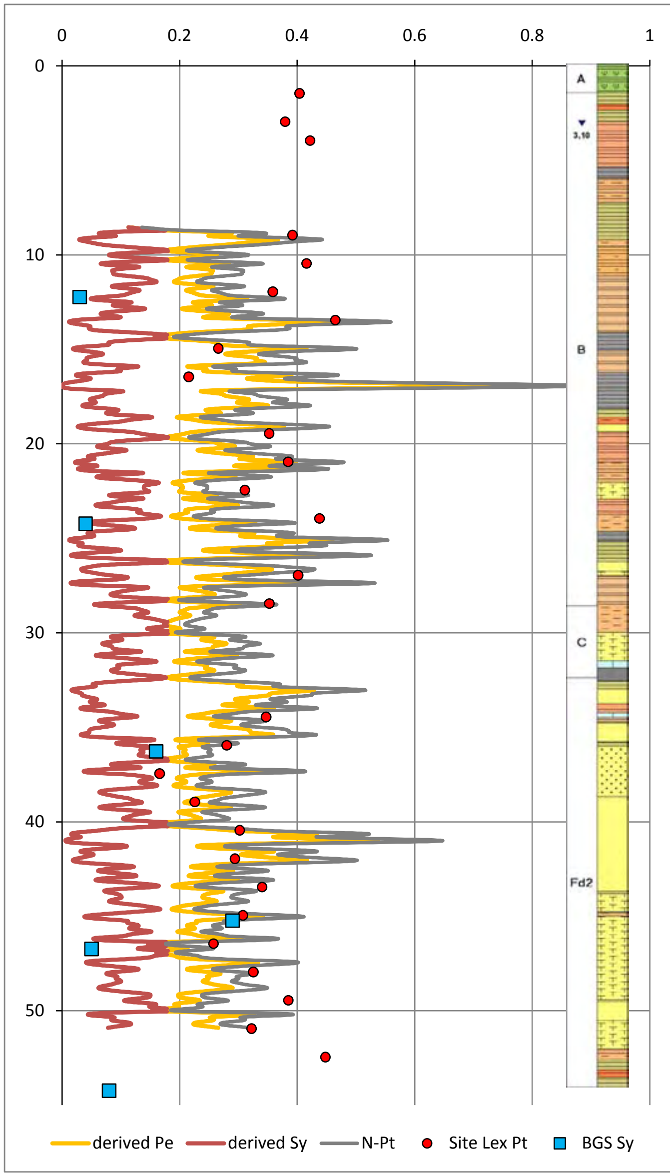
OROCOBRE: OLAROZ PROJECT

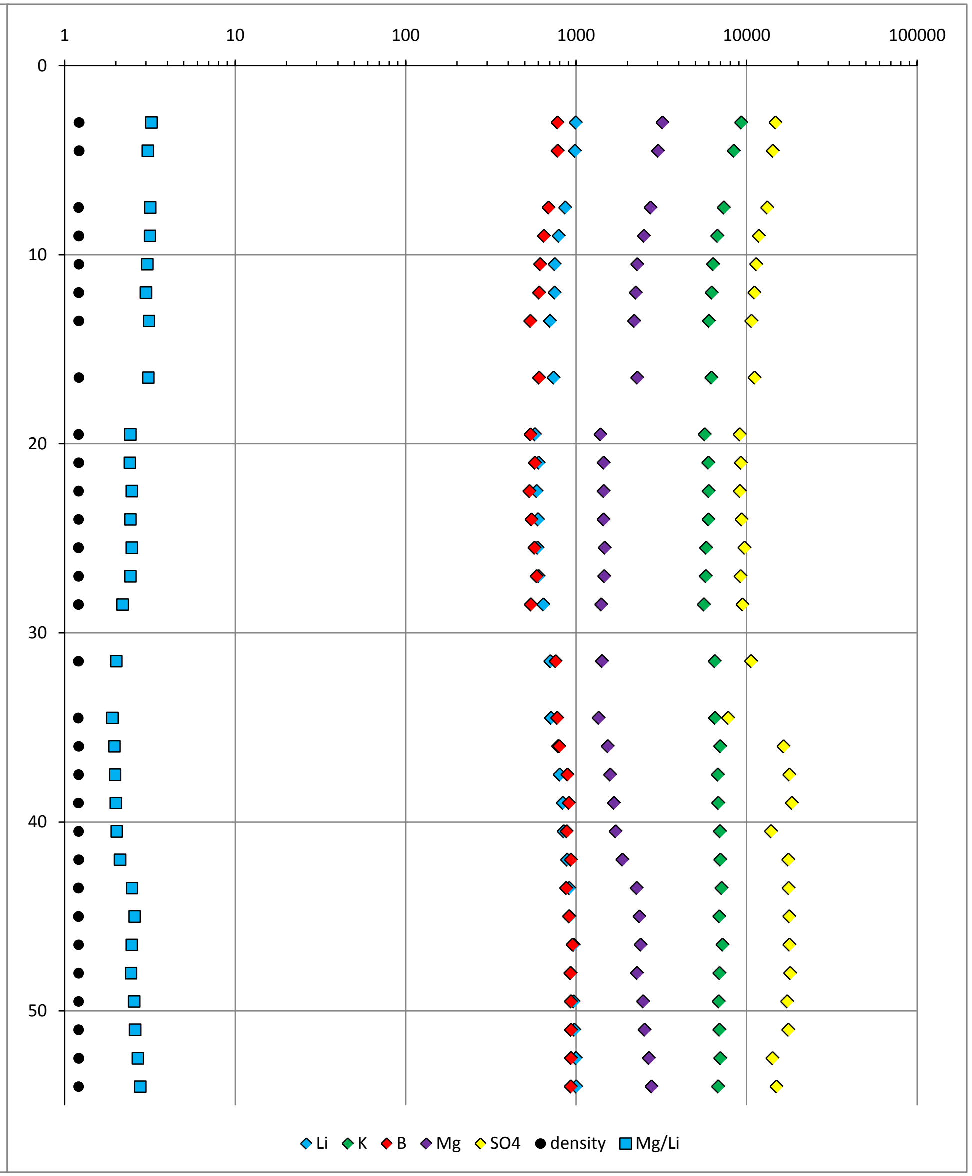
WELL REF:C03



OROCOBRE: OLAROZ PROJECT

WELL REF: C04





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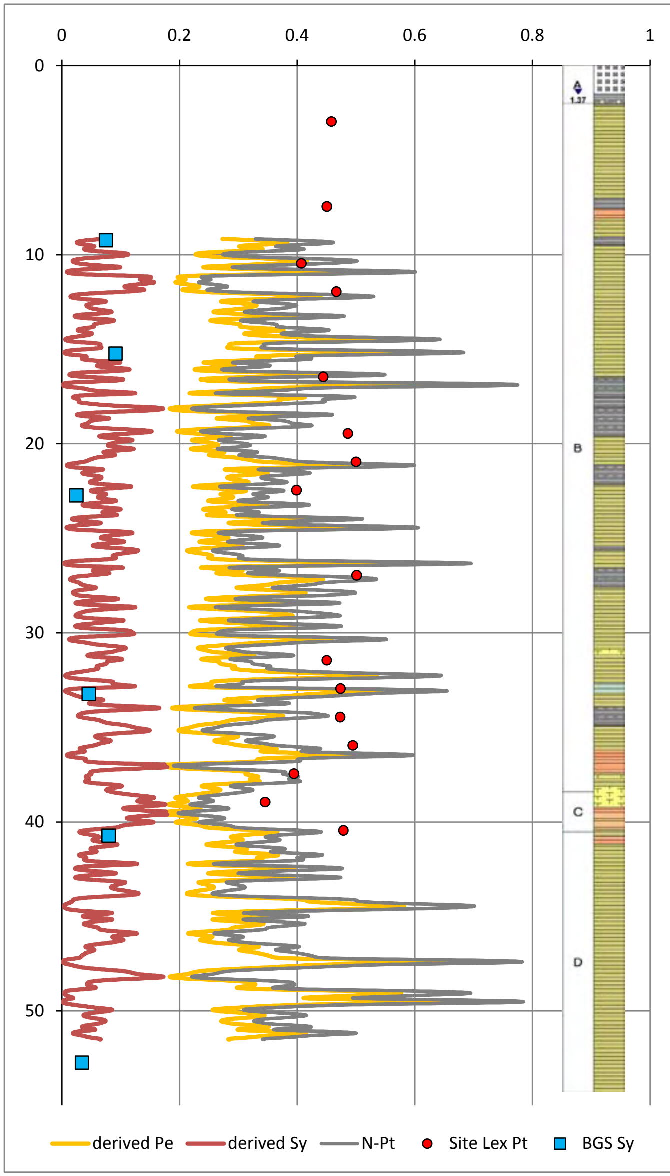
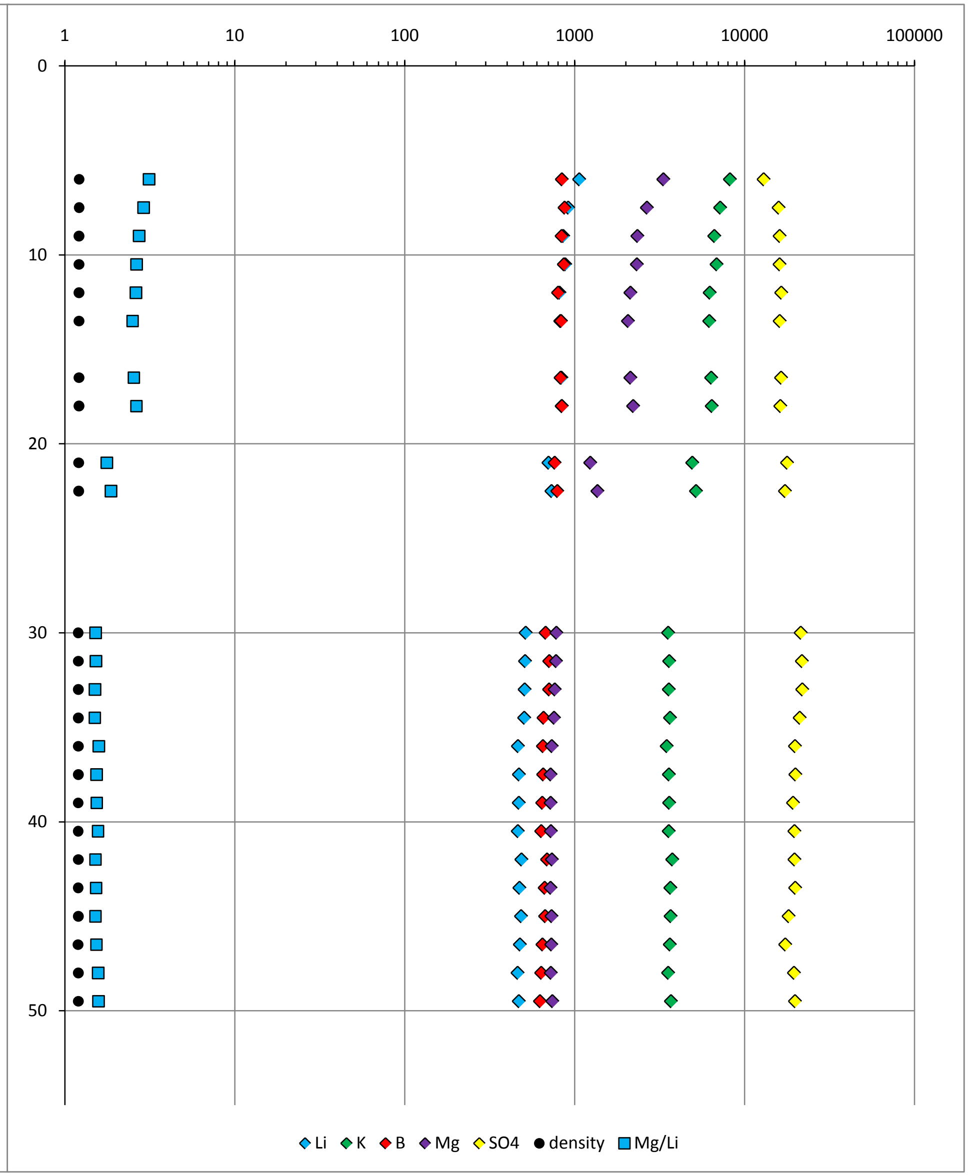
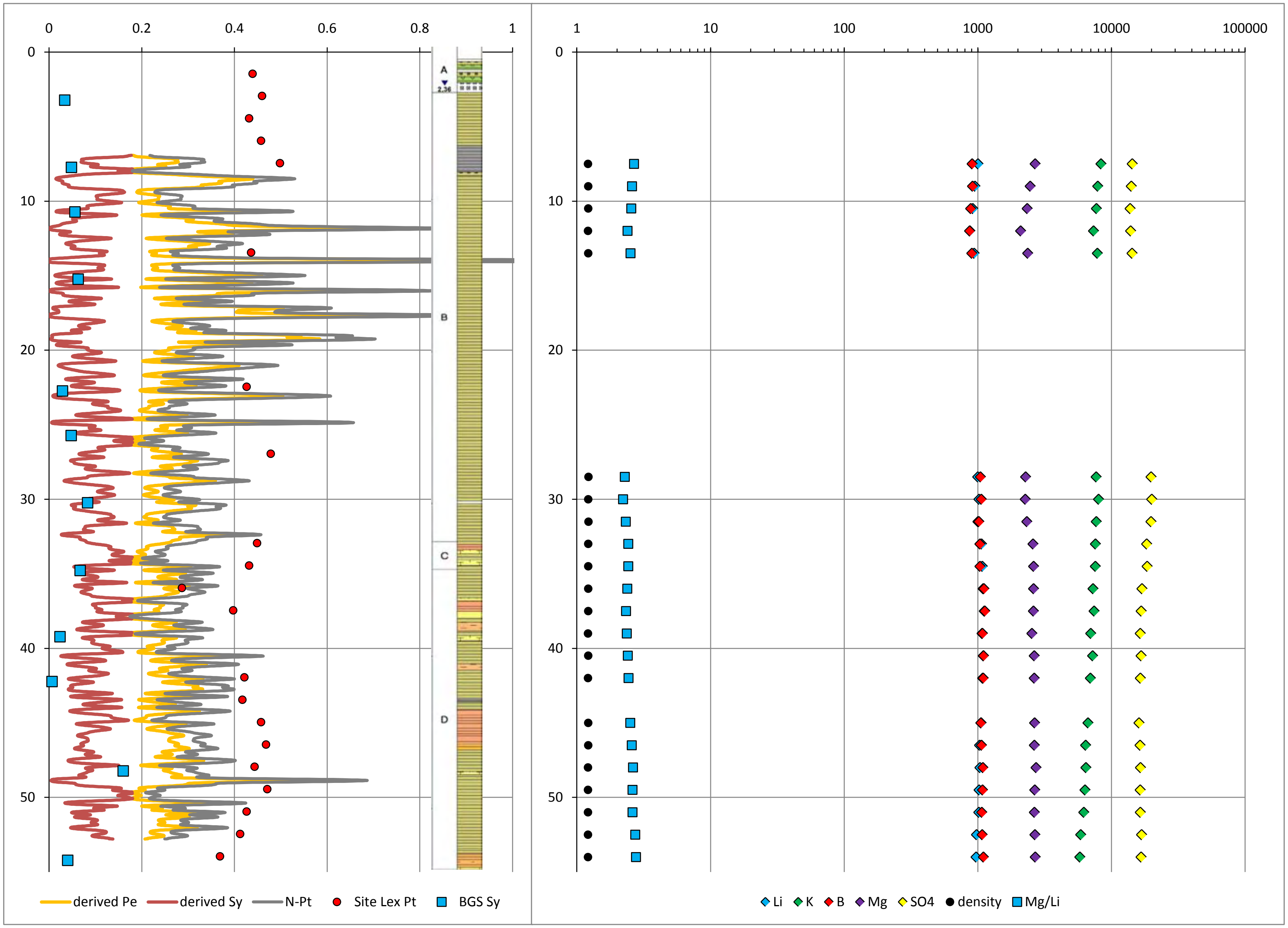




ORCOBRE: OLAROZ PROJECT

WELL REF: C06



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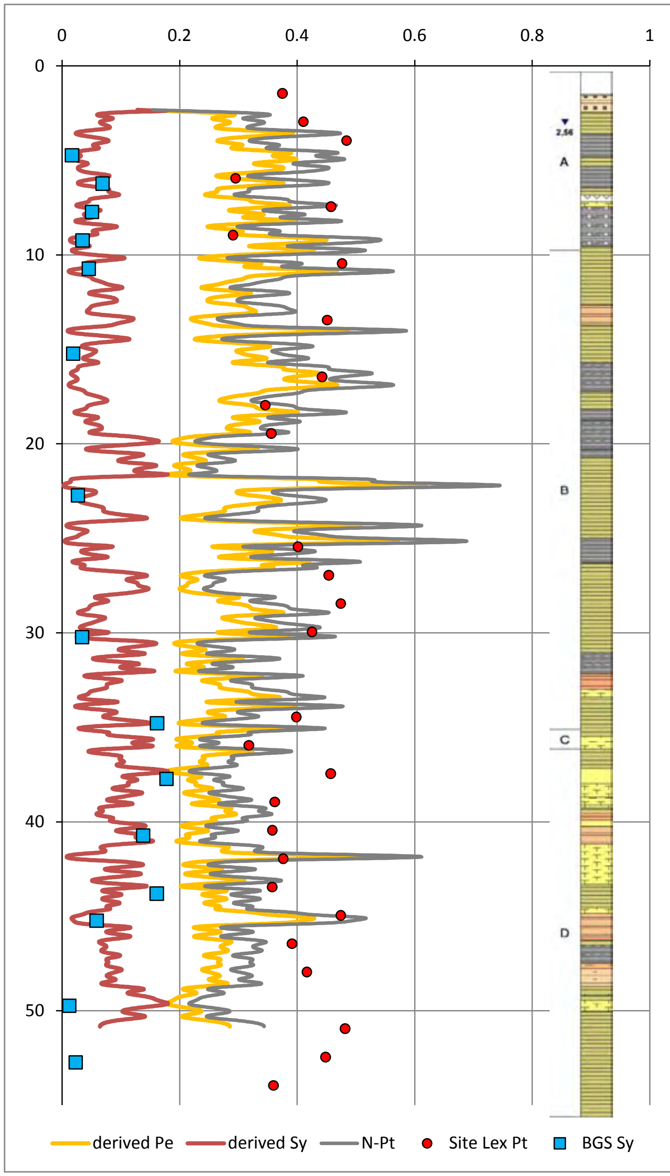

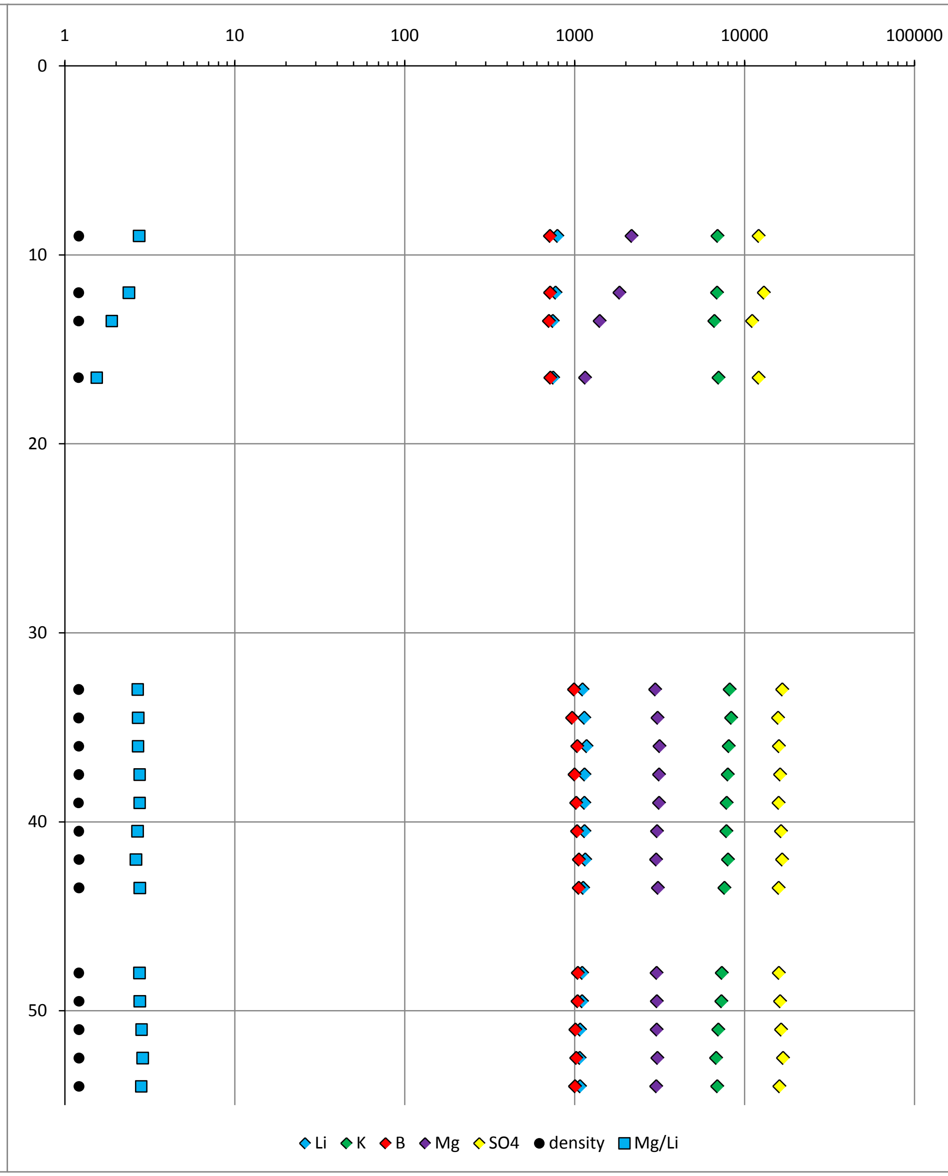

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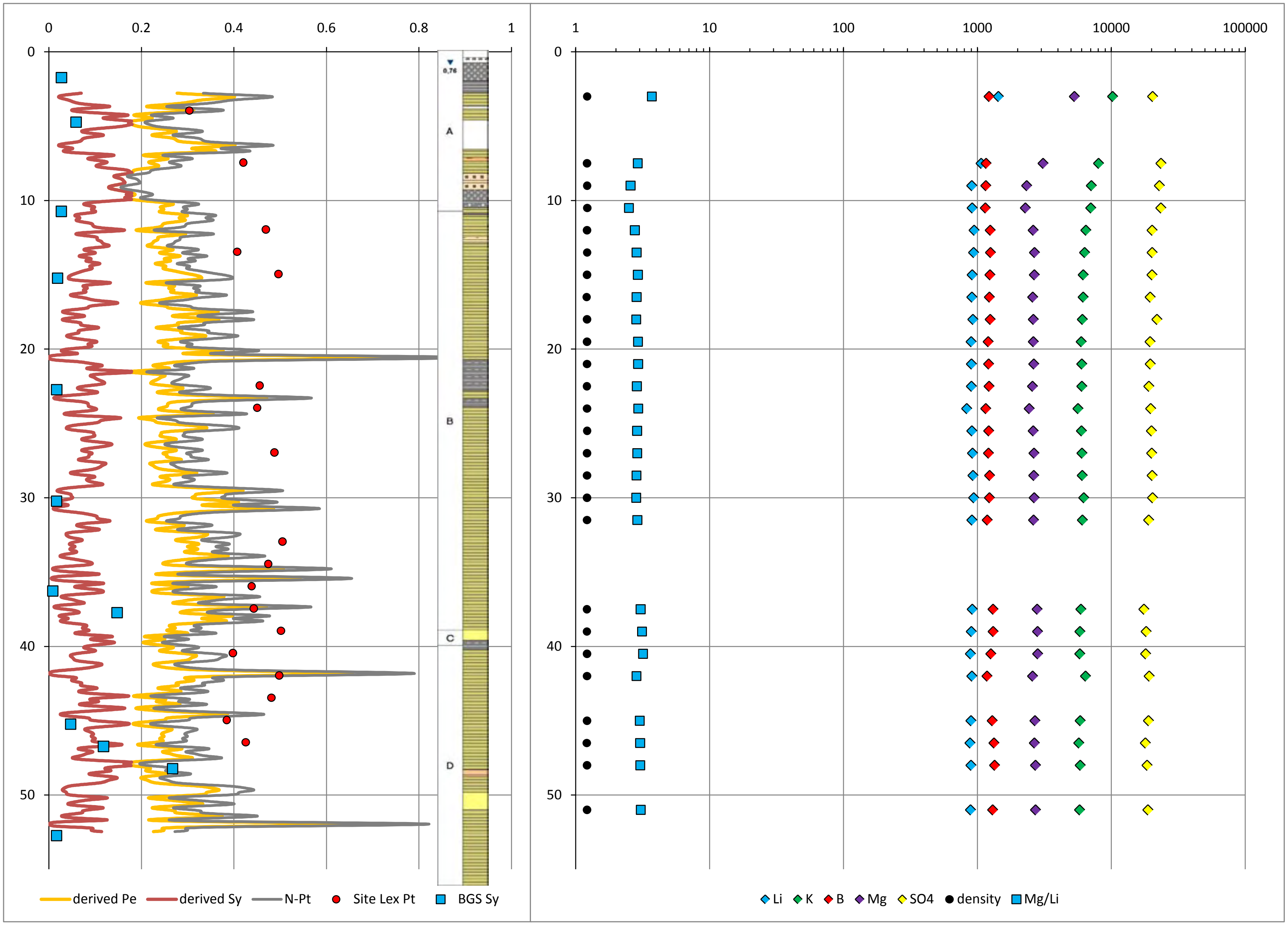

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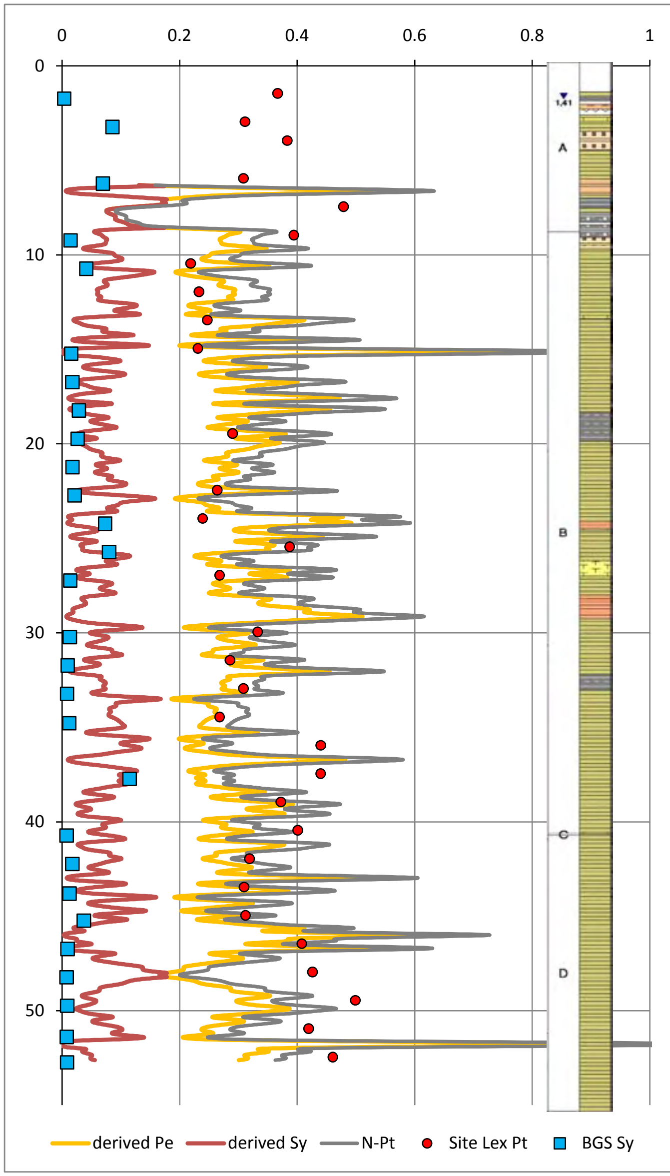

