escorsa
geology & labs

ESCORSA

MINERALOGICAL AND PETROGRAPHIC SERVICES

1 INTRODUCTION

Correctly assessing geological materials is essential in the exploration and exploitation of geological resources in important sectors such as mining, industrial rock, gas or oil. Moreover, these services are critical for civil engineering projects to assess geological materials for research purposes.

escOrsa offers assessments of petrographic, mineralogical and geochemical samples of any type. The technical team consists of senior consultants, graduates and PhDs with extensive experience in this field.

- Petrographic assessment with transmitted and reflected light microscopy
- Mineralogical assessment using X-ray diffraction
- Textural and semi-quantitative chemical composition assessment using SEM-EDS
- Laser grain-size distribution. Coulter counter method
- Geochemical assessment using MS-ICP OES
- Chemical analysis with X-ray Fluorescence
- Porosity characterization. Nitrogen adsorption porosimetry (BET determination)

2 IN-HOUSE LABORATORY FOR THIN SECTION PREPARATION OF ROCKS AND MINERALS

The preparation of thin sections of rocks and minerals is a highly specialized service that requires the use of sophisticated equipment by highly qualified technical staff, combined with advanced knowledge of mineralogy and petrography.

2.1 THIN SECTION PREPARATION

Our in-house thin section laboratory can prepare all types of thin sections and ore mounts for optical and microanalytical study. The friable or unconsolidated samples are set in epoxy resin, which can be dyed to study the microstructure and porosity. We also perform selective staining to differentiate minerals.

2.2 Polished metallographic thin sections and ore mounts

A good polish quality is essential to analyze thin sections using high-resolution techniques (e.g. electron microscopy SEM-EDS and microprobe). EscOrsa's thin-section laboratory has precision cutting equipment, including resin vacuum systems and specialized polishers to finish the thin sections with highly accurate polishing.

Figure 1: Polished thin sections and ore mounts are used for determination of opaque metallic minerals (e.g. chalcopyrite, $CuFeS_2$)

2.3 Special thin sections

escOrsa's geological laboratory prepares thin sections with special features according to the needs of each client. Thus, especially thick thin sections can be prepared (15 to 100 microns), and sections can be double polished for fluid inclusion analysis, or made from friable or water-sensitive materials.

Figure 2: Our facilities, equipments and knowledge allow us to prepare special thin sections

2.4 THIN SECTION AND ORE MOUNT LIST OF SERVICES:

Thin section and ore mounts list of services
Standard thin section, 30 microns thick, (27x46 mm) uncovered
Polished thin section, 30 microns thick, (27x46 mm), SEM-EDS probe quality
Epoxy resin inclusion for friable or unconsolidated samples, bore-hole cuttings, soils, tailing and mine dumps …
Dyed epoxy resin inclusion for microstructure and porosity analysis
Selective mineral staining for carbonates: calcite, dolimite, ankerite…
Special samples (water-sensitive, soluble samples, very small minerals…)
Epoxy inclusion with quartz sand coverage: a small perimeter layer of quartz sand is disposed on special samples. This allows to protect samples during the thin section process, avoiding loss of material and lateral mineral cracking. In the other hand, this coverage allows to control the exact thickness of the thin section, using the interference colors of the quartz grains
Polished ore mounts (25 mm diameter)

3 MINERALOGICAL AND PETROGRAPHIC CHARACTERIZATION SERVICES

3.1 PETROGRAPHIC ASSESSMENT WITH TRANSMITTED AND REFLECTED LIGHT MICROSCOPY

3.1.1 Identification of minerals and textures and classification of rocks with polarized light microscopy

The study and analysis of thin sections and metallographic specimens using transmitted polarized and reflected light microscopy for opaque phases is one of the main techniques used for the petrographic assessment of samples and is essential in areas such as mining and oil exploration.