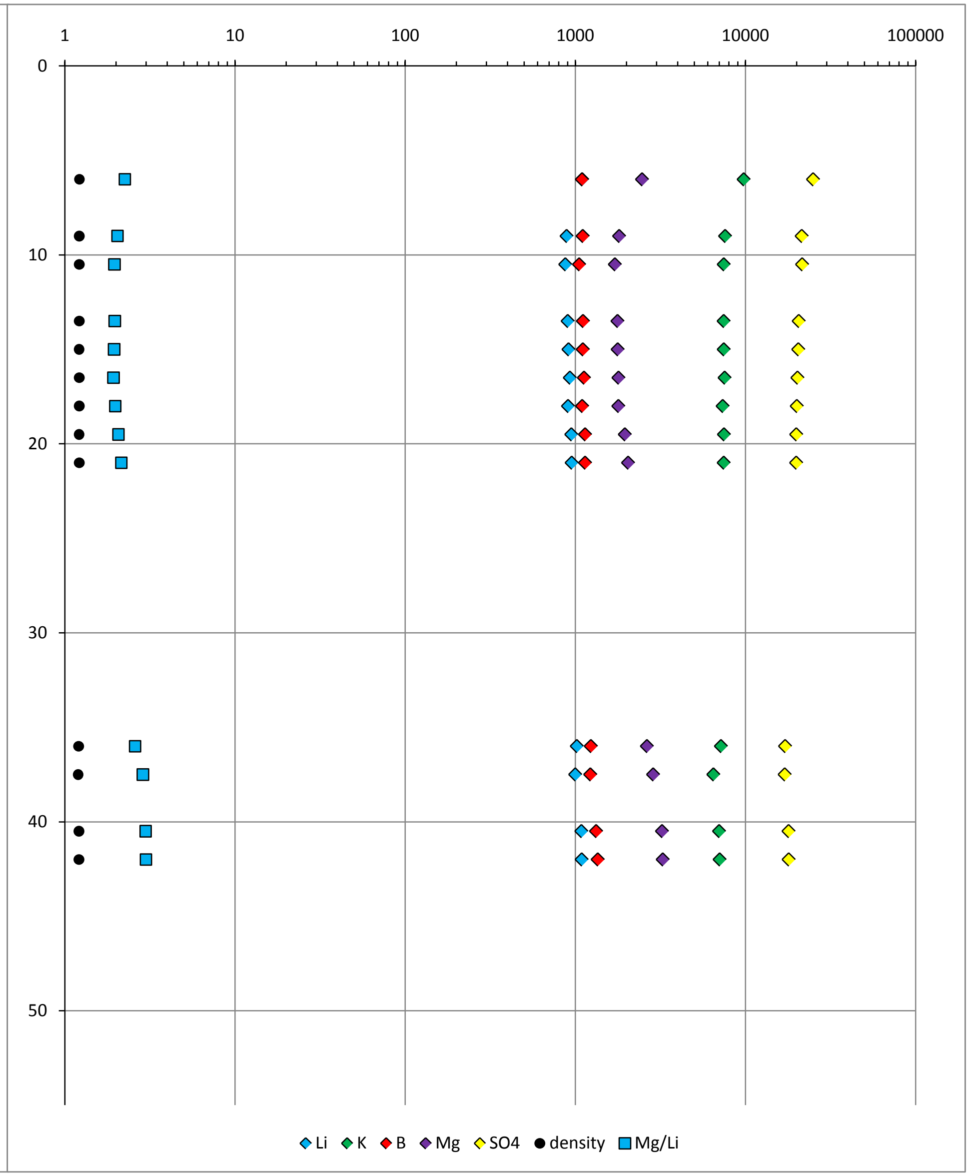

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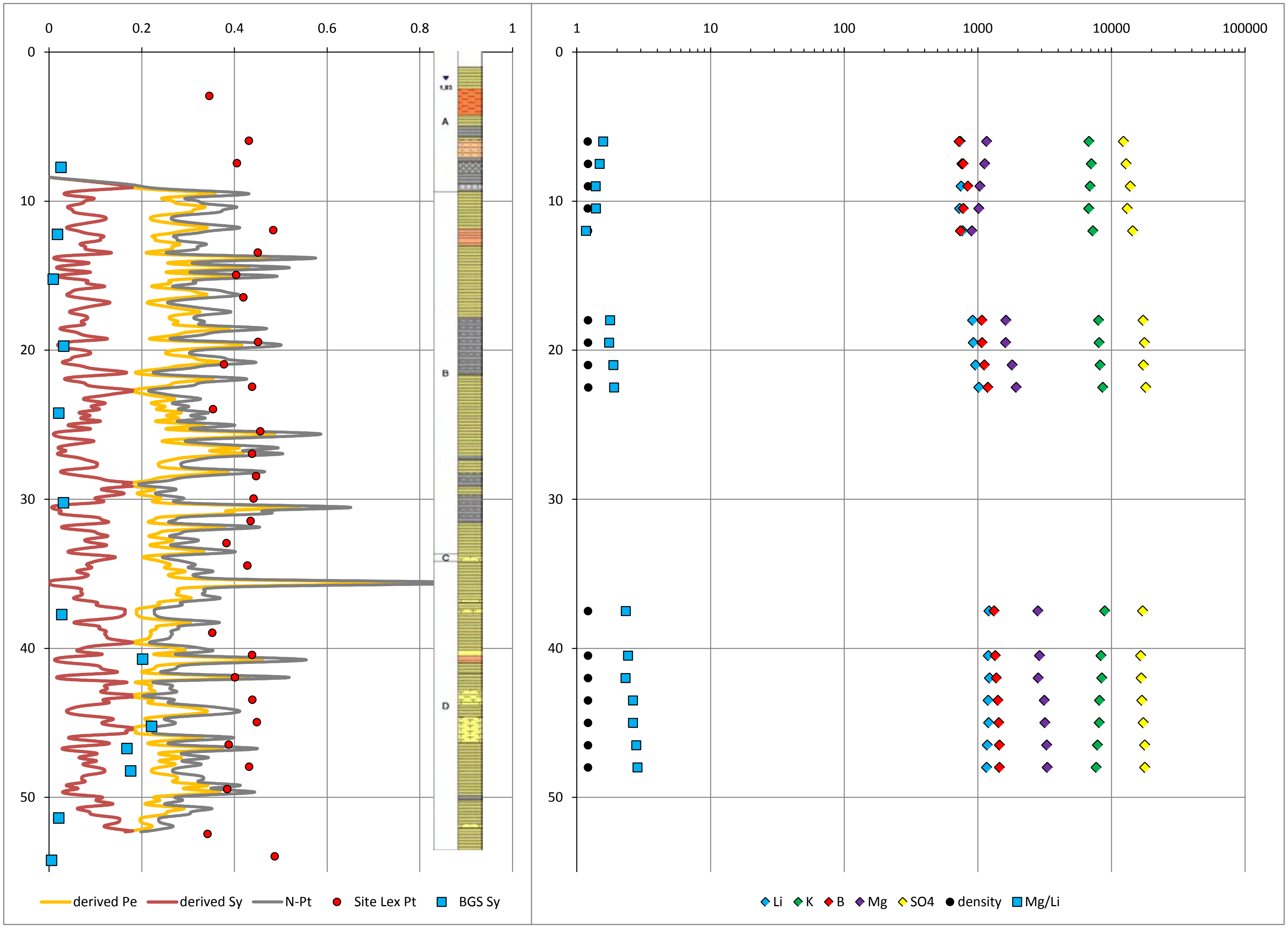
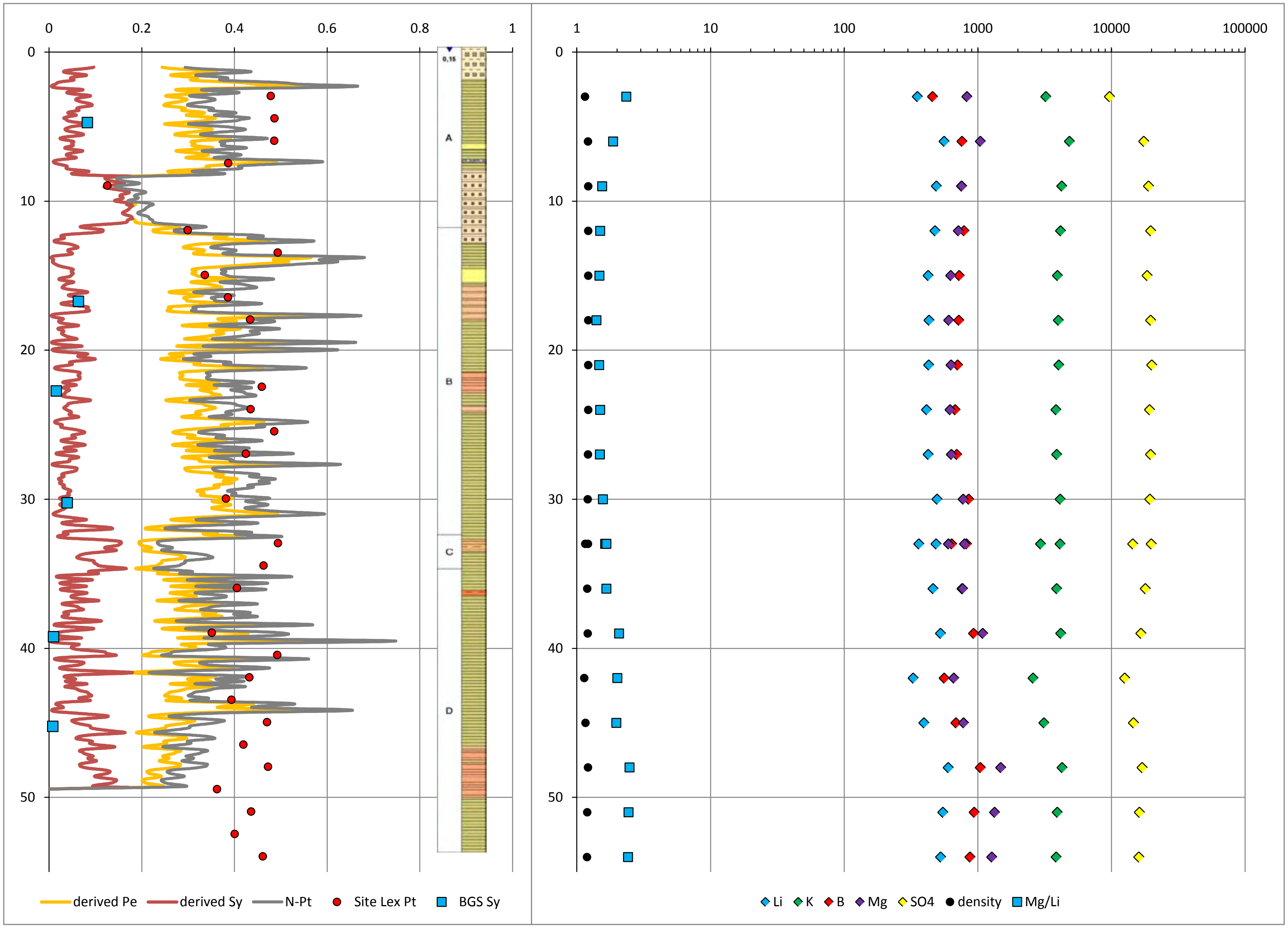
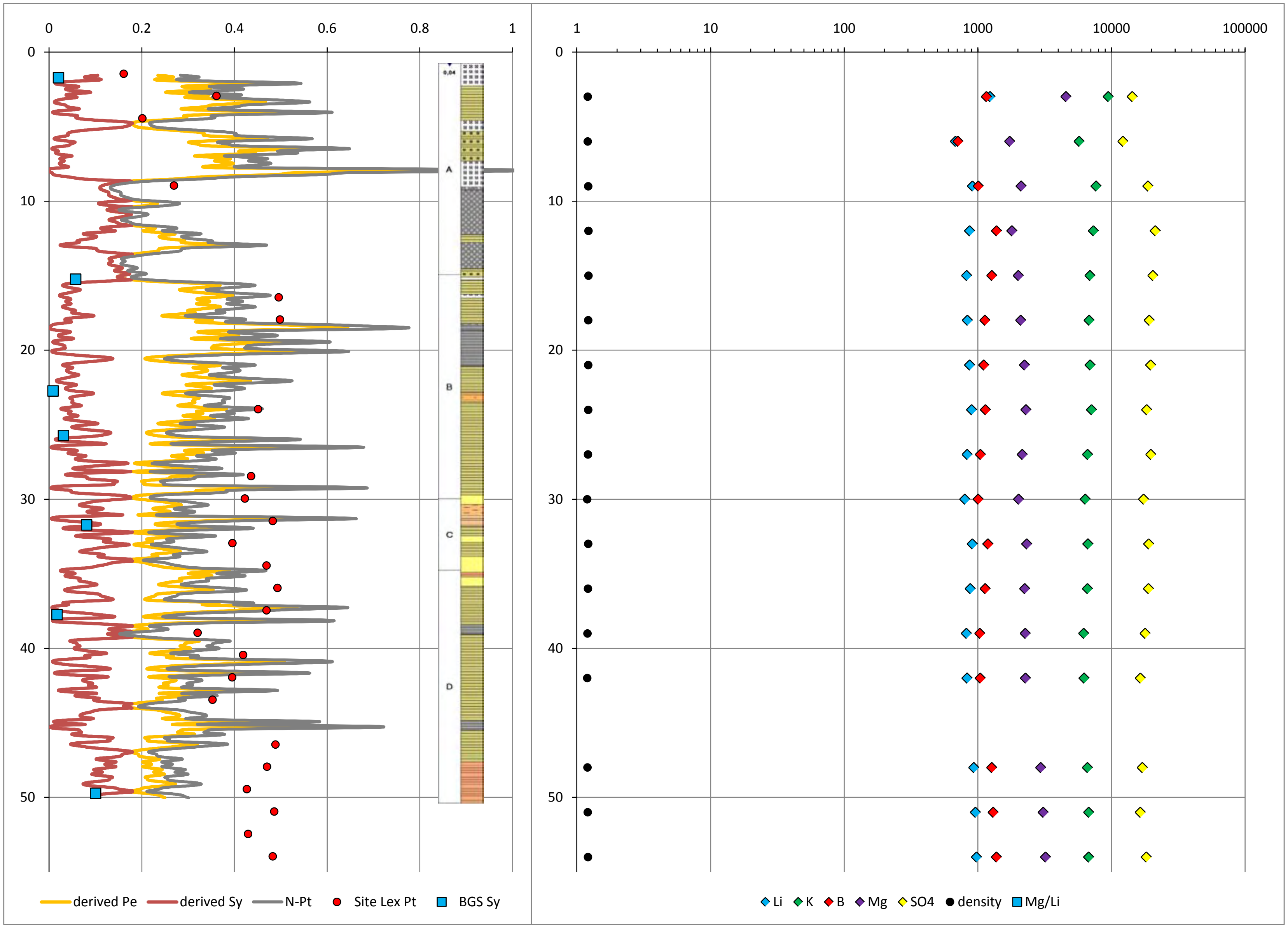


OROCOBRE: OLAROZ PROJECT

WELL REF: C11



OROCOBRE: OLAROZ PROJECT | WELL REF: C12



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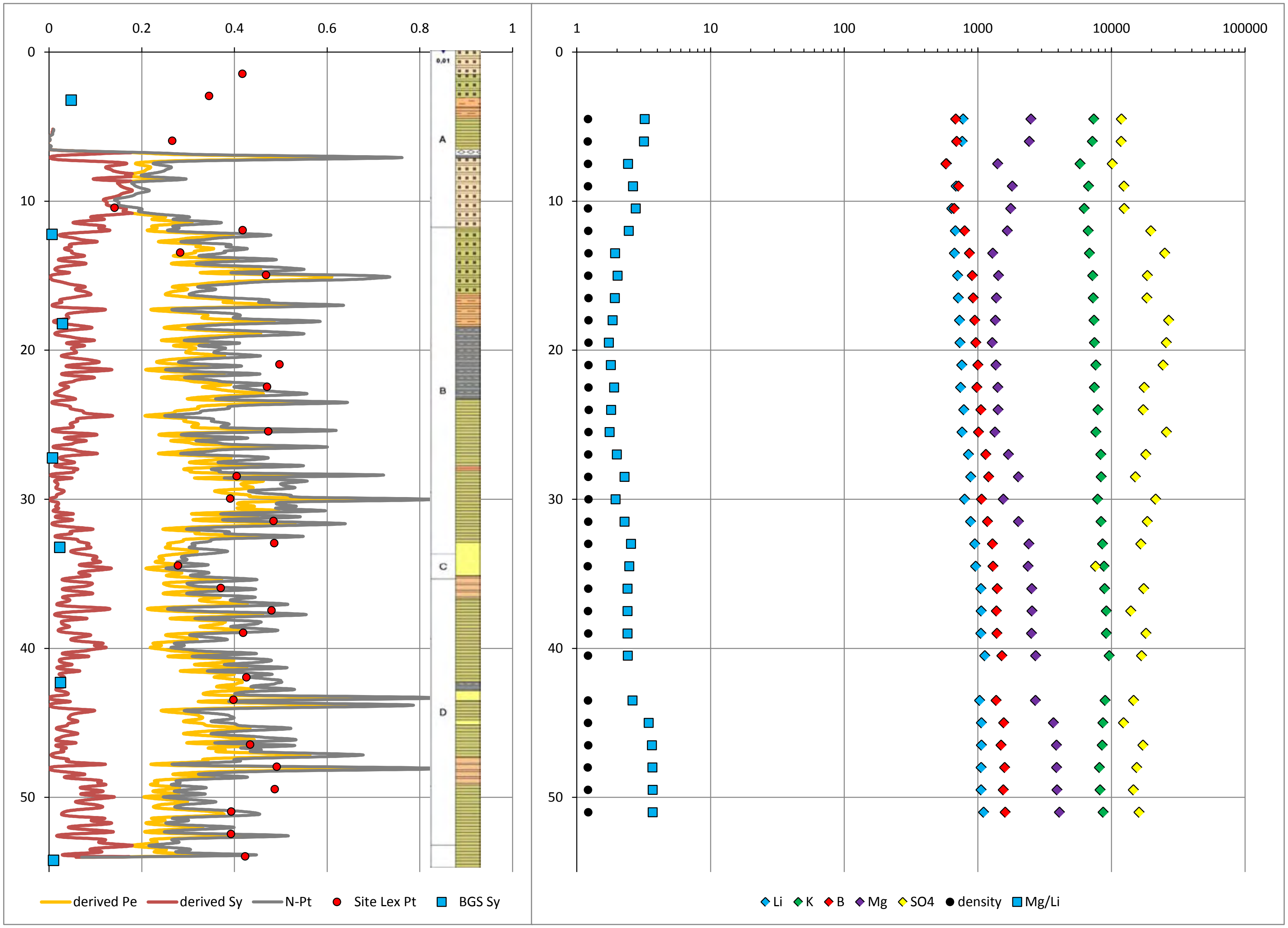

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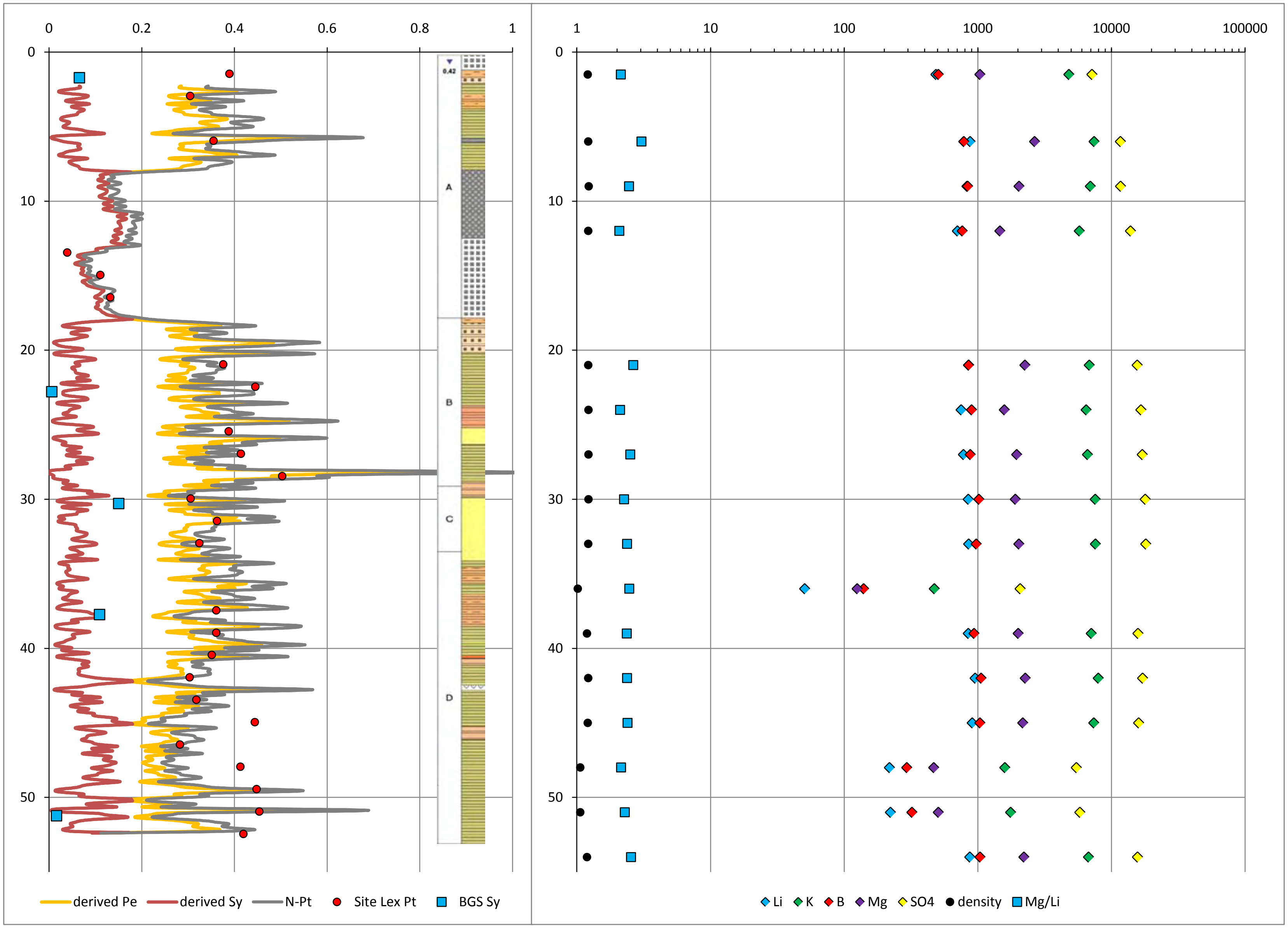
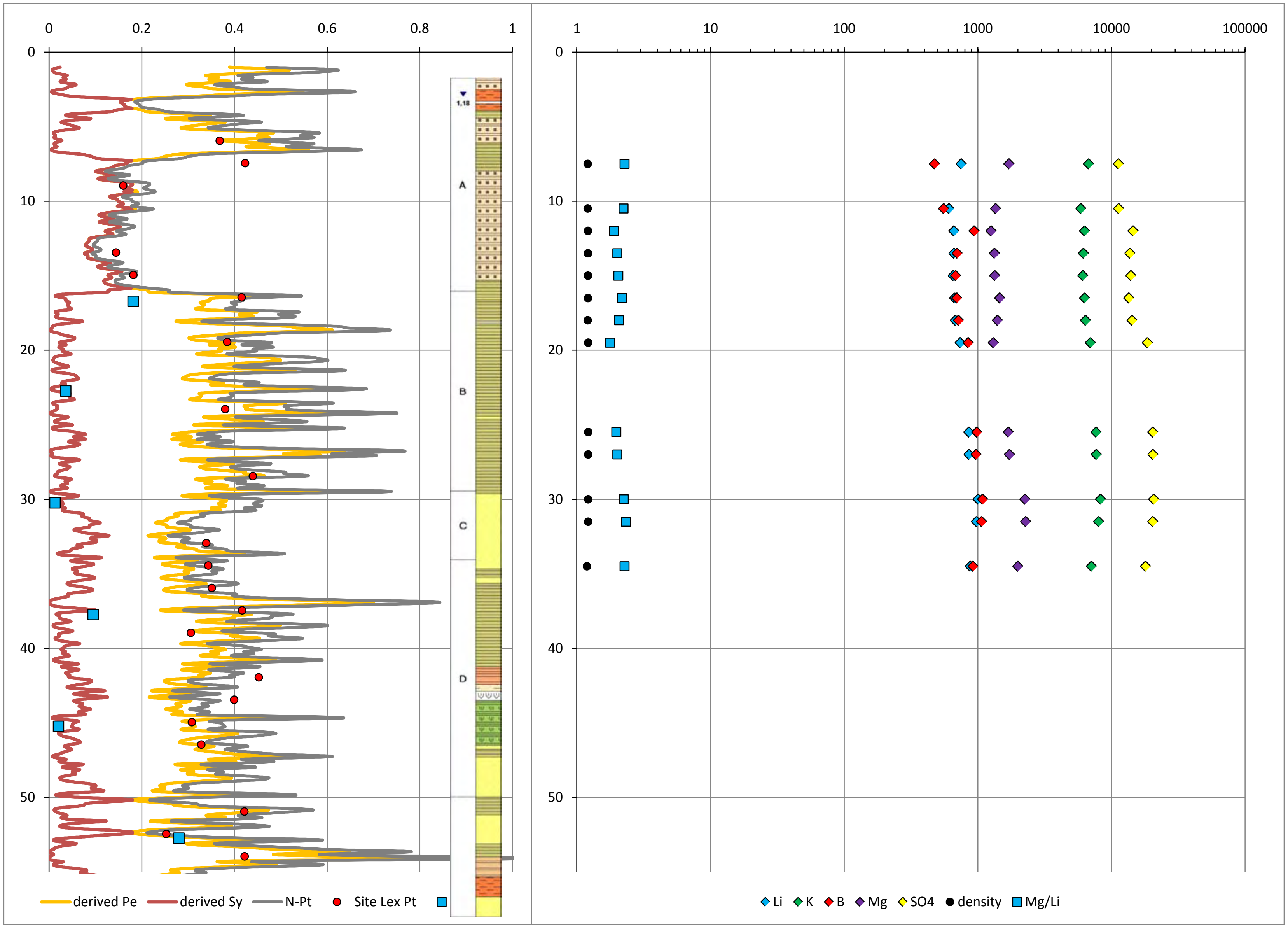