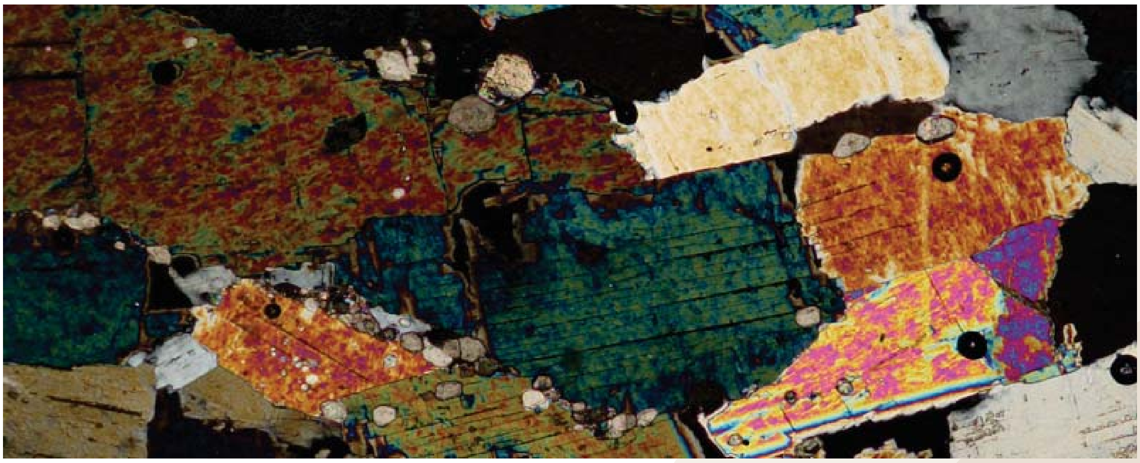


Figure 3: Anhydrite ($CaSO_4$) under polarized transmitted light microscopy

3.1.2 Mineralogical analysis with digital imaging treatment

Mineralogical and petrographic reports include microscopic photographs representative of all the detectable minerals and textures. Morphometry software and imaging are also available specifically for microscopy, enabling the digital processing of images to measure distances, areas, perimeters and angles and to conduct automatic matrices and coarse-grain quantification and the automatic counting of grains.

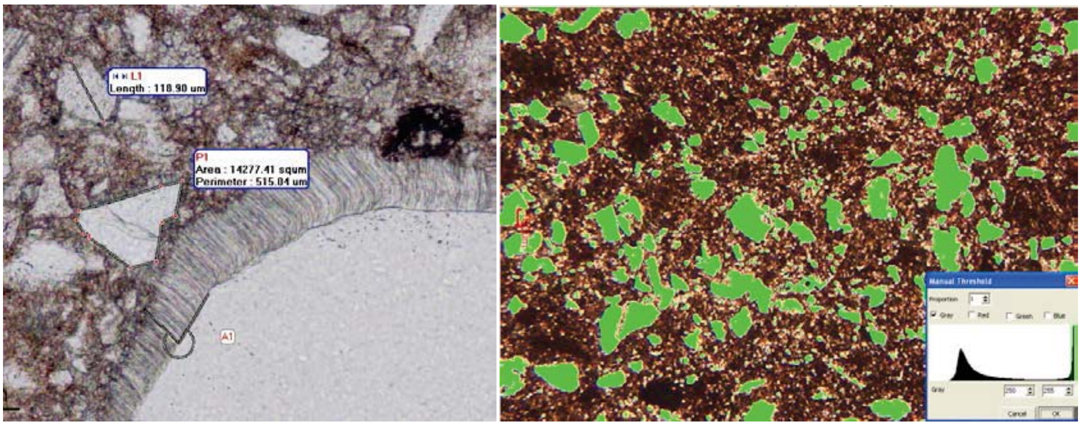


Figure 4: Left: morphometric analysis: grain size, length, areas and angle determation on thin section. Rigth: quantification using image analysis

3.1.3 Quantification of mineral phases: modal counting

escOrsa has an automated point counter device to perform statistical counts on thin sections. This device or stage sweeps the thin section, following a regular grid pattern to determine the exact proportion of minerals present in the rock. A high experience is needed to properly characterize the rocks.

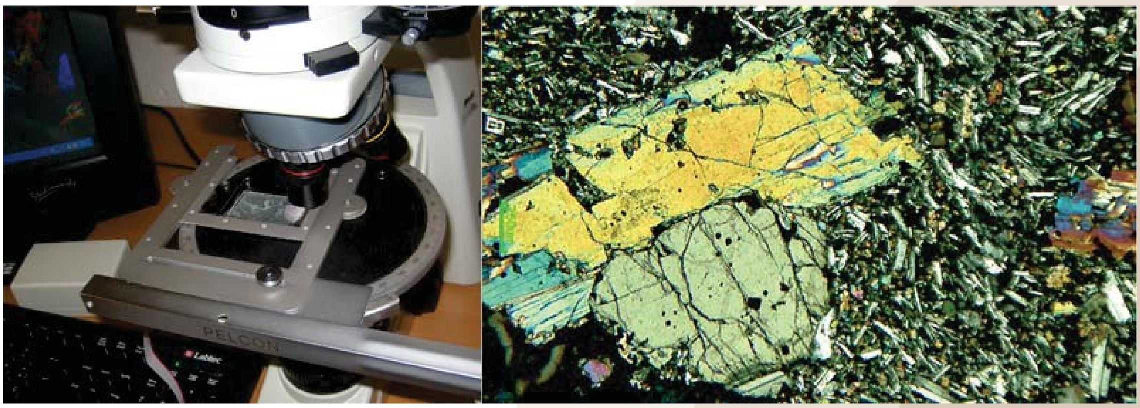


Figure 5: Left: modal point counter device at escOrsa's laboratory. Mineral constituents are obtained by counting each mineral occurrence along a series of traverse line across the thin section. Between 500 and 2000 counts per section are performed, depending on the grain size. Right: Thin section image on polarized transmitted light (e.g. basalt with pyroxene).

3.1.4 Microscopic and macroscopic photography service

escOrsa's geological laboratory has a transmitted and reflected polarized light microscope equipped with a high-resolution digital camera that allows detailed images, sequential shots and videos of thin-section preparations and metallographic specimens.

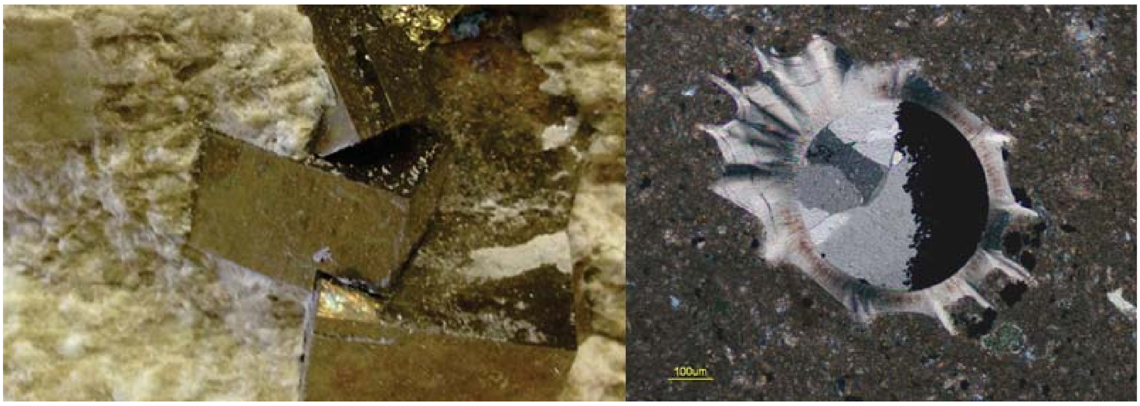


Figure 6: Samples of macroscopic (left) and microscopic (right) photography

Digital cameras also facilitate the collection of macroscopic photographs of hand samples, core fragments, minerals, fossils, etc. The macroscopic lens is calibrated, and morphometry software functionality can be applied. Thus, this approach allows the study of the size and evolution of fractures, grain size and angles, among other features.