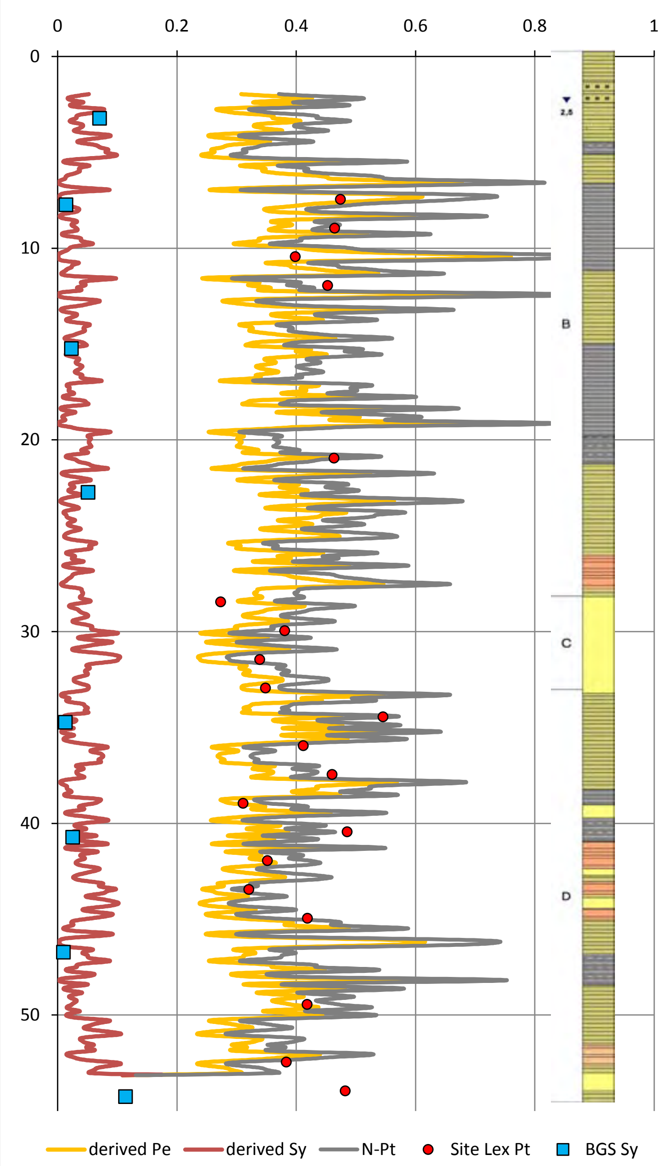
ORO COBRE: OLAROZ PROJECT

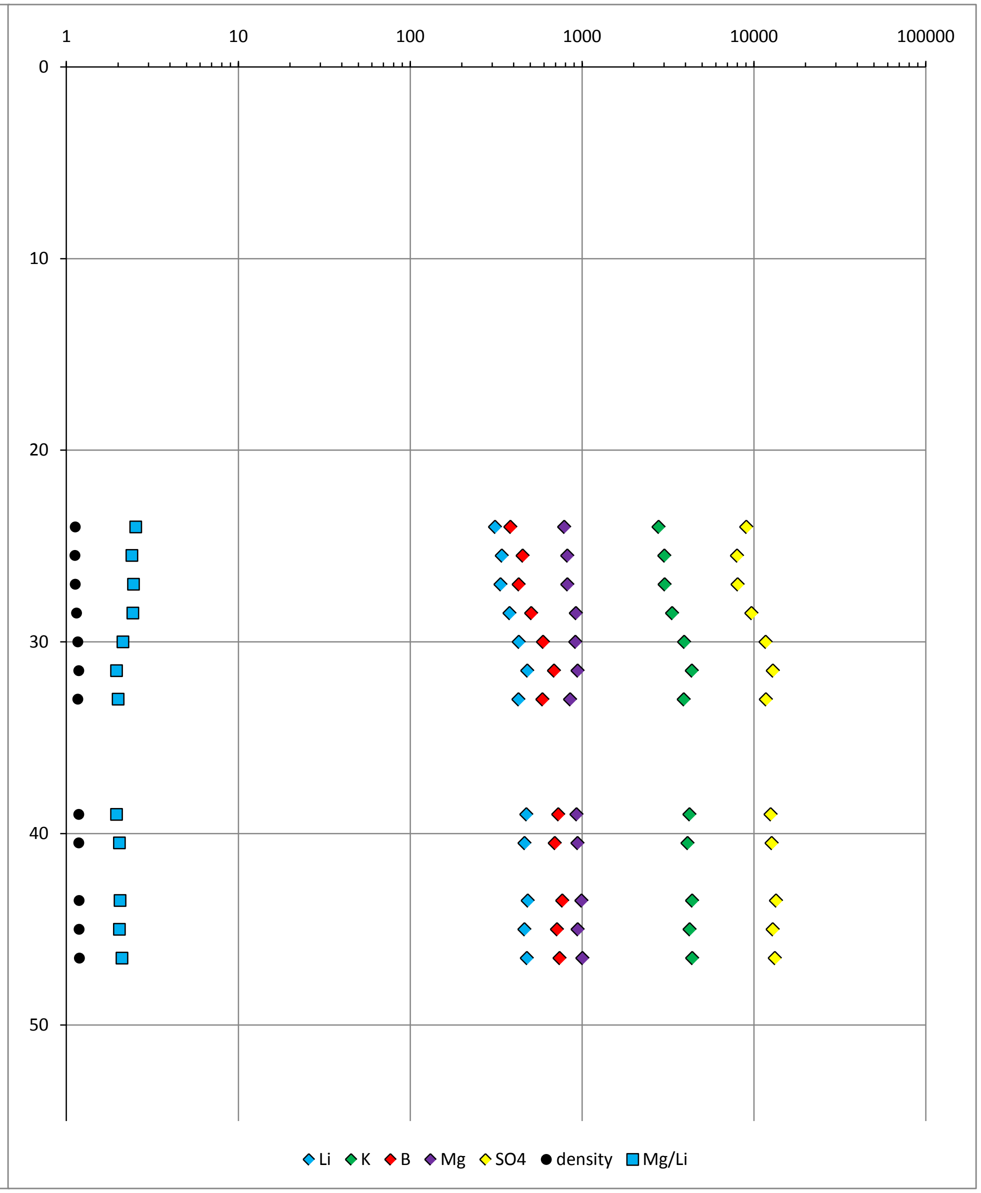
WELL REF: 15

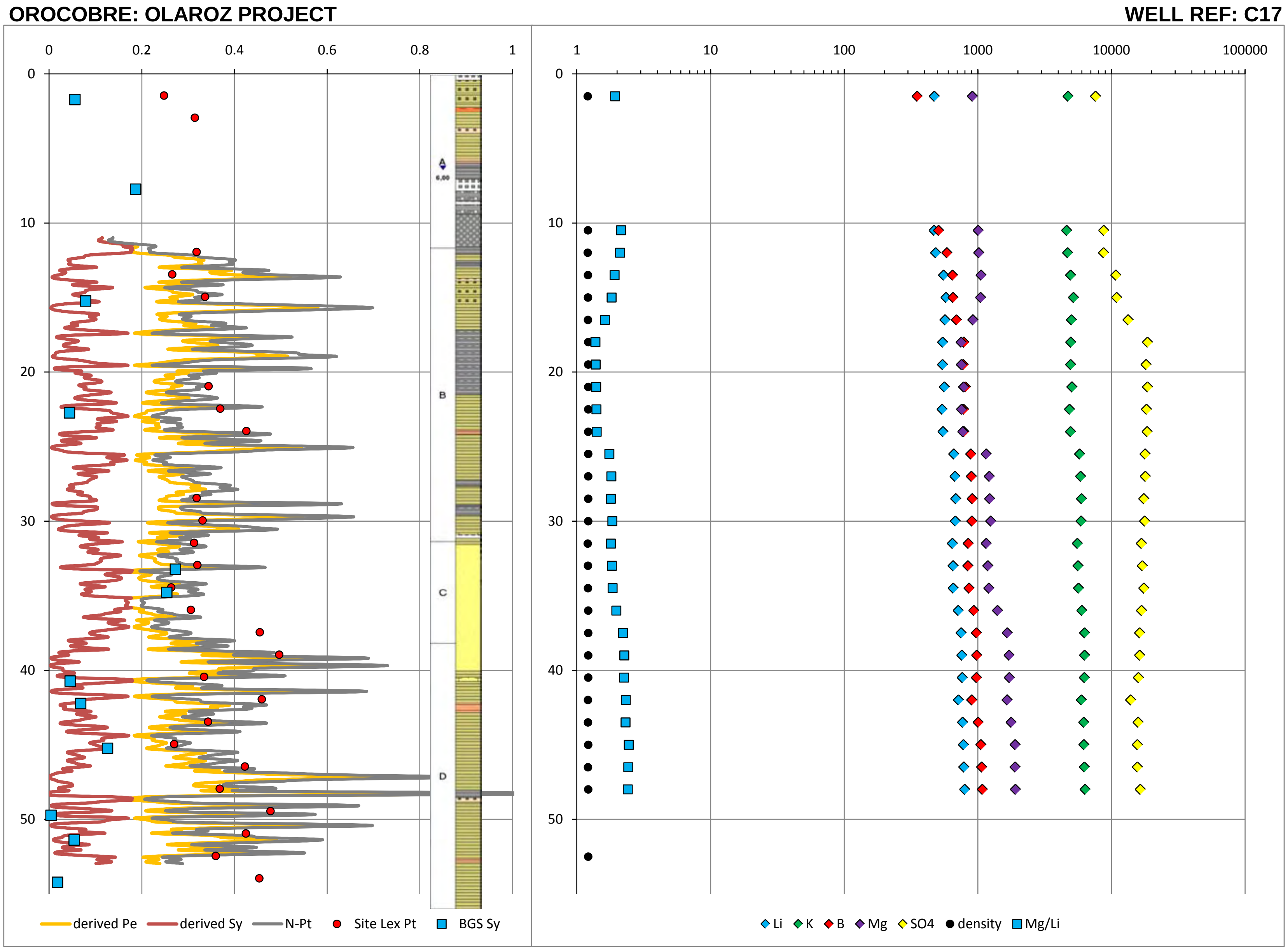


OROCOBRE: OLAROZ PROJECT

WELL REF: C16

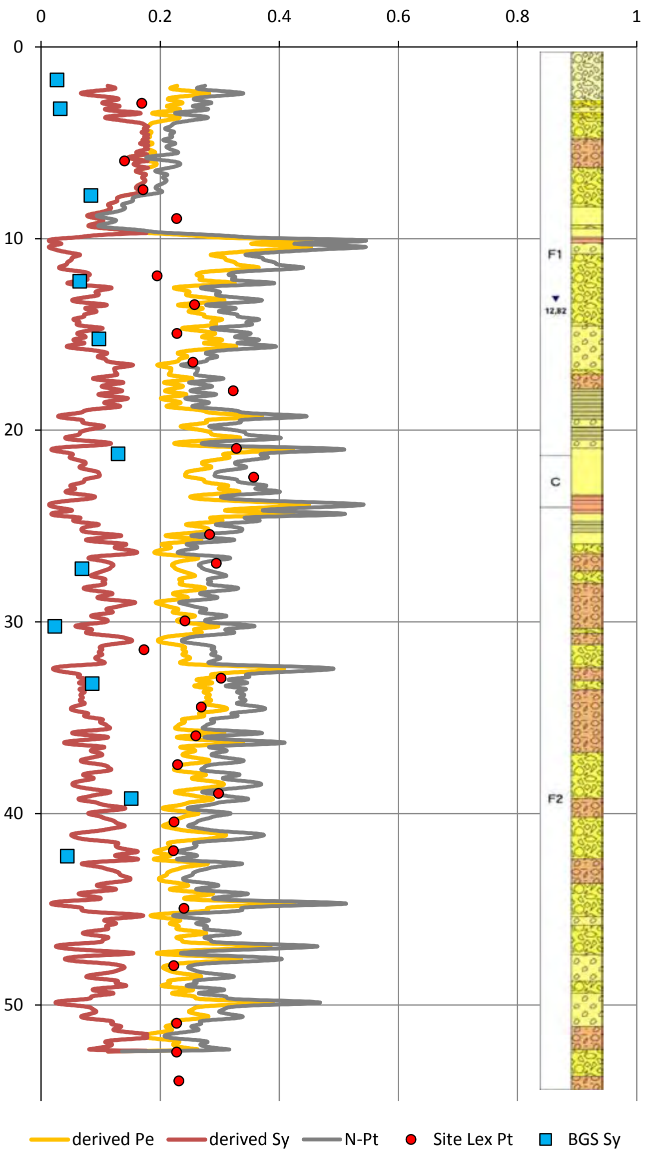


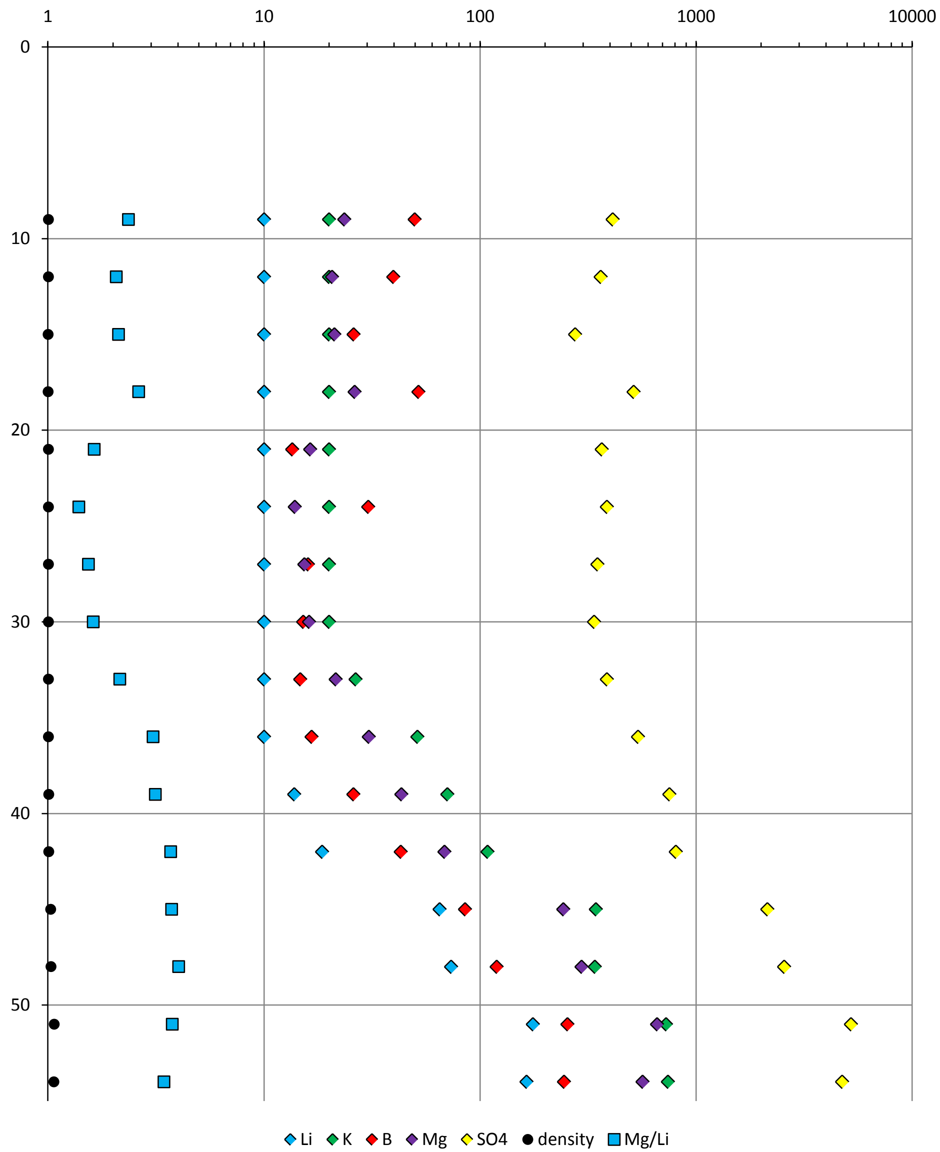



OROCOBRE: OLAROZ PROJECT
WELL REF: C17
derived Pe
derived Sy
N-Pt
Site Lex Pt
BGS Sy
Li
K
B
Mg
SO4
density
Mg/Li

OROCOBRE: OLAROZ PROJECT

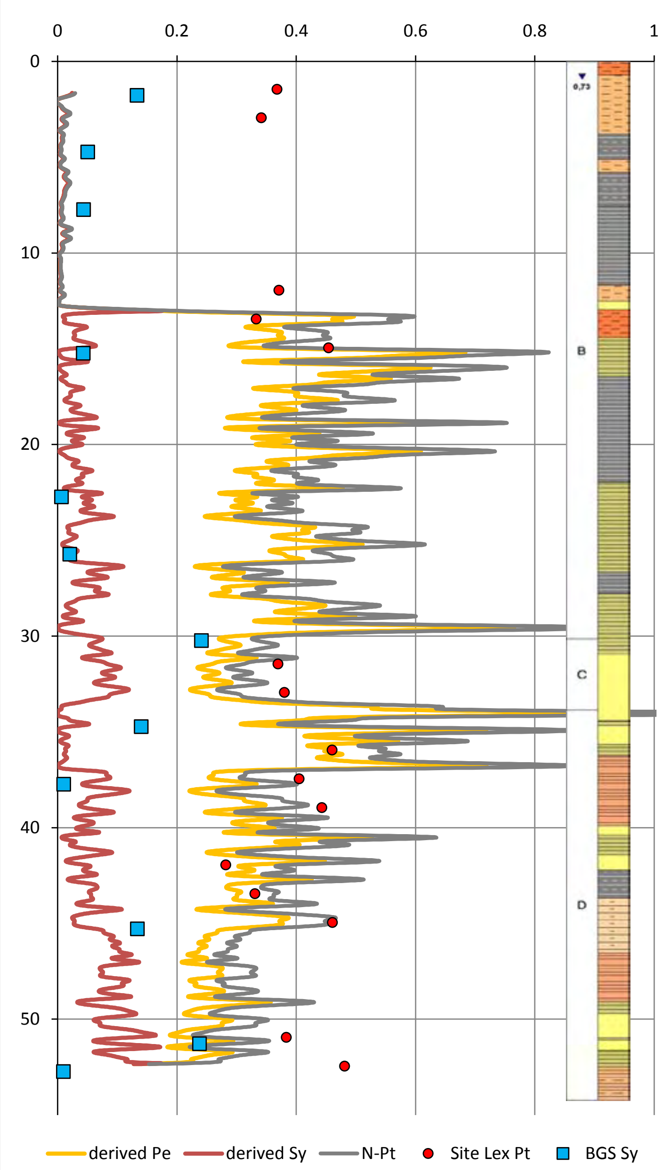
WELL REF: C18

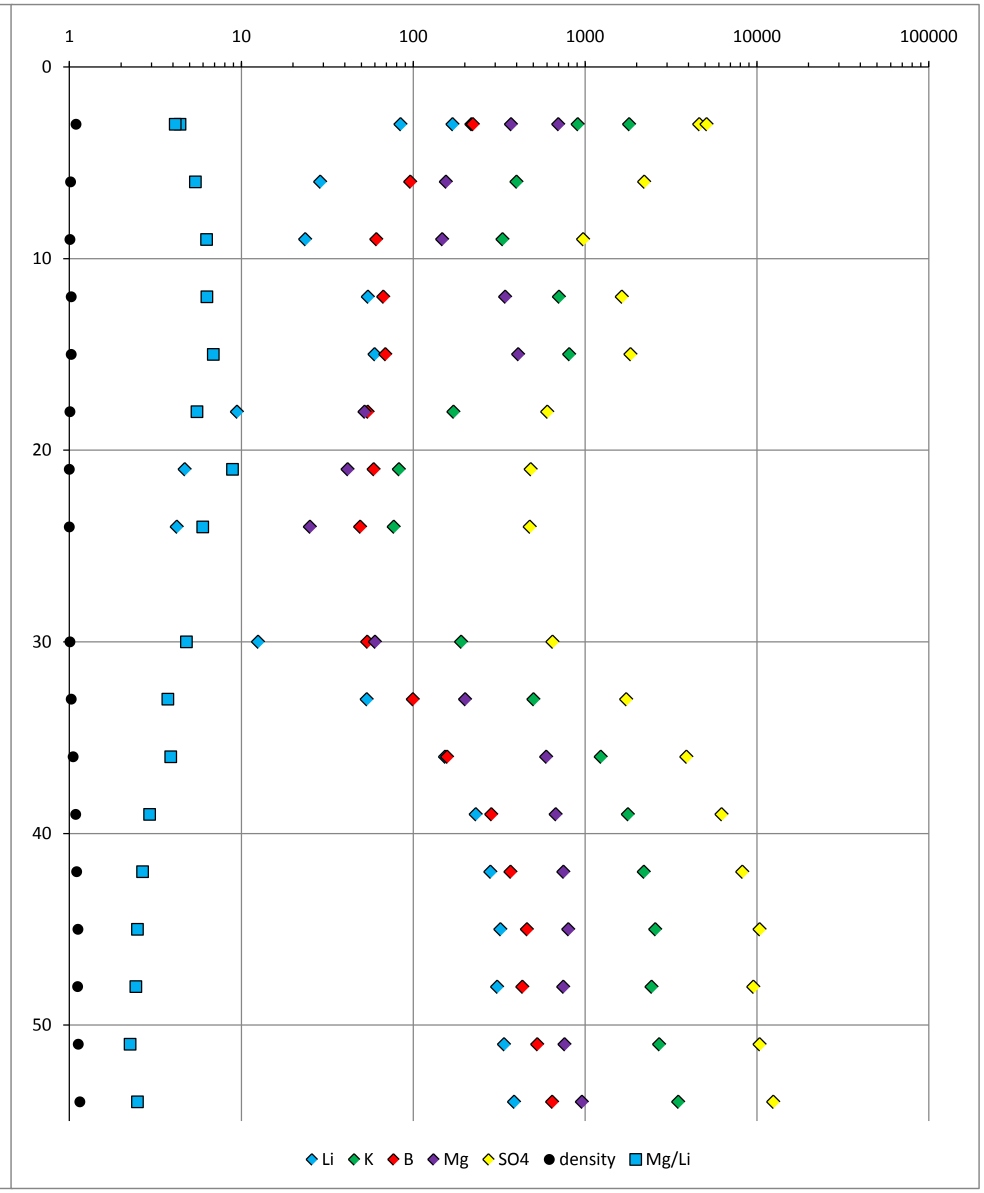




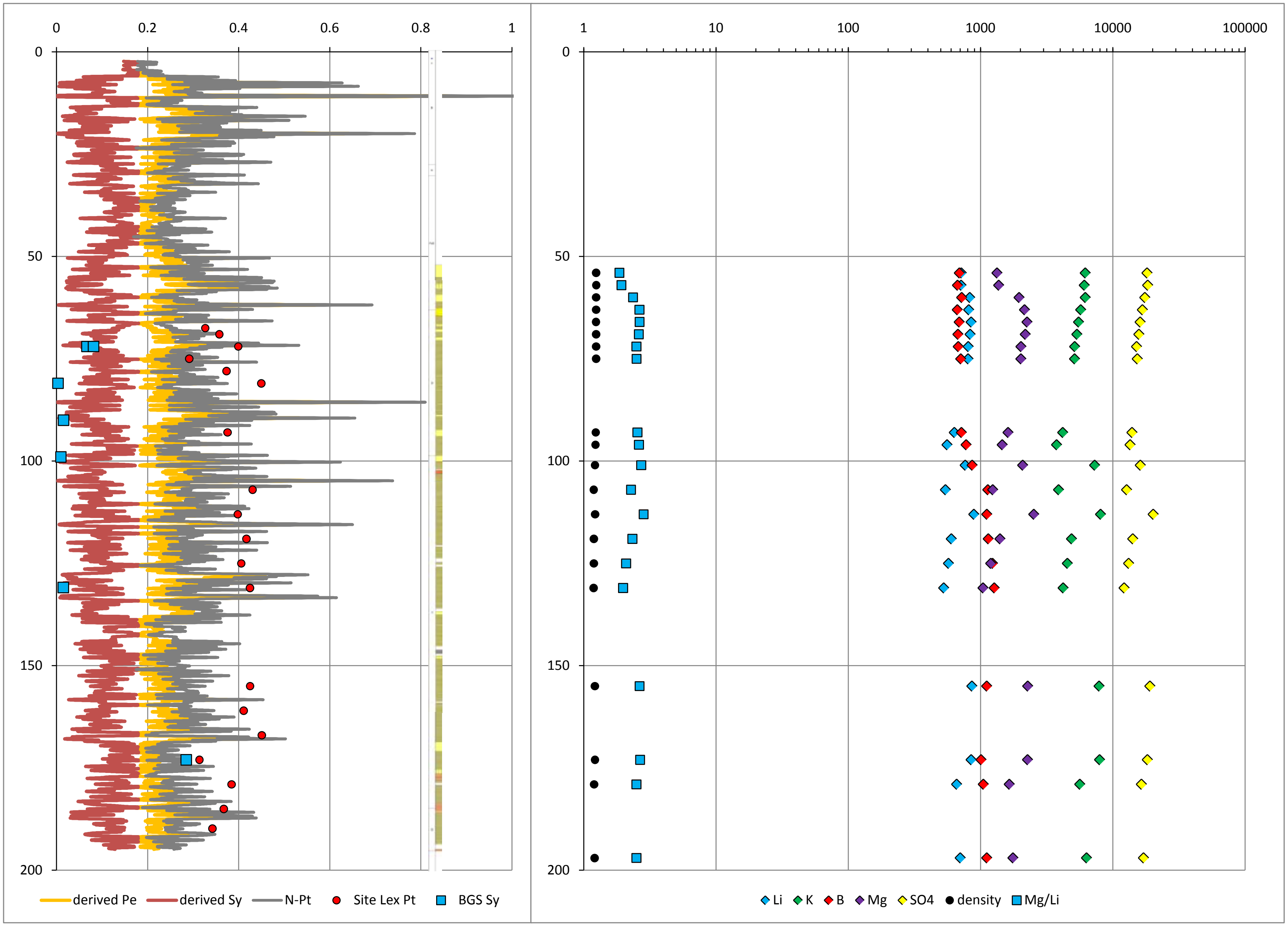
OROCOBRE: OLAROZ PROJECT

WELL REF: C19





OROCOBRE: OLAROZ PROJECT **WELL REF: CD01**



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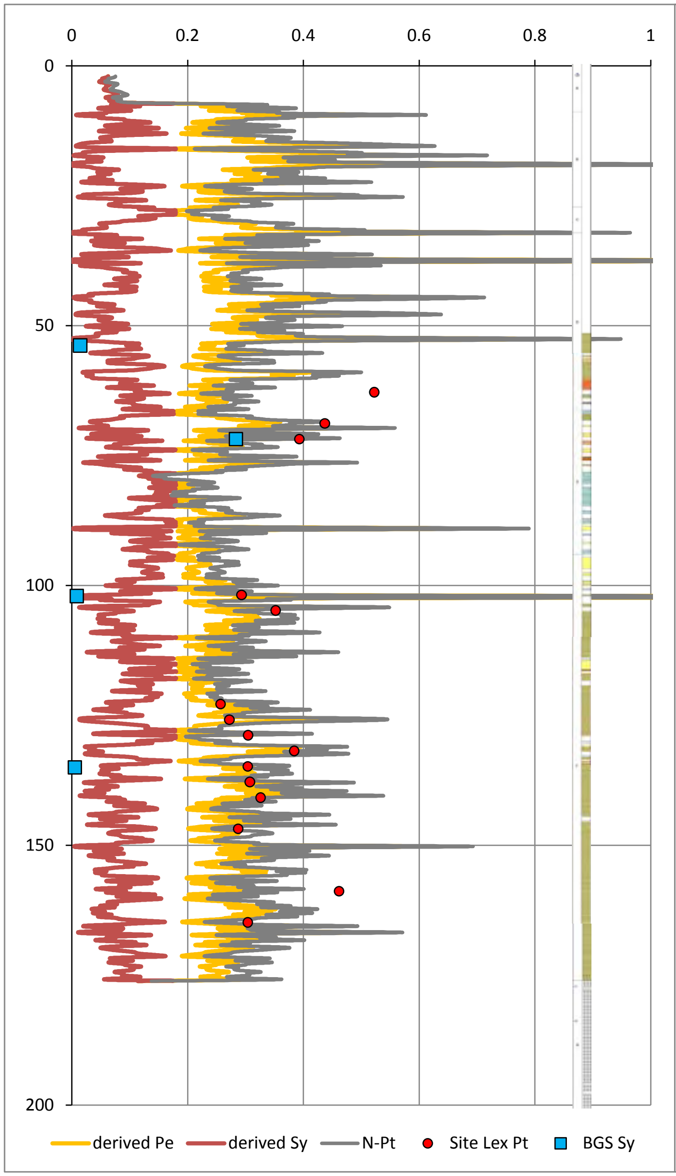

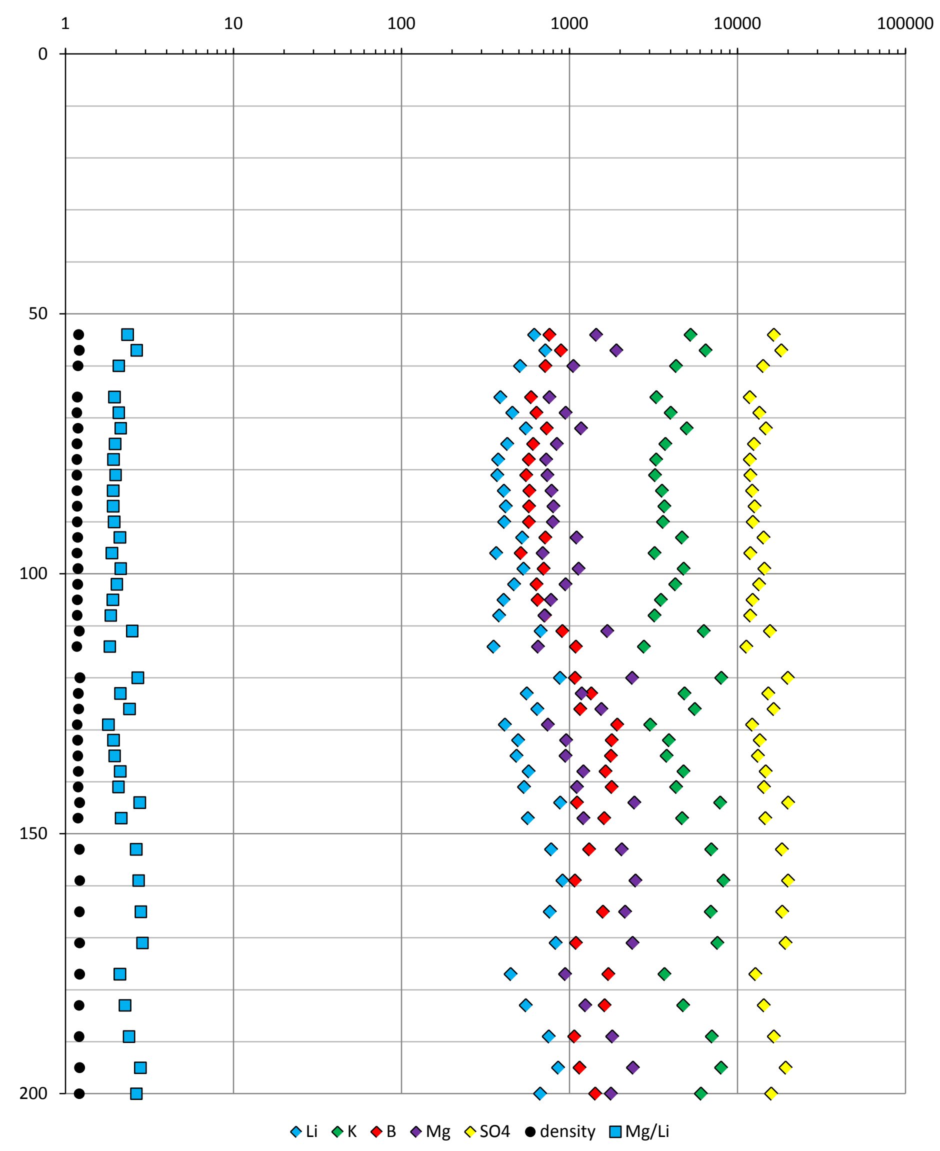

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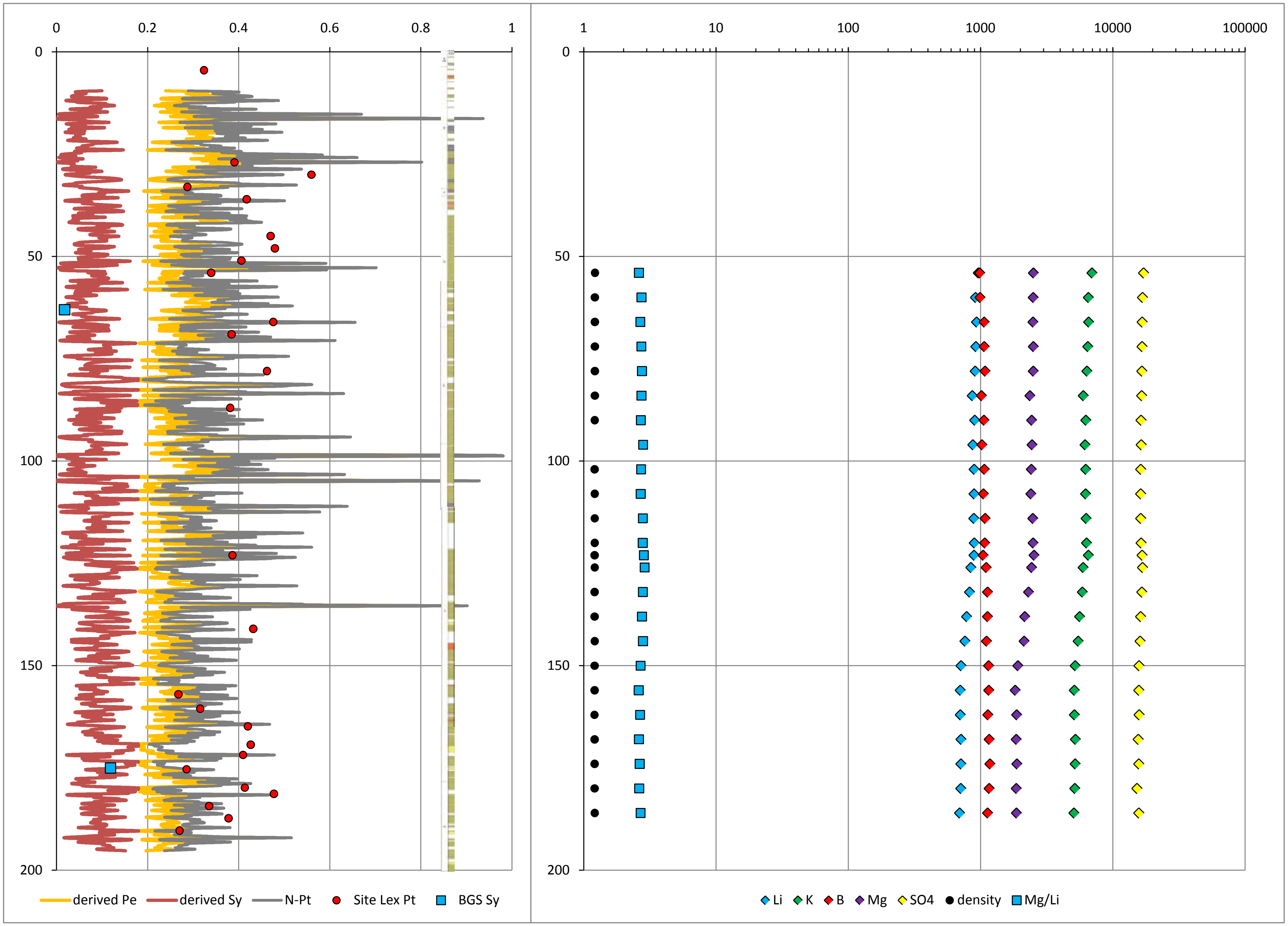
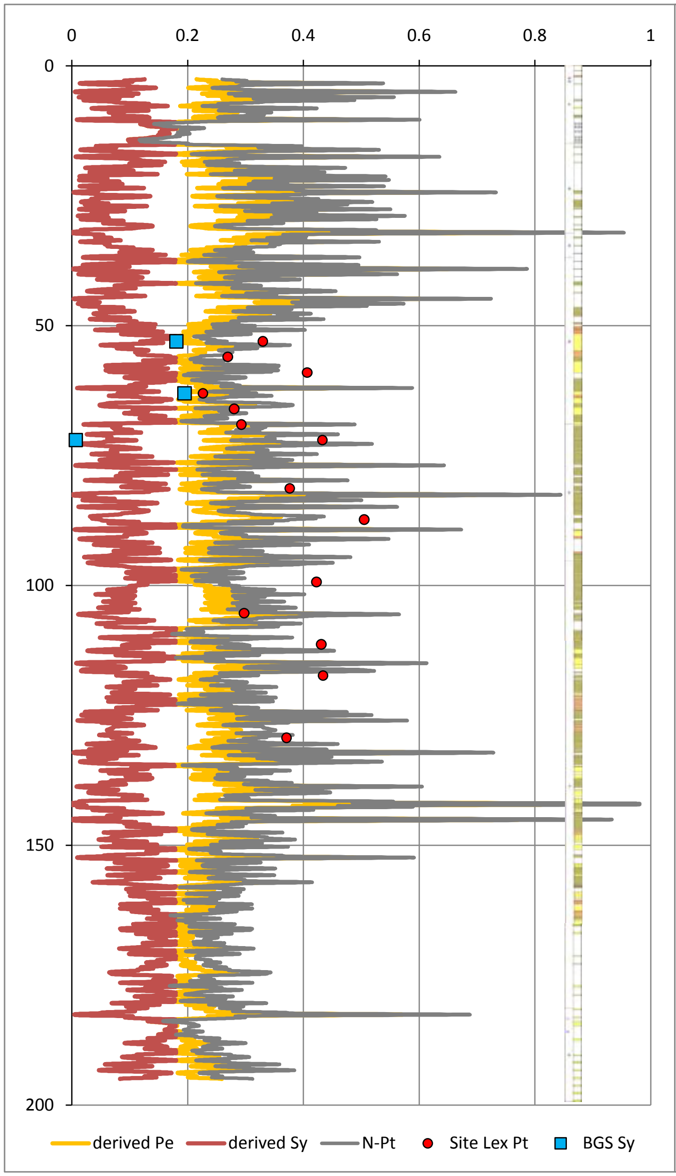
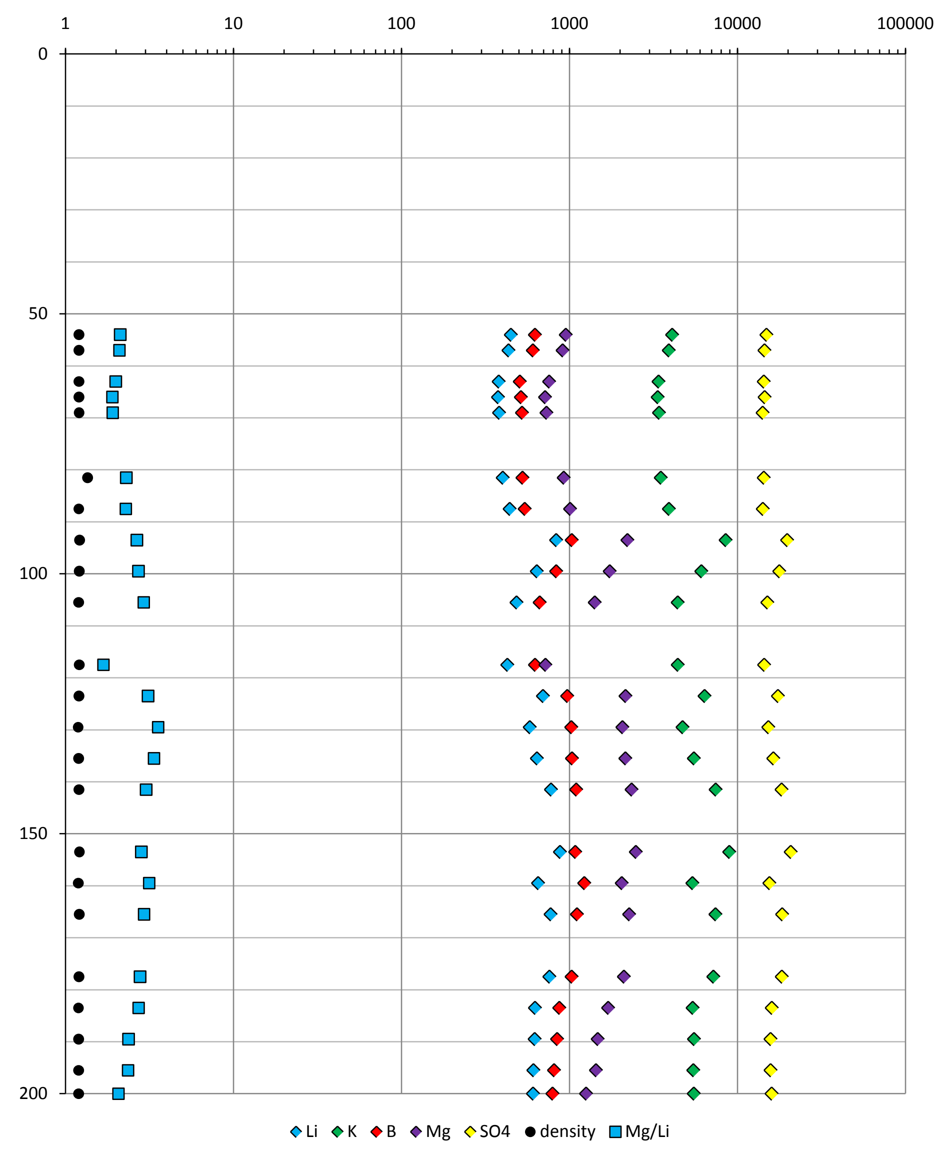
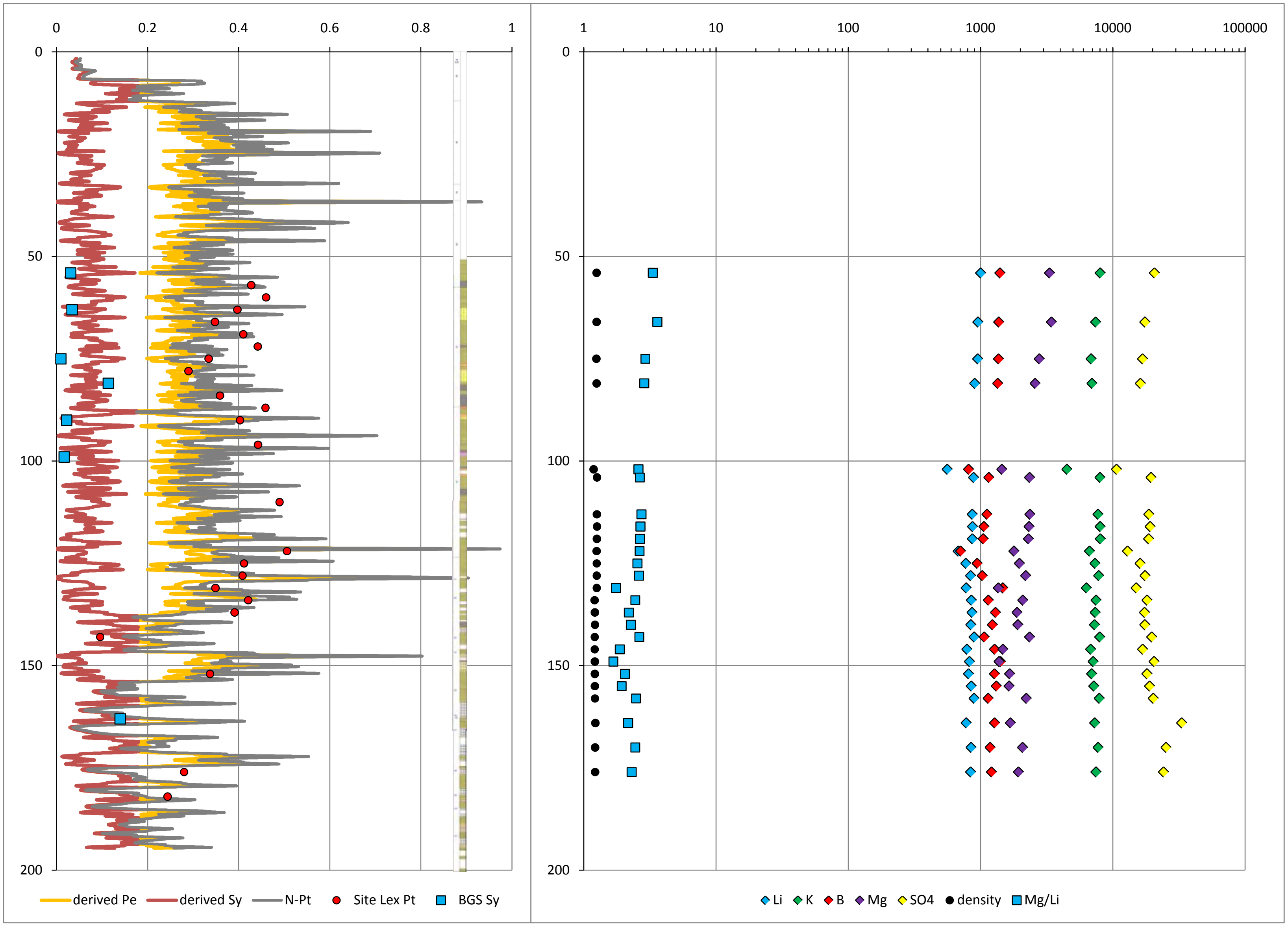


OROCOBRE: OLAROZ PROJECT **WELL REF: CD04b**

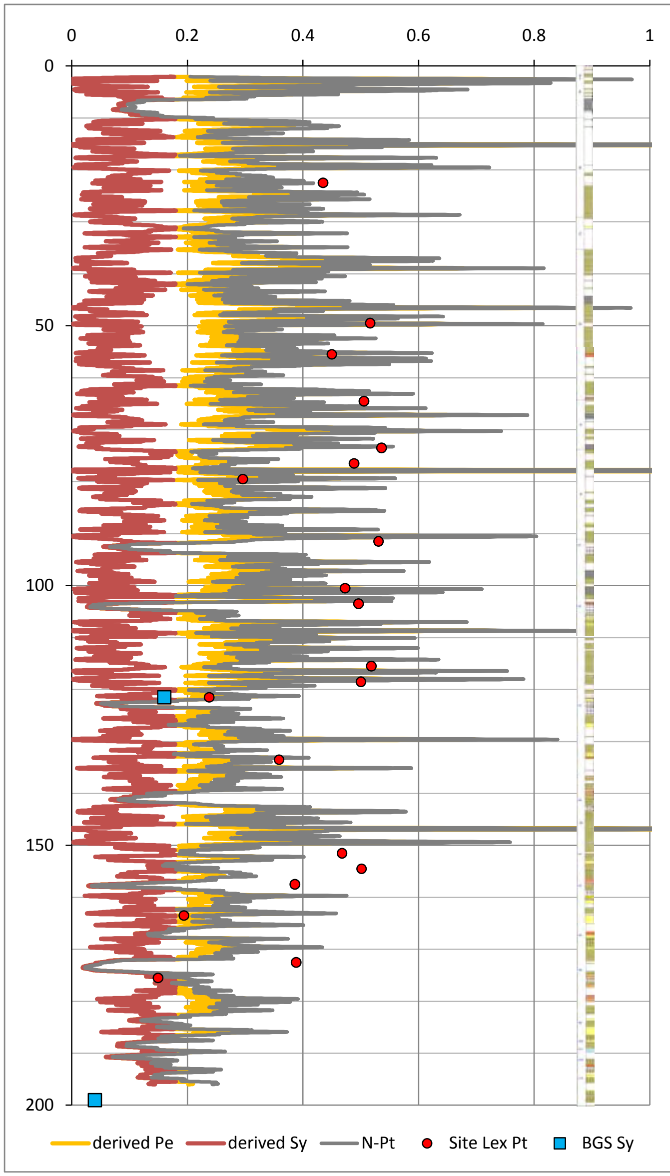


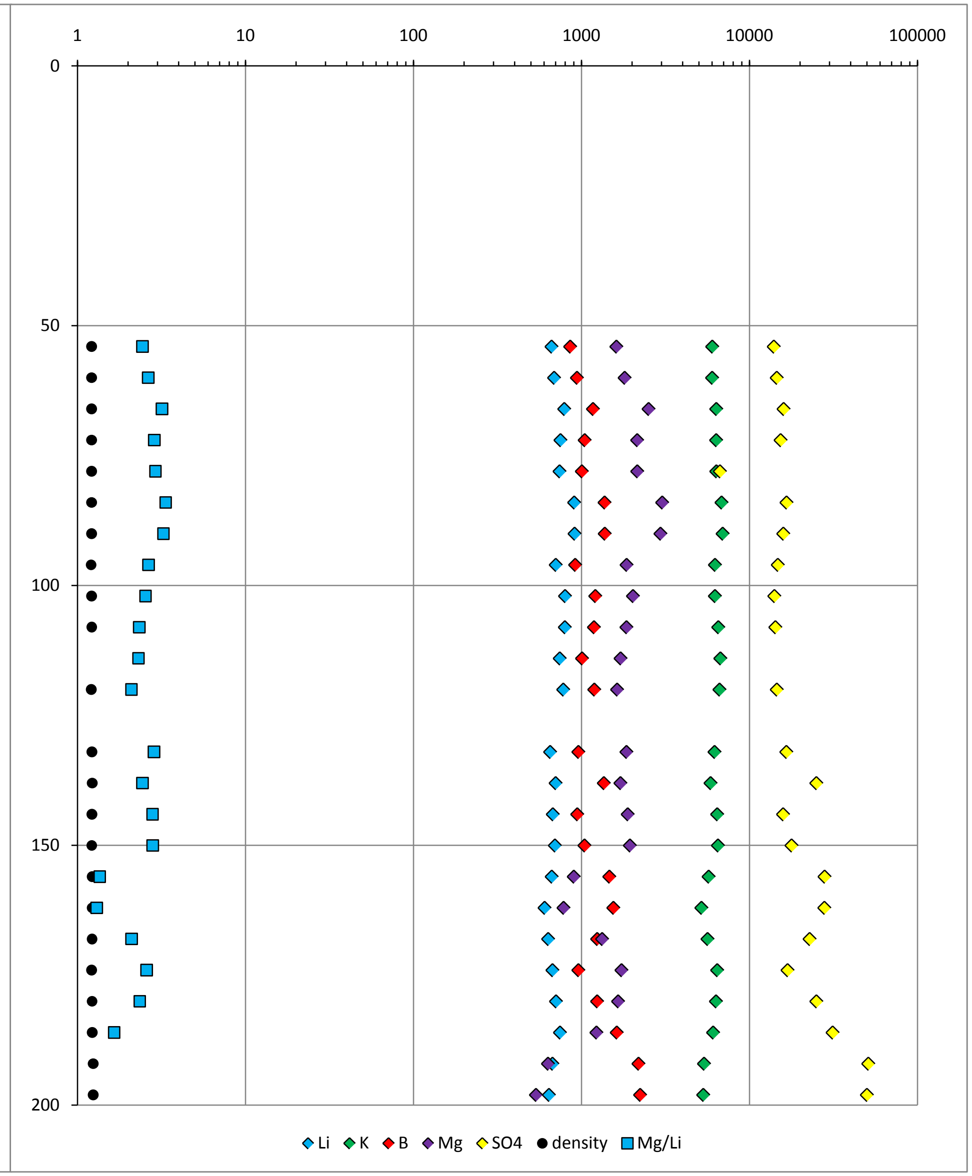


OROCOBRE: OLAROZ PROJECT **WELL REF: CD05**



OROCOBRE: OLAROZ PROJECT **WELL REF: CD06**





APPENDIX C

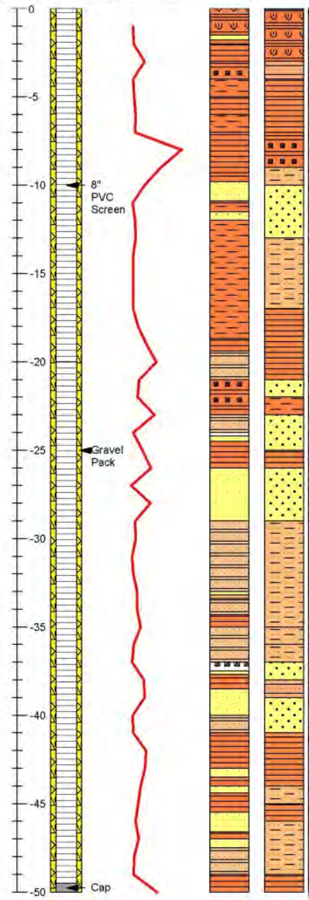
PUMPING TEST DATA

ORocobre | OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR: VALLE	START DATE: 05-11-2009	COORDINATES (POSGAR 94 Zone 3)	**WELL REFERENCE:** P1
DRILL RIG: HOLEMASTER 1000		E: 3426201 (m)	
METHOD: BRINE FLUSH	END DATE: 16-11-2009	N: 7398081 (m)	LOGED BY: Geol. FERNANDO A. MARTÍN
		Elevn: 3899 msnm	

Depth (m)	Construction	Penetration rate (0 min. 100)	Driller Log	Geologist Log	Lithology	Units	Depth (m)	Elevn. (m)	REFERENCE MAP



Lithology

HALITE: Corteza salina (halita). (8) (Lacustrine)

CLAY with ULEXITE: Arcilla marrón rojiza con abundantes ratros de ulexita en el sector superficial. Seguido por Arcilla marrón y marrón-rojiza. (10YR 4/6). (Lacustrine)

CLAY interbeded SAND: Arcilla gris-verdosa con rastros de materia orgánica y escasa arena fina. (10YR 4/2)

CLAY : Arcilla gris-verdosa y marrón-rojiza con abundantes y gruesos fragmentos de halita. Escasos fragmentos de arenisca fina con matriz carbonática.(10YR 4/2 10R 4/6). (Lacustrine)

CLAY : Arcilla negra con rastros de arcilla marrón y escasos fragmentos de arenisca fina con matriz carbonática. (2). (Transition Lacustrine-swamp? To fluvial)

CLAY with HALITE: Arcilla marrón con escasos rastros de arcilla gris-verdosa. Escasos rastros de halita. (5YR 4/4). (Lacustrine)

CLAYEY SAND: Arena media a fina con matriz arcillosa marrón (contaminación con lodo?). (5YR 4/4). (Fluvial+eolian?)

COARSE SAND: Arena gruesa con moderada selección y la mayoria de los granos componentes de color gris-oscuro. Escasa a nula presencia de material fino. (3). MICRO: Liticos (?50%), Silice-Perlita? (?25%), Qz (?20%), Concreción CaCO3 (?5%),Fe Sulf. (Pirita-Marcasita?)(<<1%). (Fluvial+eolian?)

CLAYEY SAND: Arena gruesa con matriz arcillosa negra y escasos rastros de arcilla marrón y gris-verdosa. (3). MICRO: Liticos Volcánicos(?60%), Silice-Perlita? (?30%), Qz (?15%), Concreción CaCO3 (?3%), Liticos metamórficos(?30%), Fe Sulf. (Pirita-Marcasita?)(<<1%). (Fluvial+eolian?)

CLAY : Arcilla marrón y gris verdosa. Rastros de arena gruesa con matriz arcillosa negra (contaminación? Intercalacion?). (10YR 4/2 - 3). (Lacustrine)

COARSE SAND: Arena gruesa con abundante matriz de arcilla negra. Rastros de arcilla gris verdosa. (3 - 10YR 4/2). MICRO: Liticos Volcánicos(?60%), Silice-Perlita? (?20%), Qz (?10%), Concreción CaCO3 (?10%). (Fluvial eolian? To lacustrine-swamp)

SANDY CLAY: Mix de arcilla gris verdosa con arena fina a media en matriz gris-oscura. (10Y 4/2). (Lacustrine)

COARSE SAND: Arena gruesa con escasa a nula matriz arcillosa gris-verdosa. (10Y 4/2). MICRO:Concreción CaCO3 (?60%), Liticos Volcánicos(?20%), Qz (?15%), CaCO3 (Caliche? Y cristalino) (?5%). (Fluvial+eolian?)

CLAY : Arcilla gris-verdosa con rastros de materia orgánica. Escasos rastros de arena gruesa a media (contaminación). (10Y 4/2). (Lacustrine)

COARSE SAND: Arena gruesa sin material fino (lavada por perforistas).Escasos cristales de halita. (4). MICRO: CaCO3 cristalino (?30%), CaCO3 Caliche?(?30%), Arena matriz CaCO3(?20%), Qz (?10%), Liticos Volcánicos(?10%). (Fluvial+eolian?)

CLAYEY SAND: Arena media a fina con matriz arcillosa gris-verdosa. (10YR 4/2). MICRO: CaCO3 cristalino (?40%), Arena matriz CaCO3(?30%), CaCO3 Caliche?(?15%), Liticos Volcánicos(?10%), Qz (?5%). (Transition fluvial to Lacustrine)

CLAYEY SAND: Arena gruesa a muy gruesa cona arcilla marrón y gris-verdosa. (10YR 4/2)

CLAYEY SAND: Arena media a fina en matriz arcillosa marrón. (10YR 4/2). (Transition fluvial to lacustrine)

COARSE SAND: Arena gruesa a muy gruesa con escaso material fino y cristales de halita. (4). (Fluvial+eolian?)