3.1.5 Mineralogical and petrographic characterization list of services

Mineralogical and petrographic list of services
Mineralogical, petrographic and textural characterization in thin section under transmitted polarized ligth microscopy (including hand sample "visu" description, thin section preparation, photographic and technical report)
Modal counting analysis (statistical) of mineral phases and precise rock classification on thin section, using a automatized point counter (including hand sample "visu" description, thin section preparation, photographic and technical report)
Opaques mineralogical analysis in ore mount and thin section: Mineralogical, petrographic and textural characterization under transmitted and reflected polarized ligth microscopy (including hand sample "visu" description, polished thin section or ore mount preparation, photographic and technical report)
Degree of mineral liberation (including hand sample "visu" description, polished thin section or ore mount preparation, photographic and technical report)

3.2 X-RAY DIFFRACTION ANALYSIS

3.2.1 Qualitative determination of minerals and crystalline phases using X-ray diffraction

X-ray diffraction is a technique to qualitatively determine the minerals present in rocks. This method is a widespread technique, complementing the optical microscope, and is used to identify very fine-grained minerals.

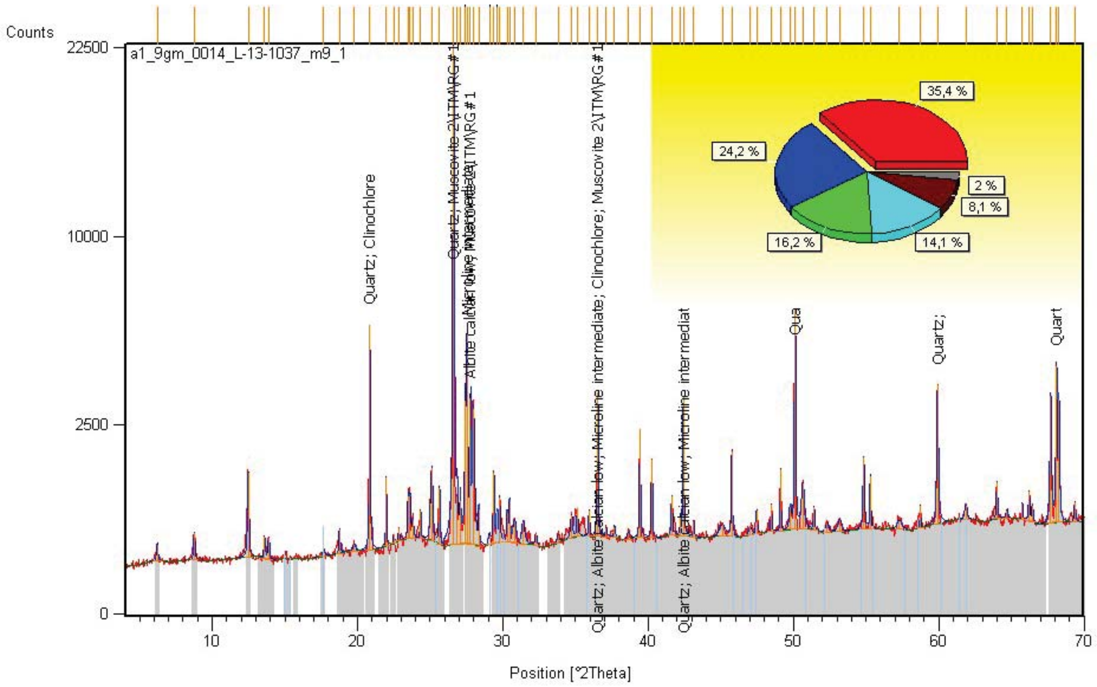


Figure 7: Randomly oriented powder diffraction results

3.2.2 Clay analysis using oriented-aggregate mounts by the powder X-ray diffraction method

The minerals of the clay group and other phyllosilicates diffract in a narrow region of the X-ray spectrum. Identifying these minerals is of great importance in the field of applied geology. escOrsa's senior geologists determine mineral composition using their proven experience in interpreting results.