CLAY interbeded SAND: Arcilla marrón con rastros de arena gruesa a media (contaminación). Abundante arena fina a muy fina. (10YR 4/2). MICRO: Arena matriz CaCO3(?70%), CaCO3 cristalino (?20%), Liticos Volcánicos(?5%), Qz (?4%), Silice (?1%), CaCO3 Caliche?(?1%). (Transition fluvial to lacustrine)

COARSE SAND: Arena fina con pocos componentes de arena gruesa a muy gruesa y rastros de arcilla marrón. Arena gruesa compuesta por fregmentos de arenisca fina con matriz carbonática. (10YR 4/2). (Transition fluvial to lacustrine)

CLAY : Mix de arcilla marrón-rojiza y verde con rastros de arena fina a media (contaminación). (5R 4/4 - 10GY 5/2). MICRO: Arena matriz CaCO3(?70%), CaCO3 cristalino (?20%), Liticos Volcánicos(?5%), Qz (?4%), Silice (?1%), CaCO3 Caliche?(?1%). (Transition fluvial to lacustrine)

CLAYEY SAND: Arena fina a media en matriz arcillosa gris-verdosa con abundantes rastros de arcilla verde. (10Y 4/2). (Transition fluvial to lacustrine)

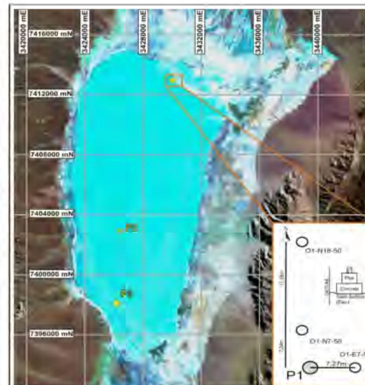
CLAY : Arcilla verdosa con rastros de arcilla marrón y arena fina a media (contaminación). (5GY 4/1 - 5YR 4/4). (Lacustrine)

CLAYEY SAND: Arena fina con pocos componentes de arena gruesa. En matriz arcillosa gris-verdosa. Rastros de arcilla verde y marrón con materia orgánica. (10Y 4/2 -10GY 5/2). MICRO: Arena matriz CaCO3(?60%), Qz (?15%), CaCO3 cristalino (?10%), CaCO3 Caliche?(?10%), Liticos Volcánicos(?4%), Silice (?1%). (Transition fluvial to lacustrine)

CLAY : Mix de arcilla marrón-rojiza y verde. (5YR 4/4 - 10GY 5/2). (Lacustrine)

Depth (m) / Elevn. (m): 0, -5, -10, -15, -20, -25, -30, -35, -40, -45, -50 / 3890, 3880, 3870, 3860, 3850

REFERENCE MAP



ID	Xm	Ym	Elev.	2"	Pipe	Terraplen	DATUM
P1	3429273	7412852	3899	0,132	0,505	0,380	3900,017
O1-E7-55	3429280	7412852	3899	-	0,296	0,365	3899,661
O1-N7-50	3429273	7412859	3899	-	0,259	0,096	3899,355
O1-N18-50	3429273	7412870	3899	-	0,084	0,043	3899,127

ID	DEPTH (m)	CASING (m) From:	To:	Ø"	Depth water first encountered (m)	Static water level (m)	Water Level Elevation(m)
P1	50	0	50	8"	3,000	2,990	3897,01
O1-7E-55	55	0	55	4"	3,000	2,506	3897,494
O1-7N-50	50	0	50	4"	3,000	2,334	3897,666
O1-18N-50	50	0	50	4"	3,000	1,984	3898,016

OROCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM
CORRELATION

CONTRACTOR: VALLE

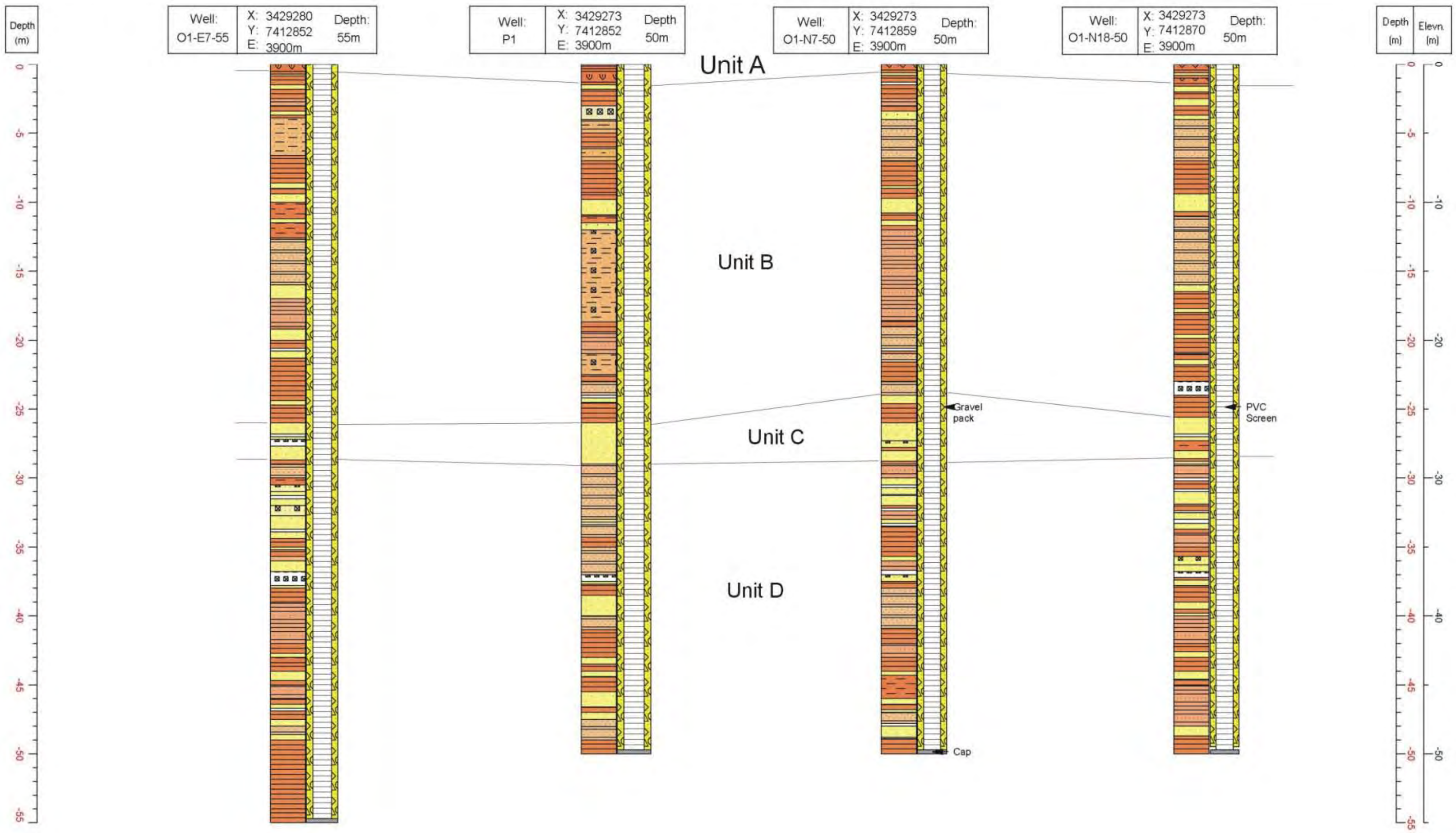
DRILL RIG: HOLEMASTER 1000

METHOD: ROTARY

WELLS REFERENCES:

O1-E7-55 - P1 - O1-N7-50 - O1-N18-50

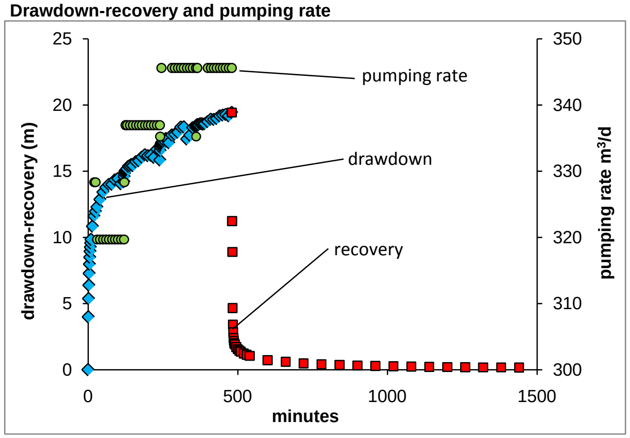
LOGED BY: Geol. FERNANDO A. MARTÍN



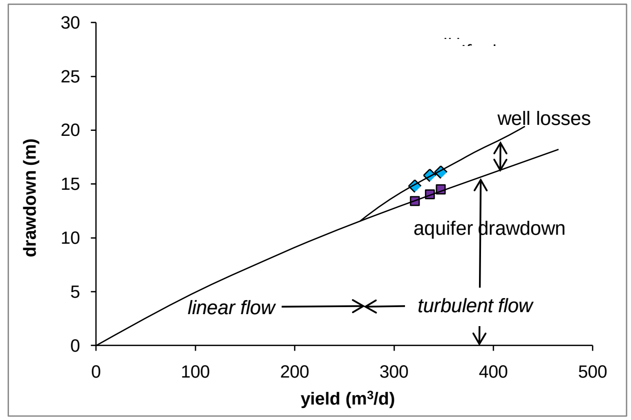
OROCOBRE

SALAR DE OLAROZ
STEP-TEST P1

Drawdown-recovery and pumping rate



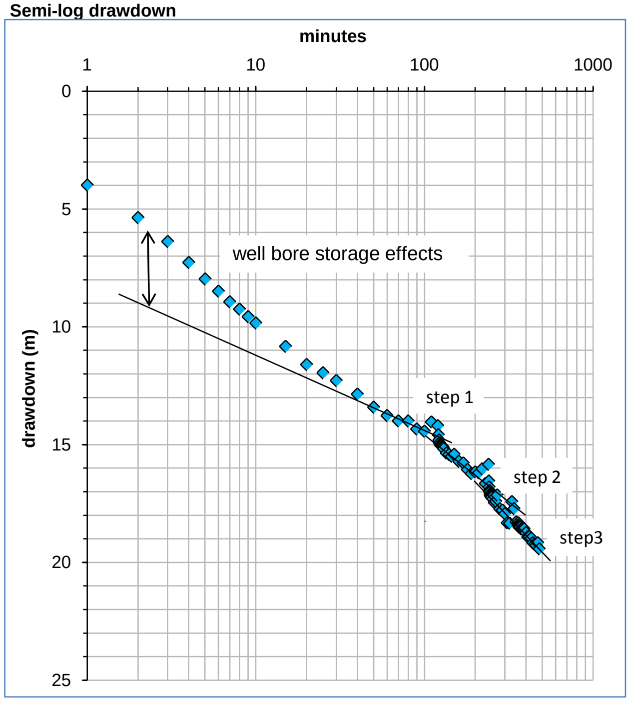
Yield - drawdown curve at 2 hours



Comments:

1. no corrections for brine density or elevation
2. the pump used has a very flat head-capacity curve thus the difference in Q between steps is small

Semi-log drawdown

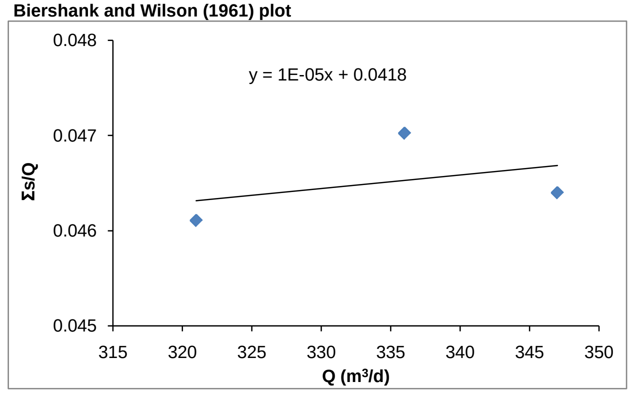


Calculations

step	s_{120m}	Δs (from graph)	Σs	Q	Σs/Q	CQ^2	BQ	efficiency
1	14.80	14.80	14.8	321	0.0461	1.03	13.42	93%
2	16.60	1.00	15.8	336	0.0470	1.13	14.04	93%
3	18.10	0.30	16.1	347	0.0464	1.20	14.50	92%
					mean			93%
					B =		0.0418	
					C =		0.00001	

Recovery after 24 hrs: 99%

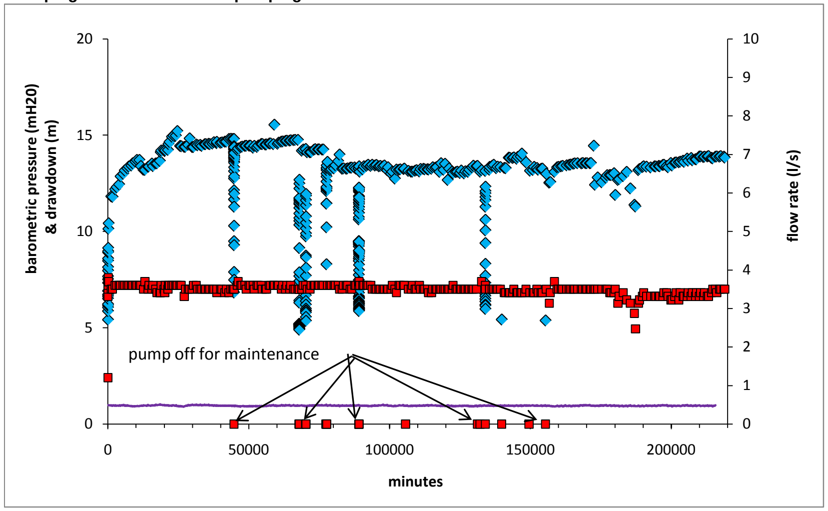
Biershank and Wilson (1961) plot



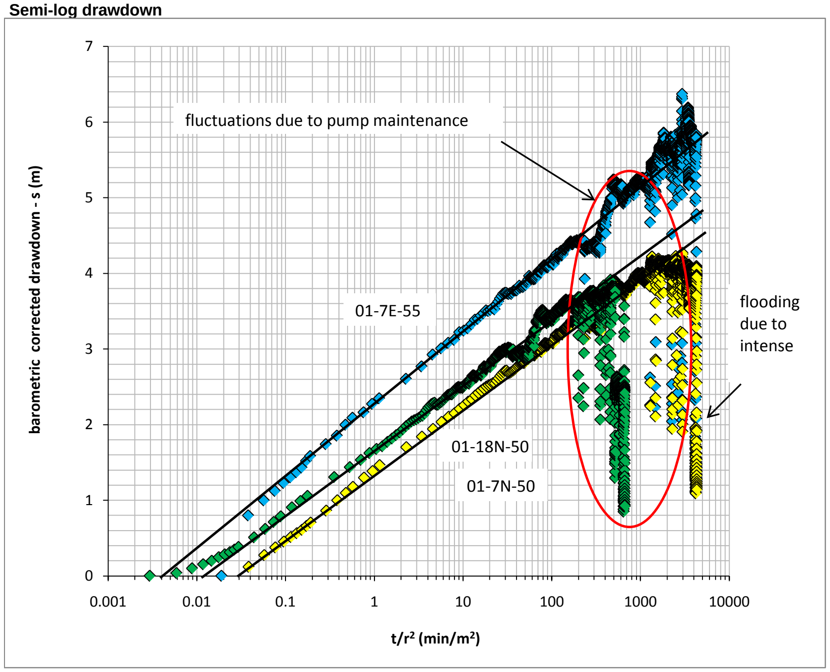
OROCOBRE

SALAR DE OLAROZ
CONSTANT RATE TEST P1
page 1

Pumping well drawdown and pumping rate



Semi-log drawdown



DATA

	radial dist from P1 (m)	Static WL (m bgl)
P1	0.00	1.97
01-7E-55	7.27	1.85
01-7N-50	7.24	1.98
01-18N-50	18.42	1.86

Screened	0-50	m
Aquifer thickness assumed	49	m
Flow rate	302	m^3/d
Pump suction	31	m

AQUIFER PROPERTY CALCULATIONS

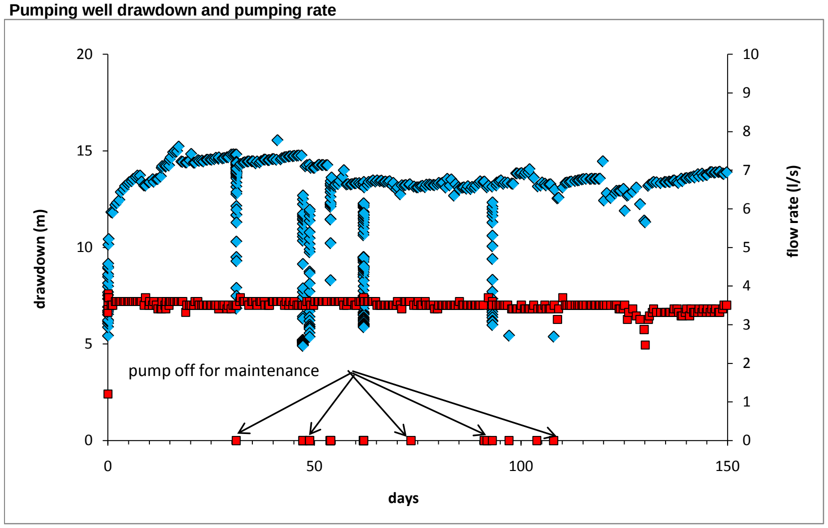
	ds		t/r^2_o
01-7E-55	0.97		0.004
01-7N-50	0.87		0.010
01-18N-50	0.87		0.030
	T (m^2/d)	bulk K (m/d)	S
01-7E-55	57	1.2	0.0004
01-7N-50	64	1.3	0.0010
01-18N-50	64	1.3	0.0030

SUMMARY
Confined conditions
permeability = 1.3 m/d
Sy = 0.4-3%
S = 0.4-3x10^{-3}
not corrected for density

OROCOBRE

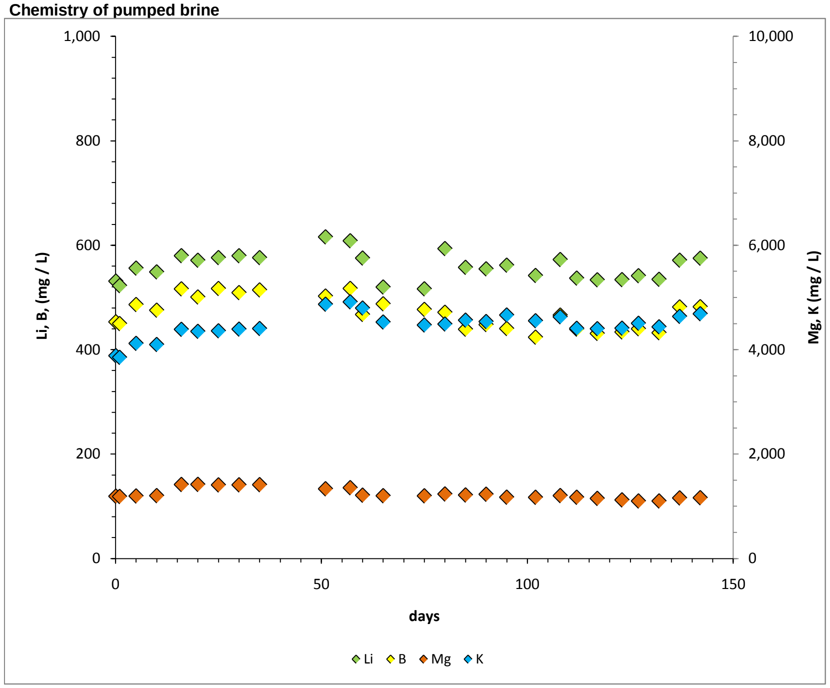
SALAR DE OLAROZ
CONSTANT RATE TEST P1
page 2

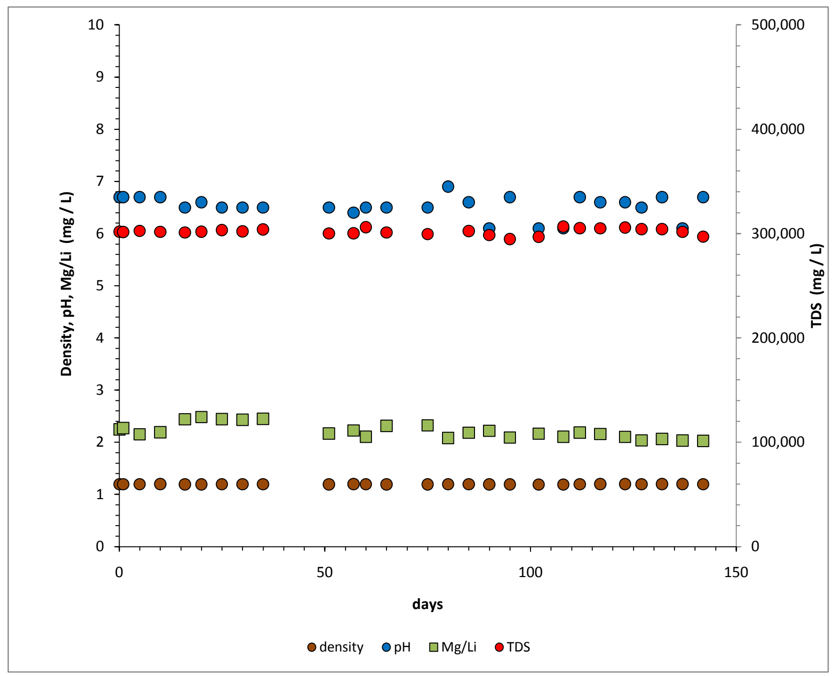
Pumping well drawdown and pumping rate



Mean Values		+/-
Density	1.195	0.002
pH	6.53	0.21
TDS (mg/l)	301,898	2,953
Li (mg/l)	559	26
B (mg/l)	471	31
K (mg/l)	4,458	254
Mg/Li	2.2	0.1

Chemistry of pumped brine



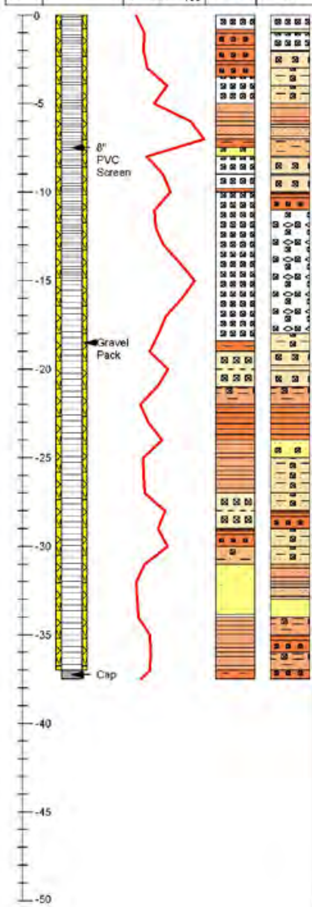


ORОCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR:	VALLE	START DATE:	04-12-2009	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: P2
DRILL RIG:	HOLEMASTER 1000			E: 3426421	
				N: 7402945	
METHOD:	Brine Flush	END DATE:	07-12-2009	Elevn: 3898	LOGED BY: Geol. FERNANDO A. MARTÍN

Depth (m)	Construction	Penetration rate (0 min. 100)	Driller Log	Geologist Log	Lithology	Units	Depth (m)	Elevn. (m)



HALITE: SIN REGISTRO: [illegible]

HALITE interbeded CLAY: Arcilla con intercalación de halita.

HALITE: [illegible]

HALITE with CLAY: [illegible]

HALITE CLAY and SAND: [illegible]

HALITE, SAND and CLAY: [illegible]

CLAY interbeded SAND: [illegible]

SAND interbeded CLAY: [illegible]

CLAYEY SAND: [illegible]

HALITE with CLAY: [illegible]

HALITE with CLAY: [illegible]

CLAY with HALITE: [illegible]

HALITE with GYPSUM: [illegible]

HALITE CLAY and SAND: [illegible]

HALITE with CLAY: [illegible]

CLAY, HALITE and SAND: [illegible]

CLAY: [illegible]

SAND with HALITE: [illegible]

Halite, Sand and Clay: [illegible]

HALITE, SAND and CLAY: [illegible]

CLAY with HALITE: [illegible]

HALITE, SAND and CLAY: [illegible]

HALITE, SAND and CLAY: [illegible]

CLAY interbeded SAND: [illegible]

SAND interbeded CLAY: [illegible]

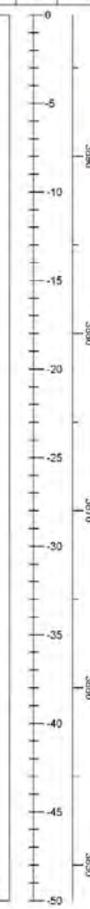
SAND: [illegible]

CLAY, HALITE and SAND: [illegible]

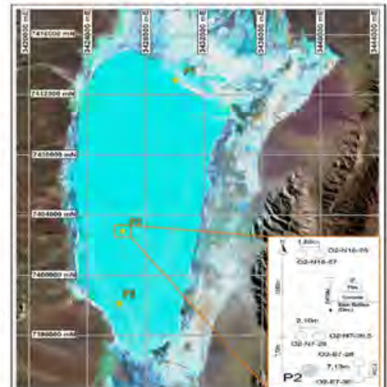
CLAY with HALITE: [illegible]

CLAY, HALITE and SAND: [illegible]

CLAY with HALITE: [illegible]



REFERENCE MAP



ID	Xm	Ym	Elev.	2"	Pipe	Concrete	DATUM
P2	3426421	7402945	3898	0,000	0,349	0,088	3898,435
O2-E7-38	3426428	7402944	3898		0,262	0,000	3898,262
O2-E7-28	3426428	7402946	3898	–	0,297	0,000	3898,297
O2-N7-36,5	3426422	7402952	3898	–	0,031	0,000	3898,031
O2-N7-26	3426420	7402952	3898	–	0,216	0,018	3898,234
O2-N18-26	3426422	7402963	3898	–	0,133	0,021	3898,154
O2-N18-57	3426420	7402963	3898	–	0,141	0,052	3898,193

ID	DEPTH	CASING			Depth water first encountered (m)	Static water level (m)	Water Level Elevation (m)
		Blind (m)	Slotted (m)	Ø"			
P2	37,5	-	37,5	8	0,800	[illegible]	[illegible]
O2-E7-38	38	25	13	4	0,800	0,875	3897,560
O2-E7-28	28	–	25	4	0,800	0,769	3897,649
O2-N7-36,5	36,5	25	11,5	4	0,800	1,012	3897,423
O3-N7-26	26	–	26	4	0,800	0,348	3898,087
O3-N18-26	26		26	4	0,800	0,465	3898,030
O3-N18-57	57	25	14	4	0,800	1,014	3897,421

OROCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM
CORRELATION

CONTRACTOR: VALLE

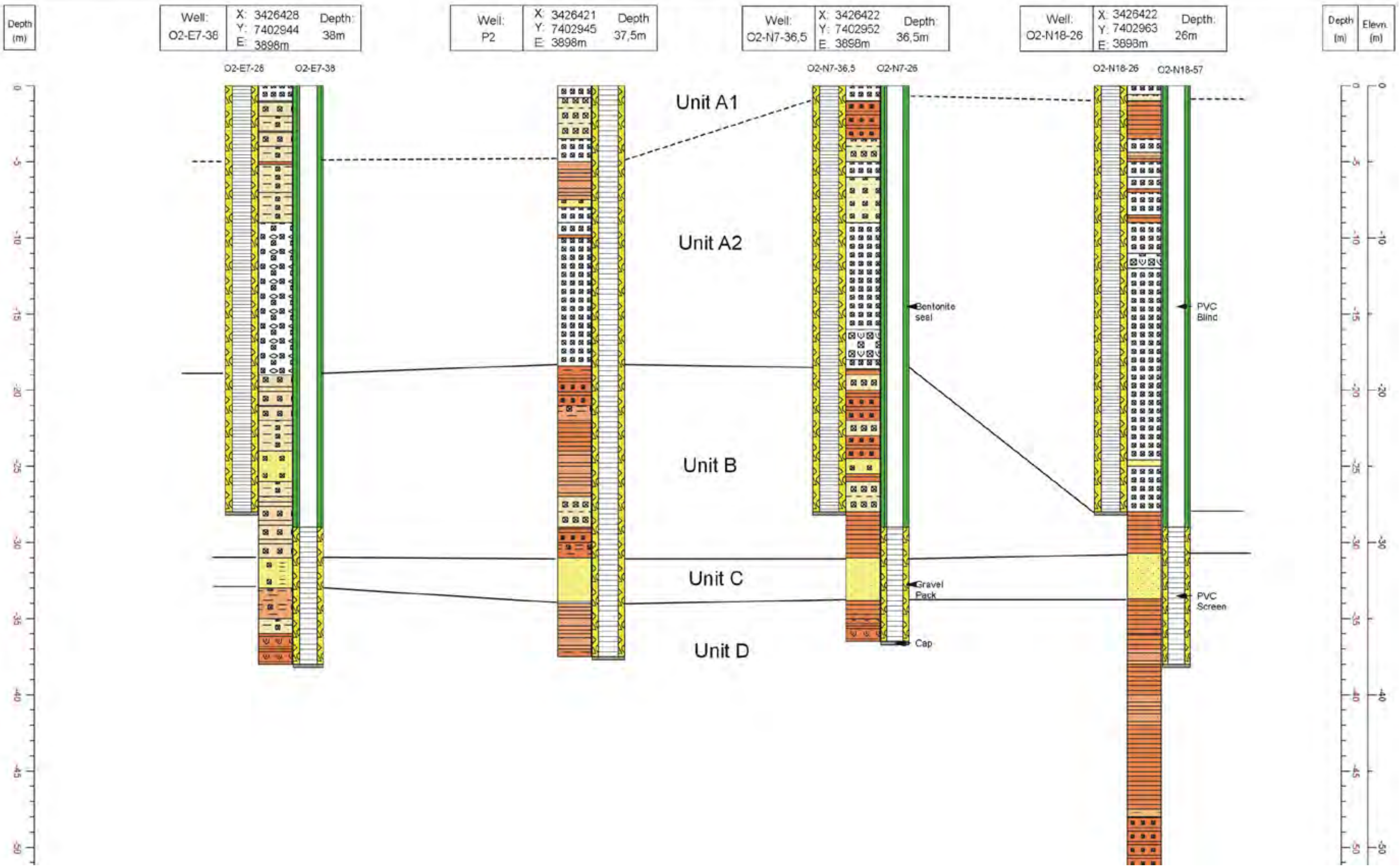
DRILL RIG: HOLEMASTER 1000

METHOD: ROTARY

WELLS REFERENCES:

O2-E7-38 - P2 - O2-N7-36,5 - O2-N18-57

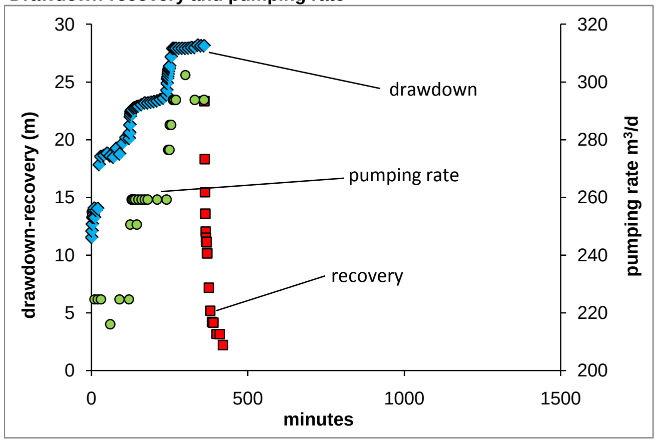
LOGED BY: **Geol. FERNANDO A. MARTÍN**



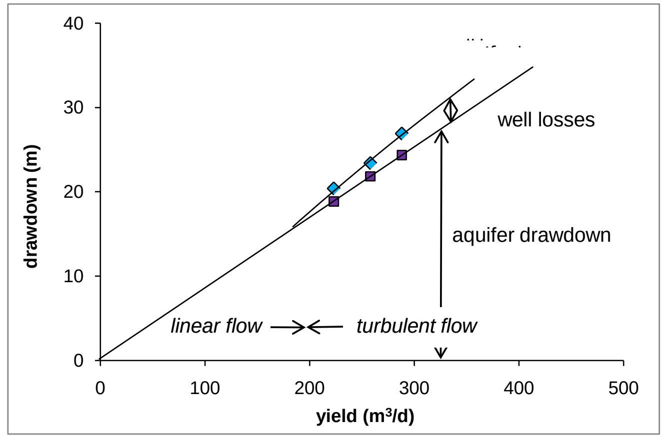
OROCOBRE

SALAR DE OLAROZ
STEP-TEST P2

Drawdown-recovery and pumping rate



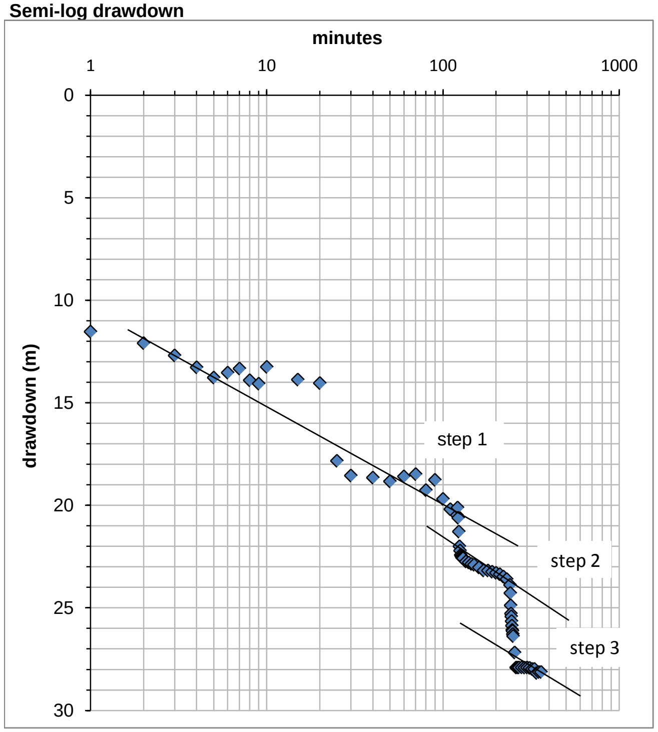
Yield - drawdown curve at 2 hours



Comments:

1. no corrections for brine density or elevation
2. the pump used has a very flat head-capacity curve thus the difference in Q between steps is small

Semi-log drawdown

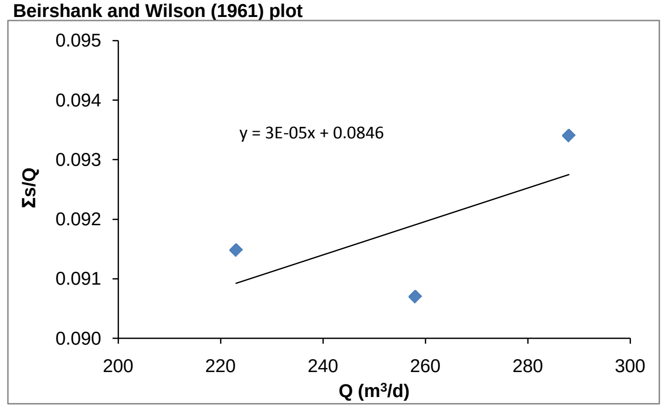


Calculations

step	s_{120m}	Δs (from graph)	Σs	Q	Σs/Q	CQ^2	BQ	efficiency
1	20.40	20.4	20.4	223	0.0915	1.49	18.87	93%
2	24.50	3.0	23.4	258	0.0907	2.00	21.83	92%
3	28.00	3.5	26.9	288	0.0934	2.49	24.36	91%
					mean			92%
					B =		0.0846	
					C =		0.00003	

Recovery after 1 hrs: 91%

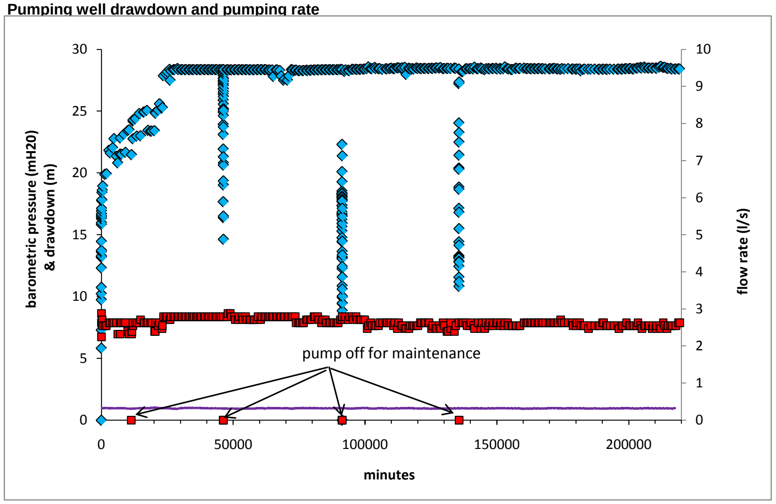
Beirshank and Wilson (1961) plot



OROCOBRE

SALAR DE OLAROZ
CONSTANT RATE TEST P2
page 1

Pumping well drawdown and pumping rate



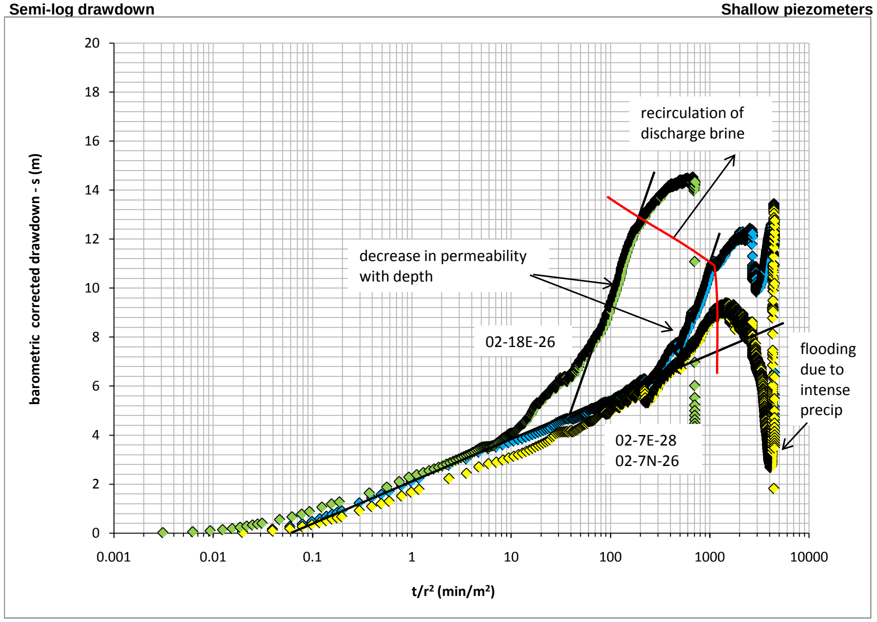
DATA

		radial dist from P2 (m)	Static WL (m bgl)	radial dist from P2 (m)	Static WL (m bgl)
	P2 (screened 0-50 m)	0.00	0.93		
Shallow p/z	02-7E-28	7.13	0.79		
	02-7N-26	7.12	0.35		
	02-18N-26	17.94	0.41		
Deep p/z	02-7E-38			7.13	0.88
	02-7N-36.5			7.12	1.01
	02-18N-36			17.94	1.10
	Screened	0-26		26-37	
	Aquifer thickness assumed	25		11	
	Flow rate	242 m^3/d			
	pump suction	36 m			

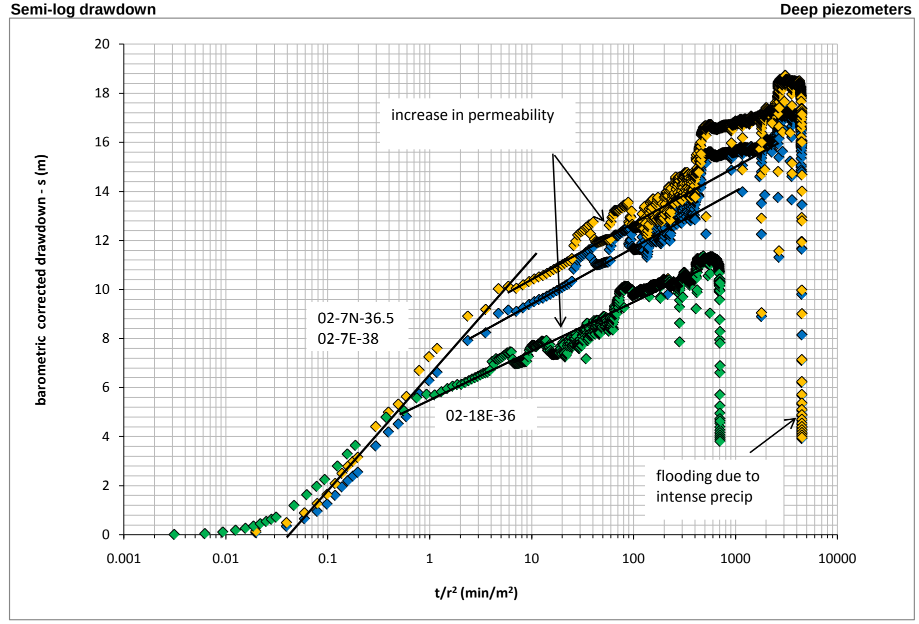
AQUIFER PROPERTY CALCULATIONS

		ds	T (m^2/d)	bulk K (m/d)	t/r^2_o	S
Shallow p/z	slope 1	1.8	25	0.98	0.06	0.002
	slope 2	11.6	4	0.15		
	ds1/ds2	0.2				
Deep p/z	slope 1	4.6	10	0.87	0.04	0.000003
	slope 2	2.2	20	1.8		
	ds1/ds2	2				

Semi-log drawdown **Shallow piezometers**



Semi-log drawdown **Deep piezometers**



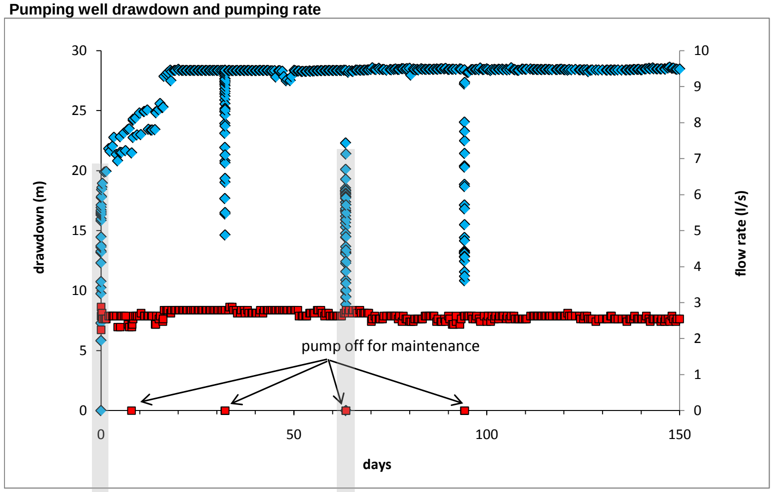
SUMMARY:

unconfined aquifer 0-6 m depth
confining layer 6-26 m depth
confined aquifer 26-50 m depth
Cf. geological log

permeability 0-6 m depth ca. 1 m/d
permeability between 6-26 m depth ~ca. 0.15 m/d
permeability below 26 m depth ca. 1 m/d
permeability beyond 15 m radial distance ca. 2 m/d

Sy = 0.2% in upper aquifer
S = $6x10^{-6}$ in lower aquifer

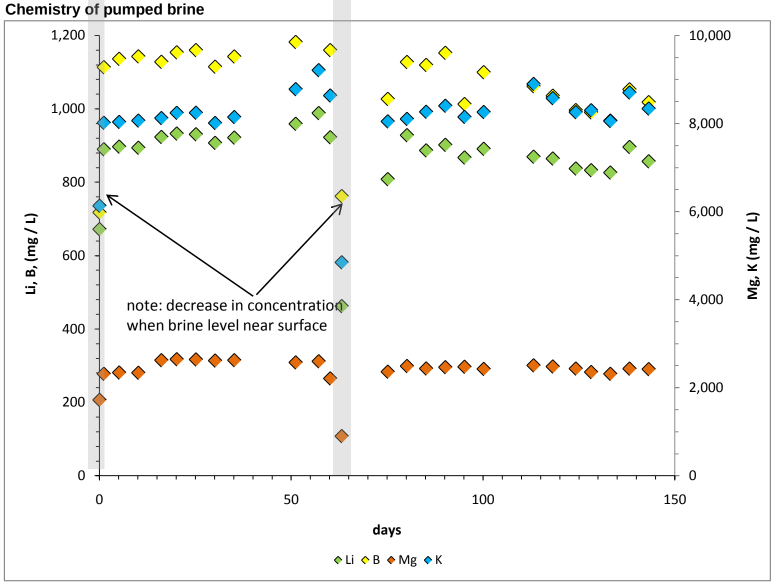
Pumping well drawdown and pumping rate

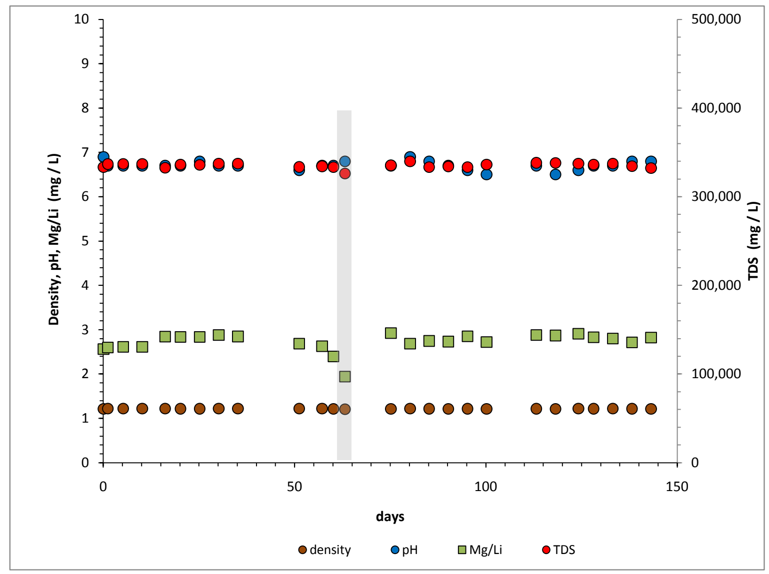


Mean Values

		+/-
Density	1.217	0.003
pH	6.71	0.10
TDS (mg/l)	335,292	2,719
Li (mg/l)	868	102
B (mg/l)	1,069	117
K (mg/l)	8,110	849
Mg/Li	2.7	0.2

Chemistry of pumped brine



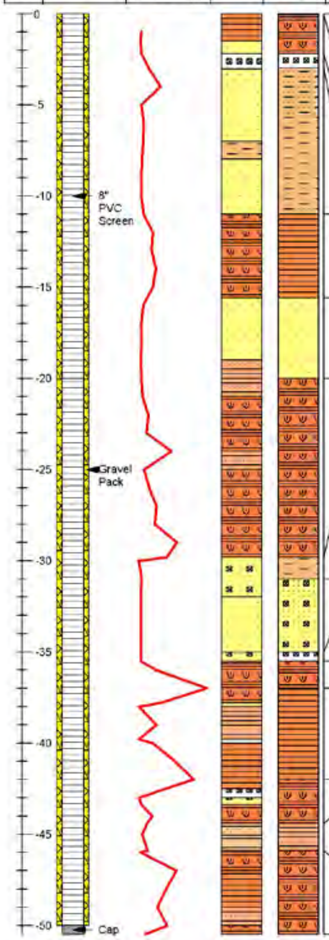


OROCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR:	VALLE	START DATE:	20-09-2009	COORDINATES (POSGAR 94 Zone 3)	**WELL REFERENCE:** P3
DRILL RIG:	HOLEMASTER 1000			E: 3426200	
METHOD:	BRINE FLUSH	END DATE:	20-10-2009	N: 7398063	LOGED BY: Geol. FERNANDO A. MARTÍN
				Elevn: 3900	

Depth (m) | Construction | Penetration rate (0 min. 100) | Driller Log | Geologist Log | Lithology | Units | Depth (m) | Elevn. (m) | REFERENCE MAP



Lithology

HALITE: Corteza de halita (0,045m). (Lacustrine)

CLAY with ULEXITE: Arcilla con escaso a nulo limo. Presencia de materia orgánica que intercala en finos niveles. Abundante ulexita en la zona superior. (Lacustrine)

HALITE: Sin registro de Cutting. Según perforistas corresponde a nivel de halita. (Lacustrine?)

CLAYEY SAND: Arena muy fina a media (mala Selección). Abundantes rastros de materia orgánica tiñen de negro toda la muestra (Matriz de acilla negra). MICRO: Selenita(?70%), Carbón+Pirrotina? (? 25%), Liticos Volcánicos? (<5%), Concreciones CaCO3 (1%), Qz (?1%). (Lacustrine - Swamp?)

CLAY : Arcilla marrón con abundantes rastros de materia ogánica y menor de arcilla verde. Abundantes cristales de selenita en toda la muestra (<1/4mm). (Lacustrine)

SAND: Sin registro de Cutting. Según perforistas corresponde a nivel de arena. (?)

CLAY with ULEXITE: Intercalan arcilla verde y marrón. Abundantes rastros de materia orgánica (arcilla negra), aparentemente, en finos niveles. Abundante presencia de ulexita y cristales de Selenita (hasta 2mm). (Lacustrine)

CLAYEY SAND: Arena (mala selección) de gruesa a fina y matriz con abundante materia orgánica (arcilla negra). Abundantes cristales de selenita de hasta 1mm. MICRO: Selenita(?30%), Qz (?30%), Liticos Volcanicos? (?30%), Carbón+Pirrotina? (< 5%). Wacke (<5%), Concreciones CaCO3 (1%). (Lacustrine - Swamp to fluvial?)

SAND with HALITE: Arena gruesa a fina (mala Selección). Granos liticos hasta 10mm (son escasos) de areniscas finas (contaminacion?). Halita en agregados policristalinos son muy escasos. Muestra lavada por perforistas (solo fracción gruesa). (Transition fluvial? Aluvial? To Lacustrine.)

HALITE: Nivel de halita en agregado policristalino poroso. (Lacustrine)

CLAY with ULEXITE: Arcilla marrón con abundante presencia de ulexita y cristales de selenita. Rastros de materia orgánica (arcilla negra). (Lacustrine)

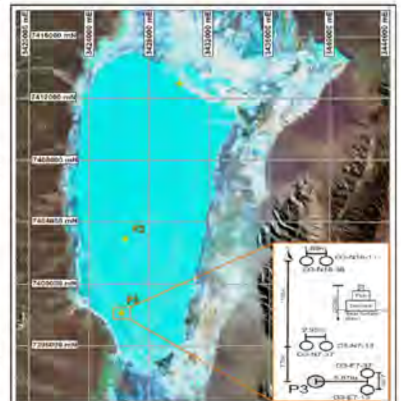
CLAY : Arcilla verde con rastros de arcilla marrón y negra (materia orgánica). (Lacustrine)

CLAY with ULEXITE: Arcilla marrón con rastros de arcilla verde y materia orgánica (arcilla negra). Abundantes cristales de selenita (hasta 0,5mm) y rastros de ulexita. (Lacustrine)

CLAY interbeded SAND: Arcilla negra con abundantes cristales de selenita de hasta 4mm y arena fina a muy fina. (Lacustrine - Swamp near transition fluvial? Aluvial? Eolian?)

CLAY with ULEXITE: Arcilla verde con abundantes rastros de materia orgánica (arcilla negra) y menor arcilla marrón. Abundante ulexita. (Lacustrine)

REFERENCE MAP



ID	Xm	Ym	Elev.	2"	Pipe	Concrete	DATUM
P3	3426197	7398063	3900	0,000	0,364	0,181	3900,846
O3-E7-13	3426204	7398062	3900	-	0,031	0,032	3900,063
O3-E7-37	3426204	7398064	3900	-	0,092	0,081	3900,173
O3-N7-13	3426199	7398070	3900	-	0,235	0,082	3900,317
O3-N7-37	3426196	7398070	3900	-	0,369	0,000	3900,369
O3-N18-13	3426199	7398081	3900	-	0,032	0,023	3900,055
O3-N18-38	3426196	7398081	3900	-	0,361	0,123	3900,484

ID	DEPTH (m)	CASING (m)			Depth water first encountered (m)	Static water level (m)	Water Level Elevation (m)
		From	To	Ø"			
P3	50,5	0	47	8	2,200	2,050	3897,950
O3-E7-13	13	0	13	4	2,200	0,870	3899,130
O3-E7-37	37	15	22	4	2,200	1,400	3898,600
O3-N7-13	13	0	13	4	2,200	0,880	3899,020
O3-N18-13	13	0	13	4	2,200	0,720	3899,280
O3-N7-37	37	15	22	4	2,200	1,589	3898,411
O3-N18-38	38	15	22	4	2,200	1,847	3898,153

OROCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

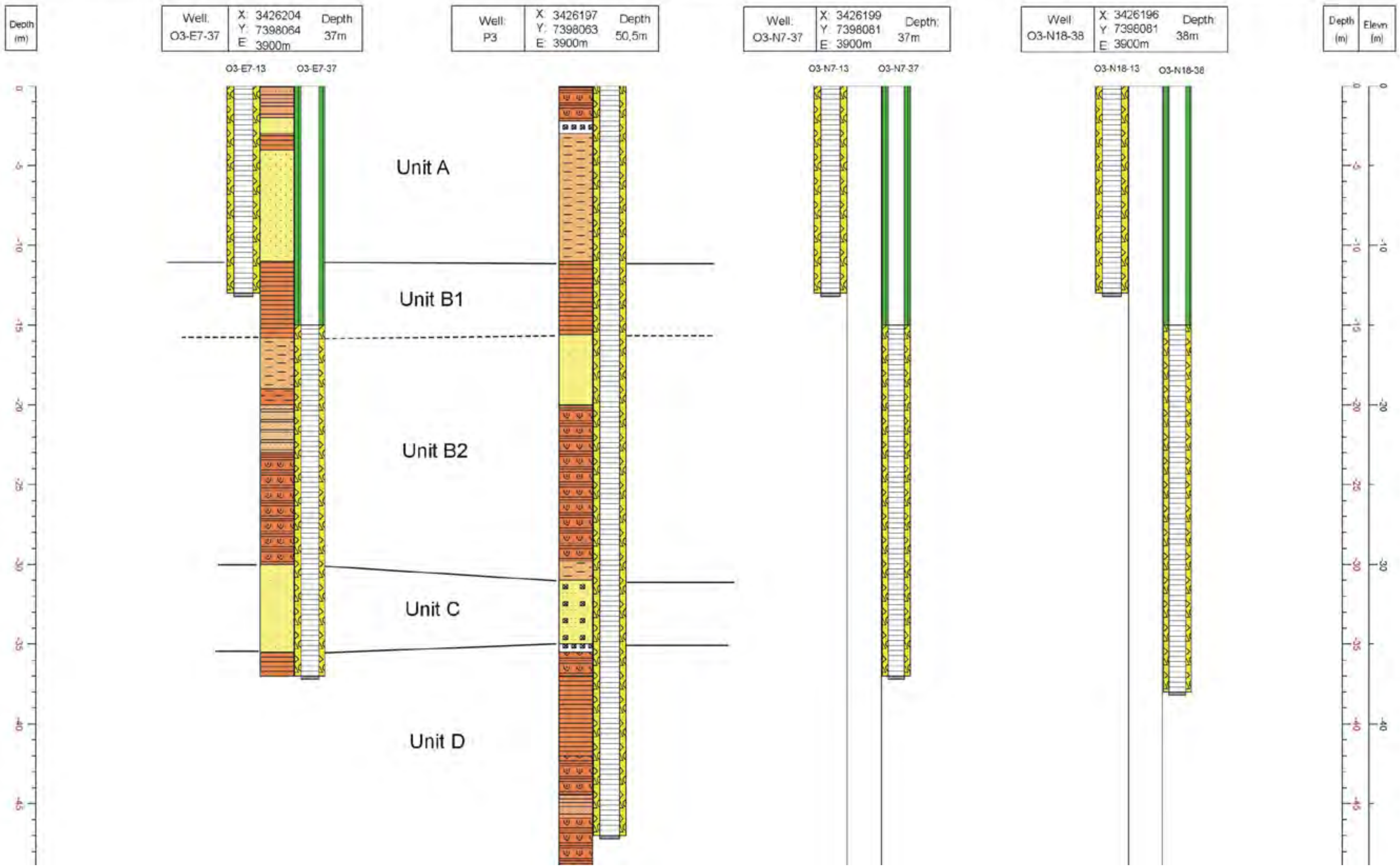
CORRELATION

CONTRACTOR:	**VALLE**
DRILL RIG:	**HOLEMASTER 1000**
METHOD:	**ROTARY**

WELLS REFERENCES:

O3-E7-37 – P3 – O3-N7-37 – O3-N18-38

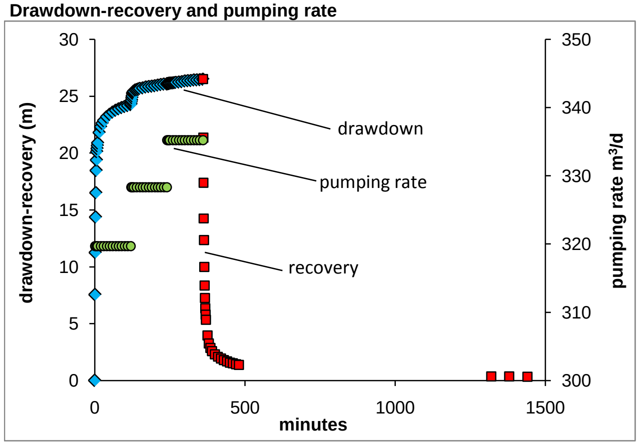
LOGED BY: **Geol. FERNANDO A. MARTÍN**



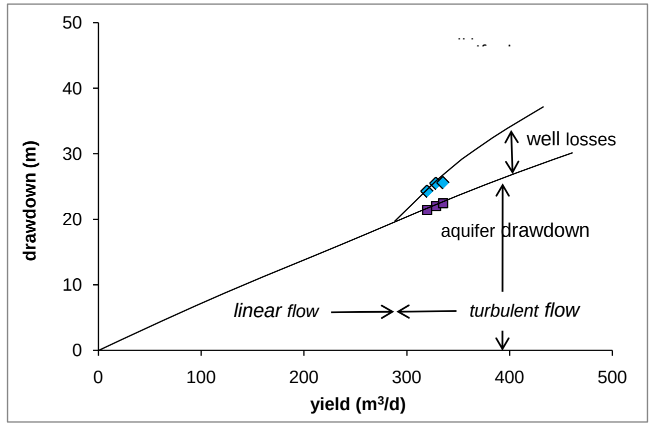
OROCOBRE

SALAR DE OLAROZ
STEP-TEST P3

Drawdown-recovery and pumping rate



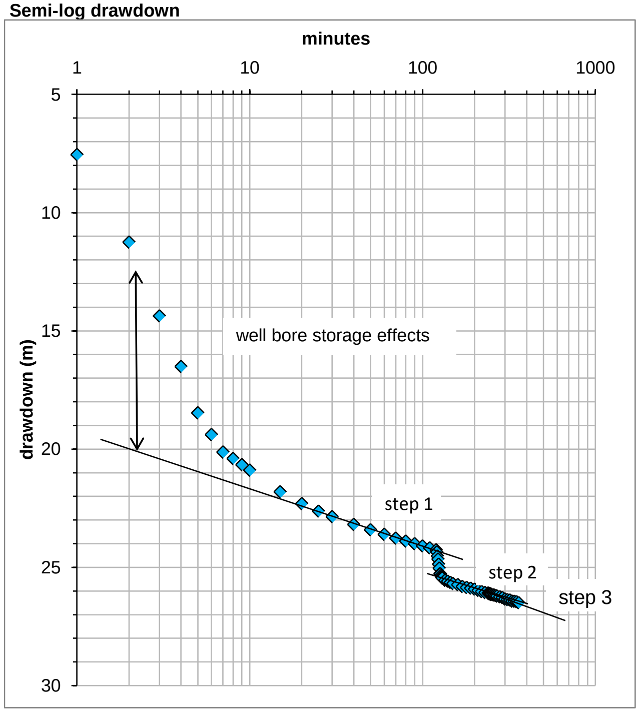
Yield - drawdown curve



Comments:

1. no corrections for brine density or elevation
2. the pump used has a very flat head-capacity curve thus the difference in Q between steps is small

Semi-log drawdown

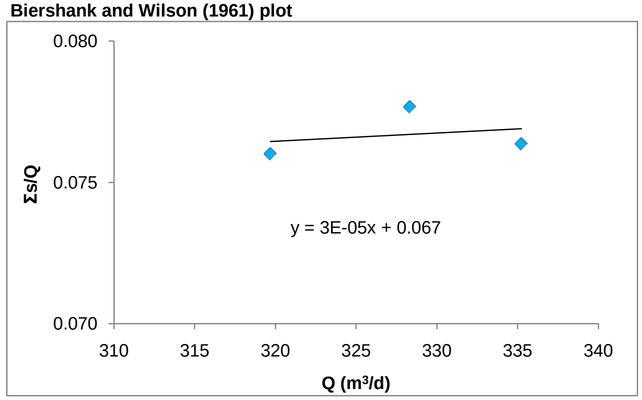


Calculations

step	s_{120m}	Δs (from graph)	Σs	Q	Σs/Q	CQ^2	BQ	efficiency
1	24.30	24.30	24.3	320	0.0760	3.07	21.42	88%
2	26.10	1.20	25.5	328	0.0777	3.23	22.00	86%
3	26.50	0.10	25.6	335	0.0764	3.37	22.46	88%
				mean				87%
				B =			0.067	
				C =			0.00003	

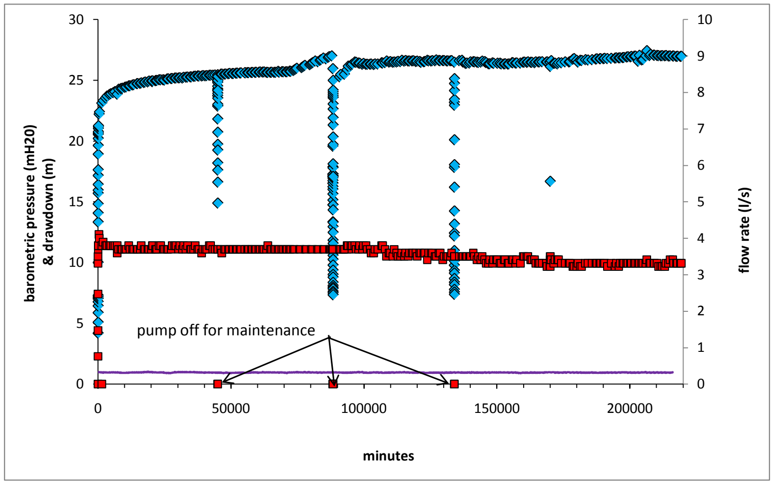
Recovery after 18 hrs: 99%

Biershank and Wilson (1961) plot



OROCOBRE

SALAR DE OLAROZ
CONSTANT RATE TEST P3



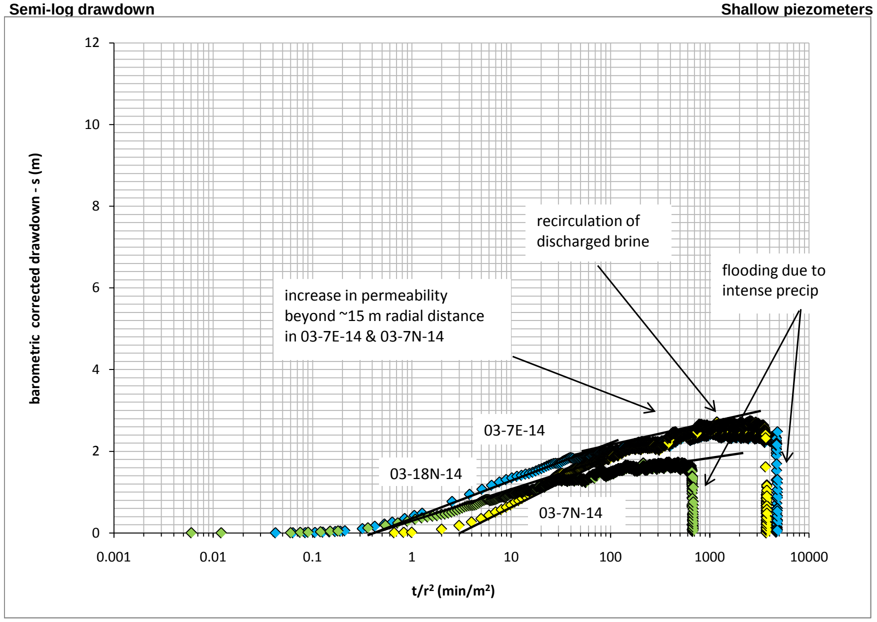
DATA

		radial dist from P3 (m)	Static WL (m bgl)	radial dist from P3 (m)	Static WL (m bgl)
	P3 (screened 0-50 m)	0.00	2.05		
Shallow p/z	03-7E-14	6.87	0.87		
	03-7N-14	7.78	0.98		
	03-18N-14	18.26	0.72		
Deep p/z	02-7E-38			6.87	1.40
	02-7N-36.5			7.78	1.59
	02-18N-36			18.26	1.85
	Screened	0-26		26-37	
	Aquifer thickness assumed	25		11	
	Flow rate	242 m^3/d			
	Pump suction	46 m			

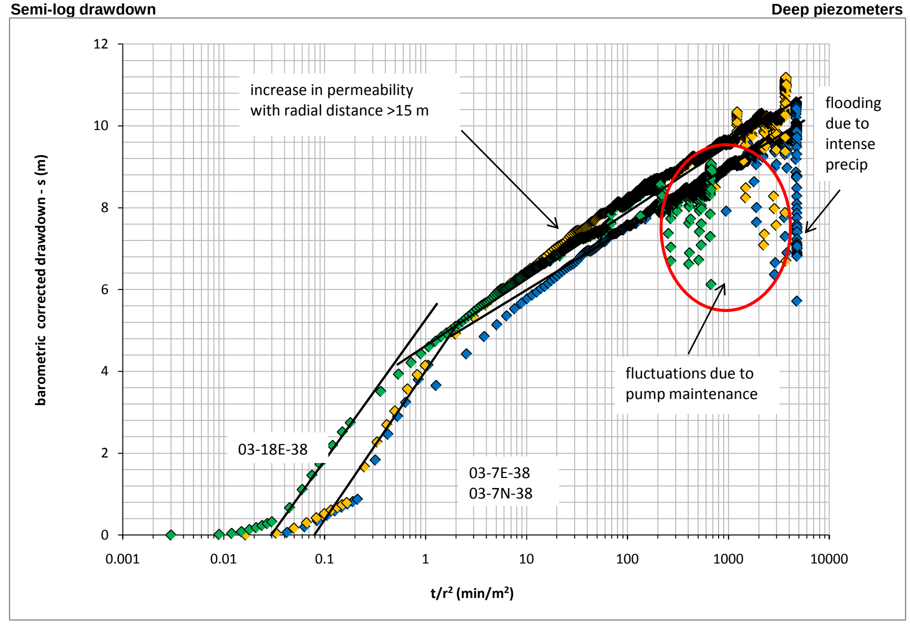
AQUIFER PROPERTY CALCULATIONS

		ds	T (m^2/d)	bulk K (m/d)	t/r^2_o	S
Shallow p/z	03-7E-14	0.9	49	2.0	0.3	0.023
	03-7N-14	1.3	34	1.4	3.0	0.16
	03-18N-14	0.7	63	2.5	0.3	0.030
Deep p/z	slope 1	2.6	17	1.5	0.08	0.00006
	slope 2	2.6	17	1.5	0.08	0.00039
	ds1/ds2	2.6	17	1.5	0.02	0.00007

Semi-log drawdown — **Shallow piezometers**



Semi-log drawdown — **Deep piezometers**



SUMMARY:

unconfined aquifer 0-11 m depth
confining layer 11-16 m depth
confined aquifer 16-50 m depth
Cf. geological log

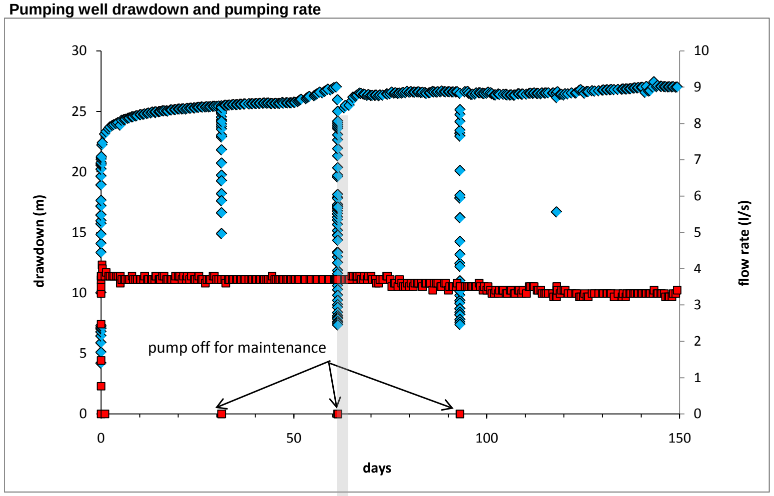
permeability in unconfined and confined aquifers 2.5 m/d
close to pumping well (<15 m radial distance) permeability ca. 1.5 m/d

Sy = 2%-16% in unconfined aquifer
S = 0.6-4x10^{-4} in confined aquifer

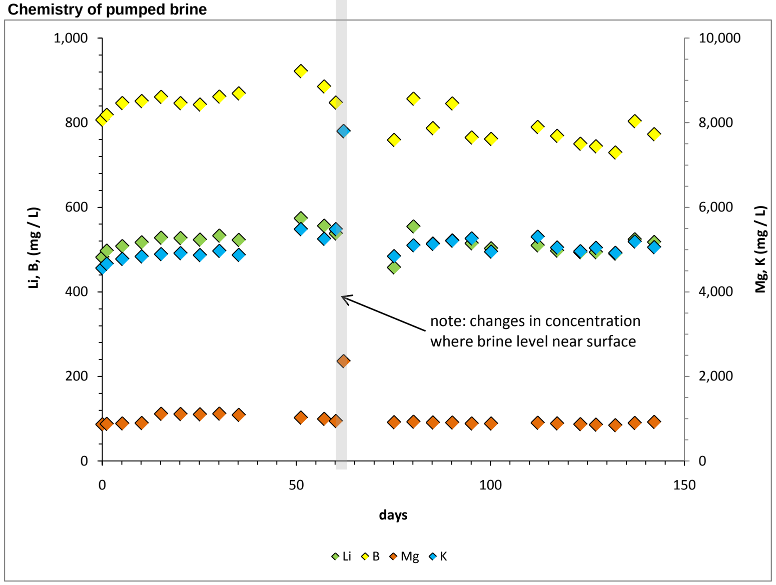
OROCOBRE

SALAR DE OLAROZ
CONSTANT RATE TEST P3
page 2

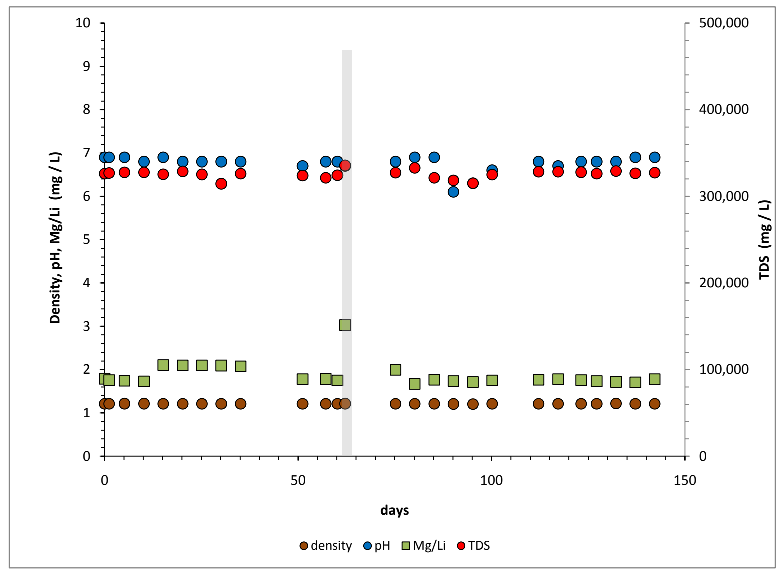
Pumping well drawdown and pumping rate



Chemistry of pumped brine



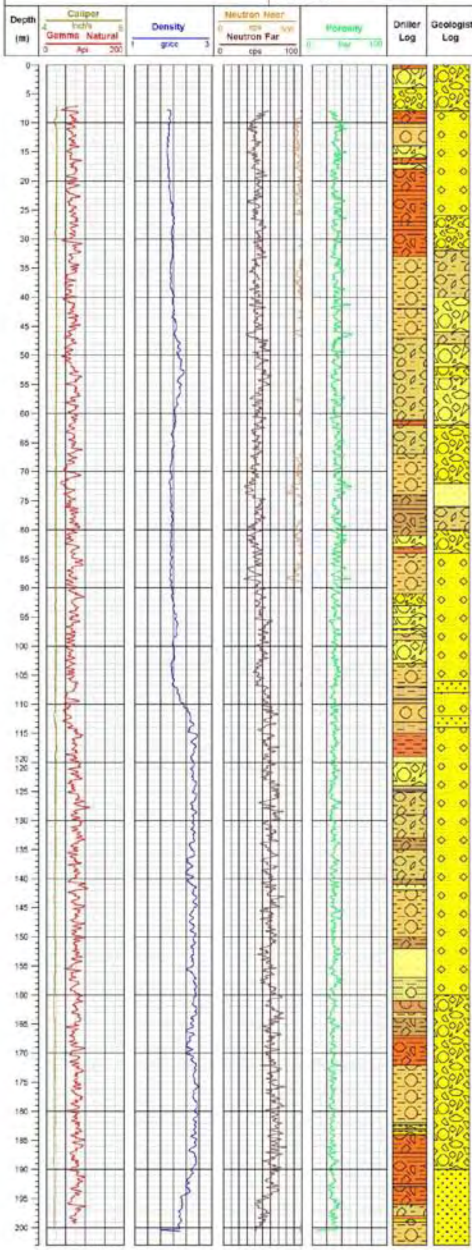
Mean Values		+/-
Density	1.211	0.003
pH	6.77	0.19
TDS (mg/l)	325,667	4,657
Li (mg/l)	526	57
B (mg/l)	823	63
K (mg/l)	5,133	8705
Mg/Li	1.9	0.3



APPENDIX D

OFF-SALAR WELL LOGS

OROCOBRE OLAROZ PROJECT	CONTRACTOR:	VALLE	START DATE:	10-06-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:	DWN
RESOURCE EVALUATION PROGRAM	DRILL RIG:	HOLEMASTER 1000	END DATE:	18-06-2010	E: 3434014		
					N: 7424868		
	METHOD:	Brine Flush	DEPTH:	203m	Elevn: 3923m	LOGED BY:	Geol. FERNANDO A. MARTÍN



Lithology

GRAVEL With GRANULES: Grava fina (4 a 5mm) algunos alcanzan 1cm. Abundantes fragmentos sabulíticos (2 a 3mm) y muy escasos granos de arena muy gruesa. Clastos subredondeados conformados por pelitas y en menor proporción wakes, cuarcitas y cuarzo lechoso (Qz vein?), escasos líticos volcánicos con magnetita. La forma predominante de los clastos es plana. Matriz de arena media con moderada selección (75% eólica?) conformada por abundantes cristales de cuarzo y menor magnetita. Muy escasa presencia de finas ramas.

SANDY GRANULES: Arena sabulítica (2 a 4mm) muy escasos granos alcanzan 5mm con arena muy gruesa a media (5-10%). Clastos subredondeados a subangulosos conformados por pelitas y wakes gris-verdosas, menor cuarzo lechoso (Qz vein?) y líticos volcánicos (?). Muy escasos restos (<1%) de arcilla marrón clara (5YR 6/4).

GRAVEL: Grava con clastos subredondeados a subangulosos (fracturados por perforación. Superficie de corte fresca y bordes subangulosos) de 4 a 12mm. Muy escasa presencia de arena media (<1%). Clastos conformados por pelitas, wakes y en menor proporción cuarcitas, cuarzo lechoso (Qz vein?). Muy escasos granos rojizos afaníticos (volcánicos?).

SANDY GRAVEL WITH CLAY: Grava areno-arcillosa sabulítica. Clastos (?80%) conformados por pelitas y wakes gris verdosas con menor proporción de de cuarcitas y cuarzo lechoso. Granos subredondeados a subangulosos de 1 a 13mm. Matriz de arena media a gruesa arcillosa marrón (5YR 6/4).

SANDY GRAVEL WITH CLAY: Grava fina areno-arcillosa. Clastos (?80%) conformados por pelitas y wakes gris verdosas con menor proporción de de cuarcitas y cuarzo lechoso. Clastos subredondeados a subangulosos de 3 a 12mm con escasa sabulita (3 a 4mm).

SANDY GRAVEL WITH CLAY: Grava fina sabulítica areno-arcillosa. Clastos conformados por pelitas y wakes gris verdosas con menor proporción de de cuarcitas y cuarzo lechoso. Granos subredondeados a subangulosos de 1 a 13mm. Matriz de arena media a gruesa arcillosa marrón (5YR 6/4).

SANDY GRAVEL WITH CLAY: Grava fina areno-arcillosa. Clastos conformados por pelitas y wakes gris verdosas con menor proporción de de cuarcitas y cuarzo lechoso. Clastos subredondeados a subangulosos de 3 a 12mm con escasa sabulita (3 a 4mm).

SANDY GRAVEL: Grava fina arenosa (arena fina a muy fina) con muy escasa (<1%) arcilla marrón. Clastos principalmente subredondeados con tamaños de 2 a 10mm conformados por pelitas y wakes con menor proporción de cuarzo lechoso y líticos volcánicos (?). Muy escasa matriz (1-2%) de arena fina a muy fina.

SANDY GRAVEL: Grava fina sabulítica arenosa. Clastos principalmente subredondeados de 1 a 10mm (dominan de 2 a 5mm) un solo ejemplar alcanza los 30mm. Matriz (?5%) arena fina a muy fina con menor proporción de arcilla.

SANDY GRAVEL WITH CLAY: Grava fina areno-arcillosa con escasos fragmentos sabulíticos. Clastos subredondeados que varían de 3 a 12mm conformados por pelitas y wackes gris-verdosos y en menor proporción, fragmentos angulosos de cuarzo lechoso. Escasa matriz (?5%) de arena fina a muy fina ligeramente arcillosa.

SANDY GRAVEL: Grava fina sabulítica arenosa. Clastos principalmente subredondeados de 2 a 11mm. Matriz de arena fina a muy fina con muy escasa arcilla.

GRAVEL With GRANULES: Grava fina sabulítica. Clastos subredondeados de 2 a 7mm (muy escasos alcanzan 10mm) conformados por pelitas, wackes y en menor proporción, fragmentos angulosos de cuarzo lechoso. Matriz (1-2%) de arena fina arcillosa marrón.

SANDY GRAVEL: Grava fina arenosa con escasos componentes tamaño sábulo. Clastos de 3 a 12mm (un solo ejemplar 17mm) subredondeados conformados por pelitas, wackes y en menor proporción, fragmentos angulosos de cuarzo lechoso. Matriz (1-2%) de arena fina a muy fina.

GRAVEL With GRANULES: Grava fina sabulítica arenosa. Clastos subredondeados que oscilan de 1 a 10mm, conformados por wackes gris-verdosas y rojizas, pelitas verdes (escasas con alteración hidrotermal?) y fragmentos angulosos de cuarzo lechoso. Arena gruesa a media (?10%).

SAND: Arena media a fina con fragmentos sabulíticos (3mm) subredondeados. Sabulita compuesta por wackes gris-verdosas y rojizas, pelitas verdes (escasas con alteración hidrotermal?) y fragmentos angulosos de cuarzo lechoso.

SANDY GRAVEL WITH CLAY: Grava fina areno-arcillosa. Clastos subredondeados a subangulosos de 3 a 13mm muy escasos alcanzan 16mm. Conformados por pelitas gris-verdosas, wackes gris-verdosas y rojizas menor presencia de clastos con alteración hidrotermal (?) y fragmentos angulosos de cuarzo lechoso. Escasa matriz (?5%) de arena fina a muy fina con muy escasa arcilla. Abundante agua.

GRAVEL With GRANULES: Grava fina sabulítica arenosa con clastos subredondeados de 2 a 13mm. Arena gruesa a muy fina (20-30%). Grava conformada por pelitas gris-verdosas, wackes gris-verdosas y rojizas menor presencia de clastos con alteración hidrotermal (?) y fragmentos angulosos de cuarzo lechoso.

SANDY GRANULES: Sabulita areno-arcillosa con muy escasa grava fina. Domina fracción sabulítica (2 a 3mm), escasos fragmentos alcanzan los 10mm. En matriz de arena gruesa a fina ligeramente arcillosa (?10%).

SANDY GRANULES: Sabulita con buena selección con gránulos de 2 a 3mm. Escasa matriz (?10%) con arena media a fina y escasa arcilla marrón-clara.

V. COARSE SAND: Arena muy gruesa a fina con muy escasos granos sabulíticos (<3mm) y muy escasa presencia de limo.

SANDY GRANULES: Sabulita con buena selección (gránulos de 2 a 4mm) dominan de 2 a 3mm. Escasa matriz (?5%) con arena media a fina y escasa arcilla marrón-clara.

V. COARSE SAND: Arena muy gruesa a sabulítica (1 a 3mm) Muy escasa presencia de arena media a fina (?2%).

SANDY GRANULES: Arena sabulítica a gruesa con abundante matriz (?50%) de arena fina a muy fina limosa con escasa arcilla (contaminación con lodo de perforación?).

SANDY GRANULES: Arena sabulítica a gruesa con escasa matriz (?5%) de arena fina a muy fina limosa con escasa arcilla.

SANDY GRANULES: Arena sabulítica a gruesa con escasa (?10%) arena fina a muy fina limosa con escasa arcilla. Fragmentos angulosos de cuarzo lechosos alcanzan 15mm.

SIN MUESTRA

SANDY GRANULES: Arena sabulítica a gruesa con escasa (?10%) arena fina a muy fina limosa con escasa arcilla. Fragmentos angulosos de cuarzo lechosos alcanzan 15mm.

SANDY GRANULES: Arena sabulítica a gruesa con matriz (?30%) de arena fina a muy fina arcillosa marrón.

GRAVEL With GRANULES: Sabulita a grava fina conformada por gránulos y clastos principalmente subredondeados y escasos subangulosos con tamaños de 3 a 7mm. Conformados por pelitas gris-verdosas, wackes gris verdosas y rojizas, fragmentos angulosos de cuarzo lechoso (Qz/vein?) y fragmentos pelíticos con alteración hidrotermal (?). Matriz (10-20%) de arcilla marrón clara (5YR 6/4) con escasa presencia de arena fina a muy fina (contaminación con fluido de perforación?).

V. COARSE SAND: Arena muy gruesa a ligeramente sabulítica. Escasos gránulos alcanzan los 3mm, dominan 0.5 a 1mm. Matriz (?10%) de arcilla marrón clara (5YR 6/4) con arena fina a muy fina (contaminada con lodo de perforación?).