Figure 8: Clays form a wide group of minerals of a very fine grain size (<4 microns). Determining their mineralogy is of great importance to understand soil behavior (e.g. swelling clays)

A correct clay determination is important in order to assess the swelling behavior and other geological and geotechnical properties. Clay samples must be prepared in advance for X-ray diffraction analysis. In the escOrsa geological laboratory, we disaggregate the sample, disperse the clays and then place them in a holder, orienting the minerals. Subsequently, these clays are subjected to a heat treatment, and in a saturated atmosphere with ethylene glycol to modify their crystalline structure and to determine the different types of minerals present in the clay group.

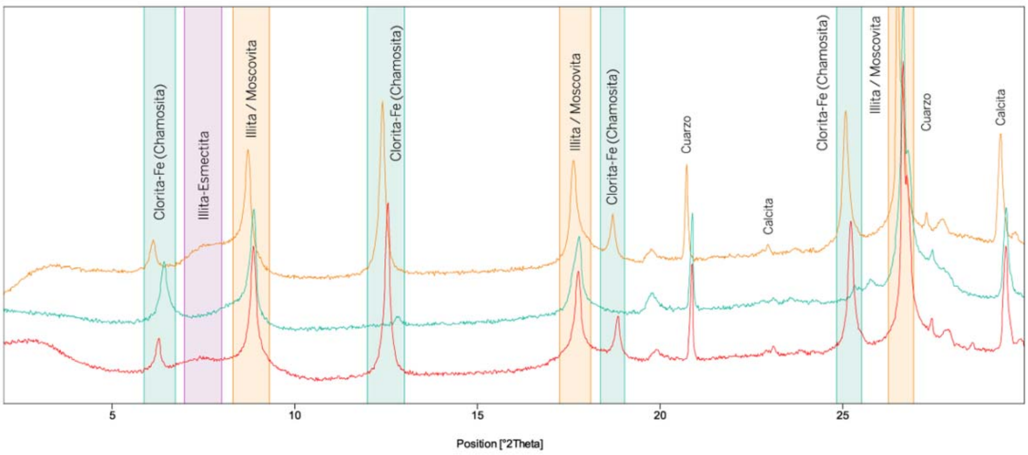


Figure 9: Clay determination using three sets of oriented-aggregate mounts: untreated, heat treated at 550°C and ethilene-glycol saturated atmosphere treatment.

3.2.3 Semi-quantitative mineral phase analysis: Rietveld method

Using X-ray diffraction, it is also possible to obtain a semi-quantitative analysis of the mineral phases present and to determine the percentage of each mineral. To do so, the Rietveld refinement or adjustment is used, which consists of adjusting a theoretical diffraction spectrum to the actual diffractogram.