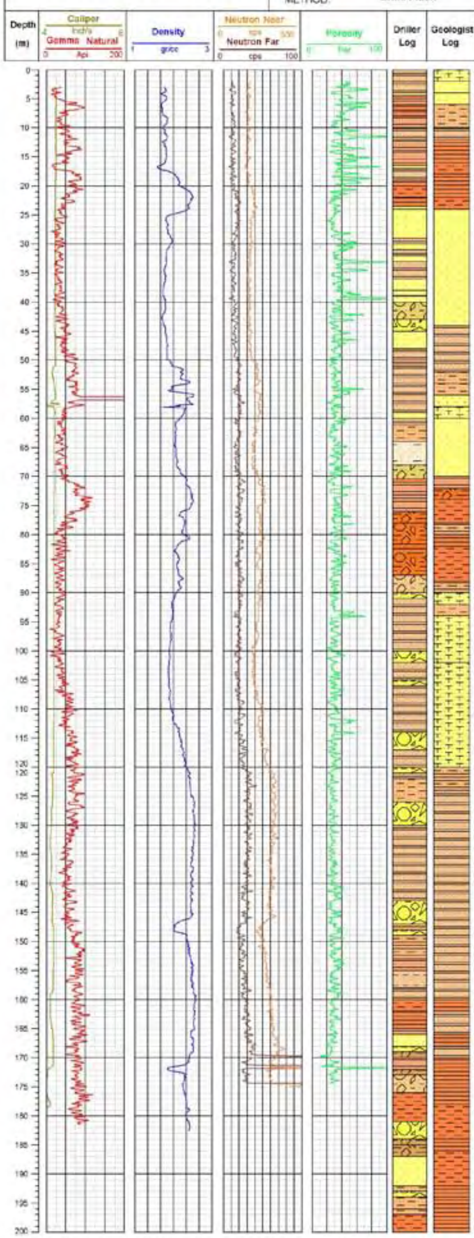
V. COARSE SAND: Arena muy gruesa a sabulítica (50-50). Escasos gránulos alcanzan los 3mm, dominan 0.5 a 1mm. Escasa arcilla marrón clara (5YR 6/4) con arena fina a muy fina (contaminada con lodo de perforación?).

V. COARSE SAND: Arena muy gruesa a ligeramente sabulítica. Escasos gránulos alcanzan los 3mm, dominan 0.5 a 1mm. Matriz (?10%) de arcilla marrón clara (5YR 6/4) con arena fina a muy fina (contaminada con lodo de perforación?).

OROCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR:	VALLE	START DATE:	10-02-2009	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: DWE
DRILL RIG:	HOLMASTER 1000	END DATE:	18-03-2009	E: 3431715 N: 7402015	
METHOD:	Brine Flush	DEPTH:	200m	Elevn: 3905	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

SILTY SAND: Arena muy fina limosa con abundantes fragmentos de ulexita, muy friable. Zona superficial alterada por labores mineras previas (boratera).

SAND: Arena fina a muy fina con poca presencia de material limoso. Abundantes cristales de selenita y menor de halita. La muestra se encuentra contaminada con el nivel superior.

SAND: Arena fina a muy fina con poca presencia de material limoso. Abundantes cristales de selenita y menor de halita. Fragmenos de finas raices. Escasa contaminación.

CLAYEY SAND: Arena media a fina en matriz limo-arcillosa gris-oscura a negra. Los granos de arena estan compuesto casi en su totalidad por cristales de selenita y en menor proporción halita?.

SAND interbeded CLAY: Arena gruesa a fina constituida casi exclusivamente por cristales de selenita. Finos fragmentos de arcilla (5YR 6/6) y escasos restros de ulexita. Muy poca presencia de material fino en arena (limo-arcilla).

CLAY : Mix de arcilla negra con abundantes cristales de selenita y menor arcilla marrón-rojiza (5YR 5/6); con escasos restros de ulexita

SANDY CLAY: Finos a muy finos cristales de selenita en matriz arcillosa gris-oscura a negra. Escasos restros de arcilla marrón-rojiza.

CLAY : Arcilla marrón compacta Masiva (seca) muy escasos restros de ulexita.

SANDY CLAY: Arcilla arenosa con escasos restros de Materia Orgánica. Arena es de media a fina con abundantes cristales de selenita

SAND: Arena fina a muy fina con escaso limo y abundantes cristales de selenita. Rastros de Materia orgánica tiñene la muestra de gris-oscuro. Escasos restros de arcilla marrón en la parte superior (contaminación?).

SAND interbeded CLAY: Arena fina a muy fina con escaso nulo material fino y abundantes cristales de selenita. Fragmentos de arcilla marrón con cristales de selenita y escasa ulexita. Hacia los 50 mts abundantes fragmentos carbonosos (?).

CLAYEY SAND: Arena fina a muy fina con escaso limo y abundantes cristales de selenita. Rastros de Materia orgánica tiñene la muestra de gris-oscuro.

CLAYEY SAND: Abundantes cristales de selenita de tamaños aproximadamente uniforme (arena gruesa a media). Abundante arcilla negra (materia orgánica).

MEDIUM SAND: Abundantes cristales de selenita de tamaños aproximadamente uniforme (arena gruesa a media) con escasos finos y restros de arcilla negra.

SILTY SAND: Arena limosa conformada por abundantes cristales de selenita y fragmentos de ulexita. Rastros de material carbonoso (?).

SAND: Arena fina a muy fina gris-oscura a negra con abundantes cristales de selenita y escasa a nula presencia de material fino (limo-arcilla). Escasos restros de arcilla y ulexita.

CLAY interbeded SAND: Arcilla negra con escasos restros de arcilla verde y ulexita. Abundantes cristales de selenita (hasta 1mm) no ligados a la arcilla (sueltos).

CLAYEY GRAVEL: Arcilla marrón con abundantes fragmentos líticos y cristales de selenita de hasta 2mm (arcilla gravosa?). Muy poco contenido de agua.

SANDY CLAY: Mix de arcilla marrón clara y arcilla negra con abundantes cristales de selenita con tamaño de arena media a gruesa. Abundante contenido de agua.

CLAY interbeded SANDY CLAY: Arcilla marrón y arena fina a muy fina en matriz arcillosa negra. Abundante cantidad de agua.

CLAY : Mix de arcilla marrón y arcilla negra cone escasos cristales de selenita.

SANDY CLAY: Arena fina a muy fina con abundante matera orgánica. Rastros de arcilla marrón (?) y ulexita. Segun perforistas arena corresponde a nivel superior (conatamineción)

CLAY interbeded SANDY CLAY: Arcilla marrón con restros de ulexita, abundantes cristales de selenita en matriz arcillosa gris-oscura (¿).

SILTY SAND: Arena fina a muy fina limosa con abundantes cristales de selenita y escasos restros de ulexita. Muy escasos restros de arcilla marrón.

CLAYEY SAND: Arena fina a muy fina con abundantes cristales de selenita y restros de arcilla negra.

SILTY SAND: Arena fina a muy fina limosa gris-oscura. Conformada por abundantes cristales de selenita.

SILTY SAND: Arena fina a muy fina limosa gris-oscura. Conformada por abundantes cristales de selenita. Muy escasos restros de ulexita hacia los 120 mts.

CLAY interbeded SANDY CLAY: Mix de arcilla negra con abundantes cristales de selenita y ulexita con escasa arcilla marrón.

SAND interbeded CLAY: Arena media a muy fina limosa gris-oscura. Conformada por abundantes cristales de selenita. Rastros de arcilla marrón en distintos niveles, abundantes hacia el fondo con menor arcilla negra.

CLAY : Arcilla marrón-rojiza con presencia de arena media gris-oscura con abundante selenita (Contaminación?)

SAND interbeded CLAY: Arena media a gruesa gris-oscura a negra con abundante selenita. Abundantes rastros de arcilla marrón-rojiza.

CLAY : Arcilla marrón-rojiza con presencia de arena media gris-oscura con abundante selenita (Contaminación?)

SAND interbeded CLAY: Arena media a gruesa gris-oscura a negra con abundante selenita. Abundantes rastros de arcilla marrón-rojiza.

CLAY : Arcilla marrón-rojiza con presencia de arena media gris-oscura con abundante selenita (Contaminación?)

SANDY CLAY: Arcilla marrón-rojiza con escasa presencia de arena media gris-oscura con abundante selenita.

CLAY : Arcilla marrón-rojiza con abundante presencia de arena media gris-oscura con abundante selenita (contaminación?). Rastros de ulexita y menor arcilla verde.

SANDY CLAY: Arcilla marrón-rojiza con presencia de arena media gris-oscura con abundante selenita.

CLAY : Arcilla marrón-rojiza con rastros de arcilla verde y menor ulexita.

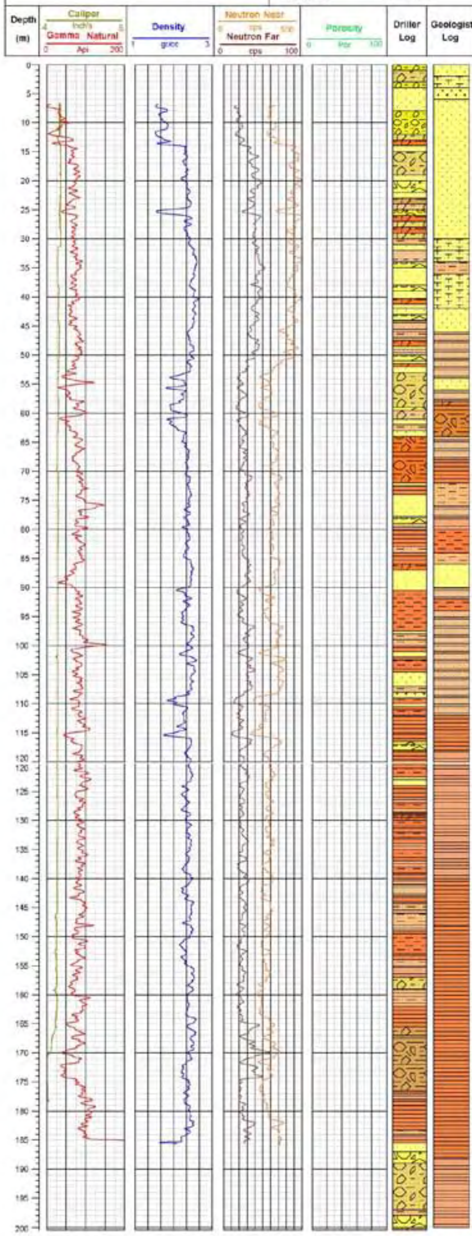
CLAY : Arcilla marrón-rojiza con abundantes rastros de Materia Orgánica y escasos restros de arcilla verde. Abundante presencia de arena media a gruesa (contaminación?).

CLAY : Arcilla marrón-rojiza y gris-verdosa con restros de ulexita y muy escasos restros de Materia Orgánica.

OROCOBRE OLAROZ PROJECT

RESOURCE EVALUATION PROGRAM

CONTRACTOR:	VALLE	START DATE:	20-03-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE: DWS
DRILL RIG:	HOLMASTER 1000	END DATE:	16-04-2010	E: 3423520 / N: 7390771	
METHOD:	Brine Flush	DEPTH:	200,5m	Elevn: 3922m	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

MEDIUM SAND: Arena media a gruesa de color heterogeneo dado el tamaño de los granos. Escaso a nulo material fino (limo-arcilloso).

SILTY SAND: Arena media a fina con muy escasos rastros de material fino (arcilla-rojiza).

COARSE SAND: Arena muy gruesa a gruesa con granos, principalmente, subangulosos. Color heterogeneo dado el tamaño de los granos. Muy escaso a nulo material fino (arcillo-limosos). Finos fragmentos fegetales (raices?).

MEDIUM SAND: Arena media a gruesa (cristales de yeso?).

SILTY SAND: Arena media a fina con muy escasos rastros de material fino (arcilla-rojiza).

SILTY SAND: Arena media a fina con rastros de material fino (arcilla marrón).

CLAYEY SAND: Arena fina a muy fina con restros de arcilla marrón.

SILTY SAND: Arena fina a muy fina limosa gris clara.

MEDIUM SAND: Arena media a fina con muy escasos restros de material fino (arcillo-limoso). Color heterogeneo. Rastros vegetales escasos.

SAND interbeded CLAY: Arena media a fina con rastros de arcilla marrón.

MEDIUM SAND: Arena media gris con muy escaso a nulo material fino.

SAND interbeded CLAY: Arena gruesa a media gris (4) con rastros de arcilla marrón (5YR5/6).

GRAVEL WITH CLAY: Arena gruesa a muy gruesa y conglomerado en arcilla marrón-rojiza(10R4/6) y gris verdosa (5GY5/2).

SAND interbeded CLAY: Arena muy gruesa a fina con abundantes rastros de arcilla marrón rojiza. (10R4/6).

CLAY : Mix de arcilla negra (2) y menor arcilla marrón (10YR6/2). Abundantes restros de arena gruesa (Contaminación?).

CLAYEY SAND: Arena gruesa a fina con restros de arcilla negra y menor marrón.

SAND interbeded CLAY: Arena media a fina con rastros de arcilla marrón. (5YR4/4).

CLAY interbeded SAND: Arcilla marron con abundantes rastros de arena gruesa a fina. (5YR4/4).

SANDY CLAY: Arcilla marrón con abundante arena muy fina limosa (5YR4/4).

CLAYEY SAND: Arena gruesa con abundante arcilla marrón. (5YR5/6).

SAND: Arena fina a muy fina con escaso a nulo material fino (5YR5/2).

SAND interbeded CLAY: Arena media a muy fina con escasos restros de arcilla marrón. (5YR5/2). Menor restos de Materia Orgánica.

SANDY CLAY: Arcilla marrón (5YR6/4) con abundantes restros de arena media a fina.

SAND interbeded CLAY: Arena media a fina con abundantes restros de arcilla marrón (5YR6/4). Muy escasos restros de Materia Orgánica.

SAND interbeded CLAY: Arena gruesa a media con restros de arcilla marrón (5YR 5/4). Muy escasos restros de Materia Organica.

CLAY : Arcilla marrón (5YR6/4) y arena muy gruesa a gruesa. Restros de Materia Orgánica.

CLAY : Mix de arcilla marrón (5YR6/4) y arcilla negra (1). Rastros de arena gruesa a muy gruesa (contaminación?).

CLAY interbeded SAND: Arcilla marrón (5YR6/4) con restros de Materia Organica. Restros de arena gruesa a muy gruesa.

CLAY : Arcilla marron rojiza (5YR5/6) con abundantes rastros de materia Organica y muy escasos de arcilla verde. Arena gruesa (contaminacion?).

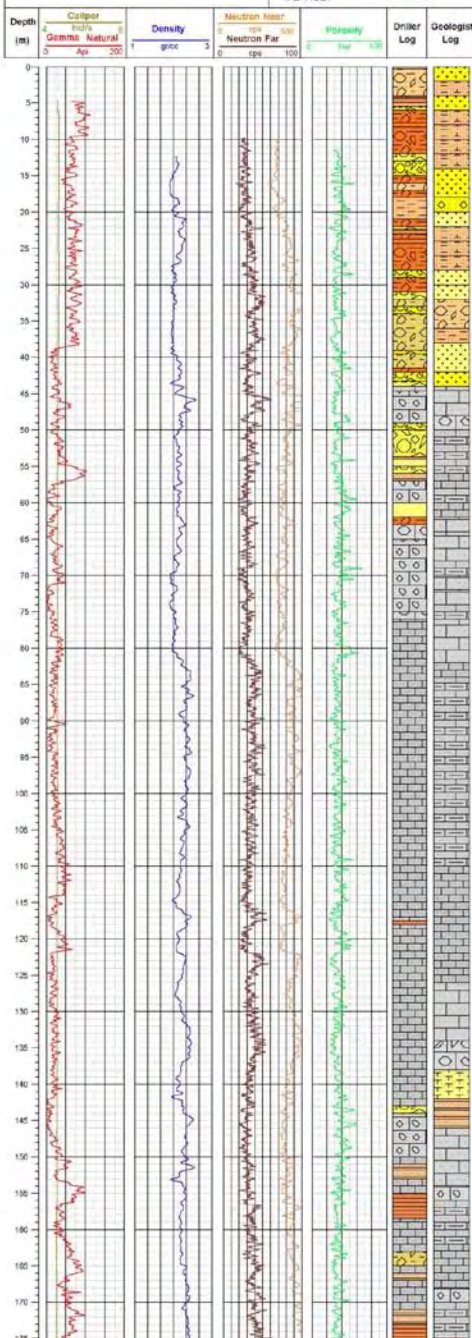
CLAY : Arcilla marrón rojiza (5YR5/6) con abundantes rastros de materia Orgánica y arcilla verde (10Y 5/4). Restros de arena gruesa (contaminación?).

CLAY : Arcilla marrón rojiza (5YR5/6) con abundantes rastros de materia Orgánica y muy escasos de arcilla verde restros de arena gruesa (contaminación?).

CLAY interbeded SAND: Mix de arcilla rojiza y gris-verdose con abundante arena media a gruesa.

CLAY interbeded SAND: Mix de arcilla rojiza y gris-verdose con escasa arena media a gruesa.

OROCOBRE — OLAROZ PROJECT	CONTRACTOR: VALLE	START DATE: 20-04-2010	COORDINATES (POSGAR 94 Zone 3)	WELL REFERENCE:
	DRILL RIG: HOLEMASTER 1000	END DATE: 23-05-2010	E: 3422112 / N: 7408000	DWO
RESOURCE EVALUATION PROGRAM	METHOD: Brine Flush	DEPTH: 180m	Elevn: 3918m	LOGED BY: Geol. FERNANDO A. MARTÍN



Lithology

V. COARSE SAND: Arena muy gruesa con muy escaso material fino (arena media a limo) con granos subangulosos en distintos tonos de rojizos y grises.

CLAYEY SAND with SILT: Arena muy gruesa limo-arcillosa, abundante matriz (?25%) arcillo-limosa marrón clara (5YR 6/4). Granos subangulosos en distintos tonos de grises, marrones y rojizos.

V. COARSE SAND: Arena muy gruesa a sabulítica (algunos granos ligeramente superiores a 2mm) en matriz con escasa arcilla-limosa marrón (5YR 6/4).

CLAYEY SAND with SILT: Arena muy gruesa arcillo-limosa con abundante matriz de color marrón claro (5YR 6/4). Granos principalmente subredondeados en distintos tonos de grises, marrones y rojizos.

CLAYEY SAND with SILT: Arena gruesa a sabulítica (abundantes granos hasta 3mm) principalmente subredondeados. Matriz (?20%) arcillo-limo arenosa (arena muy fina) de color marrón claro (5YR 6/4).

CLAYEY SAND with SILT: Arena sabulítica a muy gruesa arcillo-limosa con granos subangulosos a subredondeados con escasa matriz (10%) de arcilla-limosa marrón clara (5YR 6/4).

CLAYEY SAND with SILT: Arena muy gruesa con abundantes granos sabulíticos (ligeramente superiores a 2mm). Matriz (?25%) de arcilla limosa marrón clara (5YR 6/4).

V. COARSE SAND: Arena muy gruesa con muy escasos sabulíticos y escasa matriz (<5%) arcillo limosa marrón clara (5YR 6/4). Granos subangulosos a subredondeados.

SANDY GRANULES: Arena sabulítica a muy gruesa con granos subredondeados a subangulosos en matriz (?5%) arcillo marrón clara (5YR 6/4) con muy escaso limo.

COARSE SAND: Arena gruesa con moderada a buena selección. Granos subredondeados a subangulosos. Muy escasos restos de arcilla-limosa marrón clara (1 a 2%) (Contaminación?).

CLAYEY SAND with SILT: Arena gruesa con granos subredondeados a subangulosos. Matriz (5-10%) de arcilla-limosa marrón clara (5YR 6/4).

CLAYEY SAND with SILT: Arena muy gruesa a gruesa con granos subredondeados a subangulosos. Matriz (2-5%) de arcilla marrón clara (5YR 6/4).

CLAYEY SAND with SILT: Arena muy gruesa con granos subredondeados a subangulosos. Escasa matriz (<5%) de arcilla limosa marrón clara (5YR 6/4).

COARSE SAND: Arena gruesa con granos subredondeados y muy escasa matriz (1-2%) arcilla limosa marrón clara (5YR 6/4).

COARSE SAND: Arena gruesa a muy gruesa con granos subredondeados y escasa matriz (3-5%) de arcilla marrón clara (5YR 6/4). (contaminación?).

CLAYEY GRAVEL WITH SAND: Grava muy fina a sabulítica con clastos, principalmente, subangulosos en distintos tonos de marrones, rojos y grises. Matriz arcillo-limosa marrón-clara (5YR 6/4).

CLAYEY SAND: Arena gruesa a mediana con granos subredondeados a subangulosos en distintos tonos de marrones, rojizos y grises. Matriz arcillo-limosa marrón-clara (5YR 6/4).

COARSE SAND: Arena gruesa con granos principalmente subredondeados en distintos tonos de grises, rojizos y marrones. Muy escasa matriz (<1%). Muy escasos y pequeños fragmentos vegetales (ramas).

V. COARSE SAND: Arena muy gruesa con escasos clastos sabulíticos subredondeados en distintos tonos grises, marrones, rojizos y blanquecinos. Muy escasa matriz (1-2%) de arcilla-limo arenosa marrón clara (5YR 6/4).

COARSE SAND CARBONATE CEMENT: Arena muy gruesa subangulosa a subredondeada con abundantes fragmentos blanquecinos (?40%) carbonáticos subangulosos (cemento con fuerte reacción al HCl). Muy escasos y finos fragmentos vegetales (finas ramas?).

GRAVEL CARBONATE CEMENT: Arcilla gris blanquecina (N7) con clastos (hasta 3cm Grava fina) líticos y carbonáticos angulosos a subredondeados 15-20%) y arena fina (?) (?1%).

SAND CARBONATE interbeded CLAY: Arena muy gruesa a gruesa principalmente subredondeadas con escasos fragmentos carbonáticos blanquecinos. Arena fina limo-arcillosa (5-10%) con abundantes fragmentos vegetales (contaminación del lodo?).

SAND CARBONATE interbeded CLAY: Arena fina a muy fina con muy escasos granos (1-2%) de arena gruesa. Abundante matriz (20-25%) arcillo-limosa (10YR 6/2). Abundante granos blanquecinos (Carbonáticos). Según perforistas mustra contaminada.

FINE SAND CARBONATE CEMENT: Arena fina a muy fina con muy escasos granos (1-2%) de arena gruesa. Muy escaza matriz (2-5%) arcillo-limosa (10YR 6/2). Abundante granos blanquecinos (Carbonáticos).

SAND CARBONATE interbeded CLAY: Arena fina a muy fina con muy escasos granos (1-2%) de arena gruesa. Abundante matriz (20-25%) arena arcillo-limosa (5YR 4/4). Abundante granos blanquecinos (Carbonáticos).

FINE SAND CARBONATE CEMENT: Arena fina a muy fina con muy escasos granos (1-2%) de arena gruesa. Abundante matriz (20-25%) arcillo-limosa (10YR 6/2). Abundante granos blanquecinos (Carbonáticos). Según perforistas mustra contaminada.

COARSE SAND CARBONATE CEMENT: Arena gruesa a muy gruesa principalmente subangulosa con muy abundantes clastos blanquecinos carbonáticos (?60%) y menor líticos en distintos tonos de gris. Matriz blanquecina (carbonática?) (N7) arcillo-limosa (2-5%).

COARSE SAND CARBONATE CEMENT: Arena media a ligeramente gruesa con clastos principalmente subangulosos. Abundantes clastos blanquecinos carbonáticos (?60%).

SAND CARBONATE interbeded CLAY: Arena media a gruesa con clastos principalmente subangulosos. Abundantes clastos blanquecinos carbonáticos (?60%). Escasos restos (?10%) de arcilla arenosa (arena muy fina) marrón (5YR 4/4).

COARSE SAND CARBONATE CEMENT: Arena media a gruesa con abundantes clastos blanquecinos (?60%) subangulosos (carbonáticos). Menor líticos en distinos tonos grises y marrones subangulosos a subredondeados.

COARSE SAND CARBONATE CEMENT: Arena sabulítica a muy gruesa con abundantes clastos balnquecinos carbonáticos (60-70%). Muy escasa a nula presencia de material fino. Fragmentos carbonáticos subangulosos y granos líticos subangulosos a subredondeados.

SAND CARBONATE interbeded CLAY: Arena sabulítica a muy gruesa con abundantes clastos balnquecinos carbonáticos (60-70%). Arcilla gris-blanquecina (N7) y fragmento (1cm) de cuarzo subanguloso. Fragmentos carbonáticos subangulosos y granos líticos subangulosos a subredondeados.

COARSE SAND CARBONATE CEMENT: Arena muy gruesa con abundantantes fragmentos carbonáticos (70%). Escasa presencia de arcilla gris-blanquecina (N7).

FINE SAND CARBONATE CEMENT: Arena fina a muy fina con abundantes clastos blanquecinos carbonáticos. Muy escasa presencia de material fino (arcilla gris-blanquecina: N7).

SAND CARBONATE interbeded CLAY: Arena gruesa a muy gruesa con escasos fragmentos tamaño sabulo y grava muy fina (?4mm). Granos principalmente subangulosos. Arcilla (?10%) verde clara (5G 8/1).

SAND CARBONATE interbeded CLAY: Arcilla arenosa (fina a muy fina) gris-verdosa (5Y 7/2). Muy escasos fragmentos blanquecinos carbonáticos.

FINE SAND CARBONATE CEMENT: Grava muy fina (?5mm) (15%) con arena muy gruesa a sabulítica y abundantes fragmentos blanquecinos carbonáticos (40%). Matriz arcillo-limo arenosa.

FINE SAND CARBONATE CEMENT: Arena fina a muy fina gris (N6) con escaso limo. Muy esacasa a nula arcilla.

FINE SAND CARBONATE CEMENT: Arena gruesa a muy fina gris (N6) con escaso limo. Muy esacasa a nula arcilla.

FINE SAND CARBONATE CEMENT: Arena fina a muy fina gris (N6) con escaso limo. Muy esacasa a nula arcilla.

FINE SAND CARBONATE CEMENT: Arena gruesa a muy fina gris (N6) con escaso limo. Muy esacasa a nula arcilla.

COARSE SAND CARBONATE CEMENT: Arena muy gruesa con muy escasos granos sabulíticos subangulosos y subredondeados principalmente grises escasos marrones y rojizos. Abundantes fragmentos blanquecinos carbonáticos (40-50%). Muy escasa presencia de material fino (arena fina a limo).

GRAVEL CARBONATE CEMENT: Grava arenosa con clastos subredondeados (3cm) en matriz de arena muy gruesa con abundantes fragmentos blanquecinos carbonáticos y escasa arena fina y limo. Clastos conformados por pelitas grises (OX?) con presencia de FeOx.

SILTY SAND: Arena fina limosa gris-clara (N7). Muy escasos fragmentos (1-2%) blanquecinos carbonáticos (tamaño arena gruesa). Muy escasos restos de arcilla marrón.

SAND interbeded CLAY: Arena gruesa a muy gruesa con presencia de arean fina limosa gris-clara (20-25% contaminación?). Granos principalmente subangulosos. Muy escasos restos (1-2%) de arcilla marrón.

COARSE SAND CARBONATE CEMENT: Arena gruesa a muy gruesa con granos principalmente subangulosos. Muy escasos restos (2-5%) de arcilla verde (5G 8/1).

SANDY GRAVEL CARBONATE CEMENT: Arena gruesa a muy gruesa con granos principalmente subangulosos. Muy escasos restos (2%) de arcilla gris.

SAND CARBONATE interbeded CLAY: Abundantes fragmentos angulosos blanquecinos carbonáticos (hasta 3cm). Arcilla limo-arenosa gris (N5) (30-40%). Muy escasos restos de arcilla marrón clara.

SAND CARBONATE interbeded CLAY: Arena media a gruesa arcillosa gris (N7). Abundantes fragmentos blanquecinos carbonáticos.

FINE SAND CARBONATE CEMENT: Arena media a muy fina limosa. Escasos restros (3-5%) de arcilla verde clara (5G 8/1) y menor marrón-rojiza (2%).

SANDY GRAVEL CARBONATE CEMENT: Gruesos fragmentos líticos y carbonáticos (hasta 1cm) en matriz arena limo-arcillosa gris. Escasos restos de arcilla verde-clara (5G 8/1) y menor arcilla rojiza.

SAND CARBONATE interbeded CLAY: Arena media a muy fina limosa con escasos restros de arcilla verde y rojiza (5%). Escasos clastos carbonáticos angulosos (1mm).

SAND CARBONATE interbeded CLAY: Abundantes fragmentos carbonáticos tamaño arena gruesa y arena limo arcillosa verde (5GY 5/6). Abundantes presencia (25%) de arcilla verde clara y marrón-rojiza.

CLAY: Mix de arcilla verde clara (5G 8/1) y rojiza (10R 5/4) con abundante arena media a fina y fragmentos sabulíticos a grava fina (?4mm) (contaminación?).

Depth (m)	Elevn. (m)	Units
0–180	3918–3738	