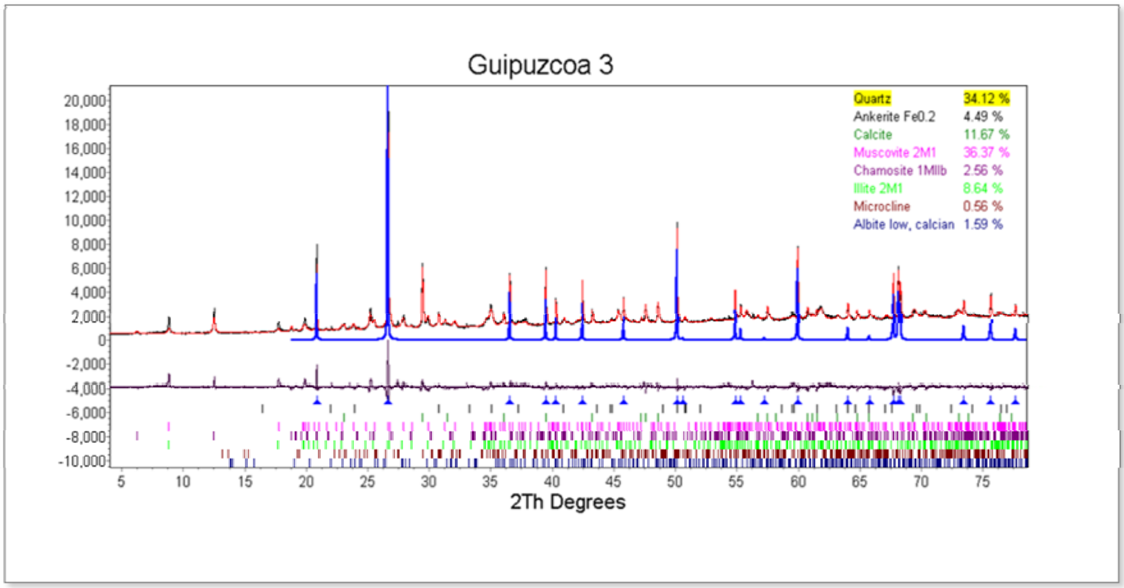


Figure 10: Rietlveld adjustement on a X-Ray diffractogram for obtaining a quantitative analysis of mineral phases.

3.2.4 X-Ray diffraction list of services

Preparatory procedures for X-ray analysis
Rock analisys: agate and ceramic mill grinding
Clay analysis: separation of silt and clay by decantation and aggregate-oriented mounts preparation
Clay analysis: aggregate-oriented mount heat treatment to 550ºC
Clay analysis: aggregate-oriented mount: ethilene-glycol saturated atmosphere treatment
Mineralogical determination in X-ray diffraction
Standard qualitative mineralogical analysis. Random poder method.
Clay analysis using three sets of oriented-aggregate mounts: untreated, heat treated at 550ºC and ethilene-glycol saturated atmosphere treatment
Quantitative mineralogical analysis in XRD. Rietveld method

3.3 ELECTRON MICROSCOPY WITH AN SEM-EDS ENERGY ANALYSER

3.3.1 Mineralogical and petrographic assessment using an electron microscope with an SEM-EDS energy analyser.

Electron microscopy is used in all fields of geology to study rock textures and mineralogy. To analyse the samples, they must be previously coated with a thin carbon layer or a metal, such as gold, so that the sample becomes conductive.

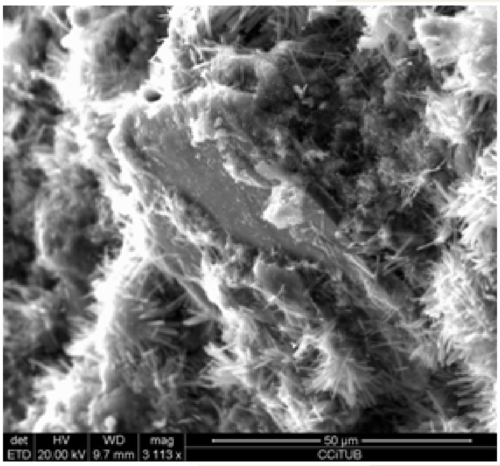


Figure 11: Neo-formation of thaumasite (needle shaped minerals) formed by the reaction between gypsum and portland cement, in a damaged cement-stabilized soil in a highway road (Catalonia).

3.3.2 Semi-quantitative wavelength-dispersion analysis

The X radiation spectrum emitted by minerals subjected to electronic excitation is used for semi-quantitative chemical analysis by wavelength-dispersion spectrometry. Detection and measurement of the energy permits elemental analysis (Energy Dispersive X-ray Spectroscopy or EDS), that can provide rapid qualitative, or with adequate standards, quantitative analysis of elemental composition. X-rays may also be used to form maps or line profiles, showing the elemental distribution in a sample surface.

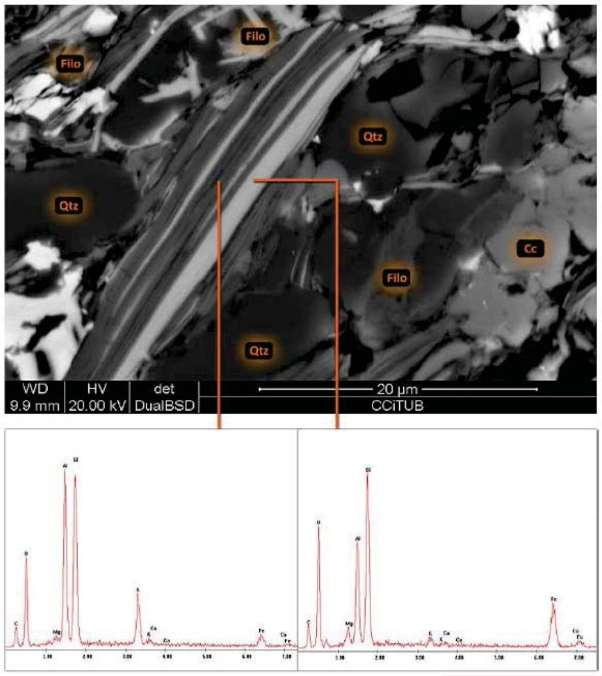


Figure 12: Determination of the internal layering of an illite-smectite mixed clay using the X-ray spectrometry of backscattered energy.

3.4 OTHER SERVICES

3.4.1 Laser grain-size distribution. Coulter counter method

Knowing the grain size distribution of sediments or mine tailings is commonly needed for multiple purposes. Usually, when the grain size is very small, lower than 40 microns, is not possible to obtain a correct grain size distribution. In this case, the best results are obtained with laser granulometry using a Coulter Counter.

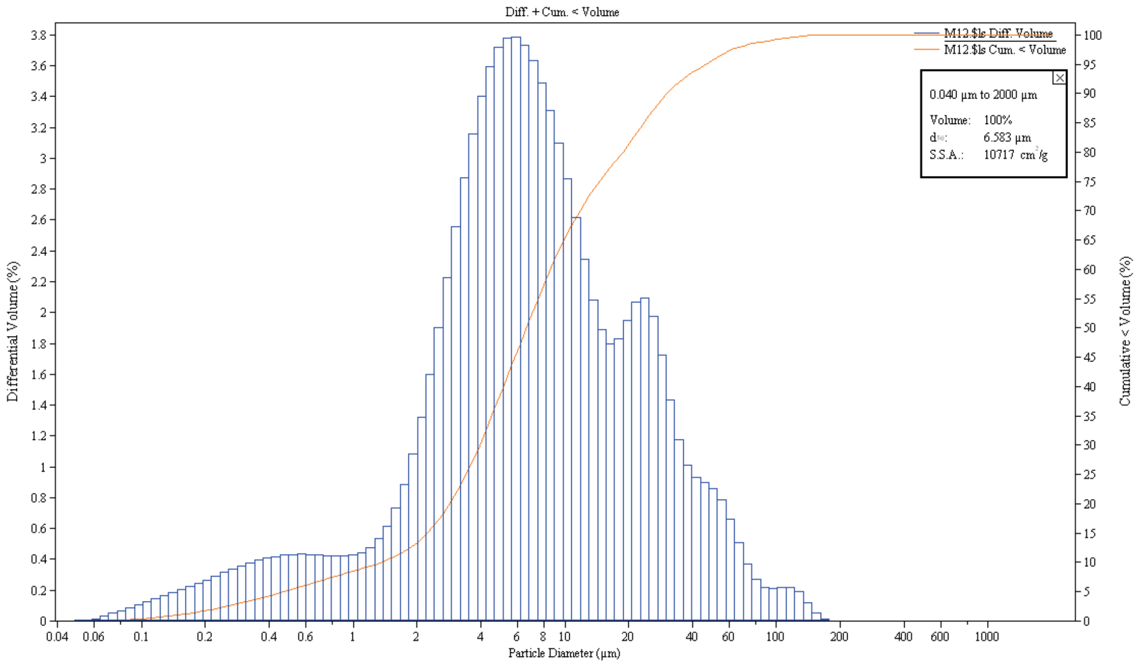


Figure 13: Sample of laser grain size distribution obtained with the Coulter Counter.

3.4.2 Geochemical assessment using MS-ICP OES

MS-ICP OES is an inorganic analysis technique using digestion in aqua regia, which allows the identification and quantification of the elements that constitute the sample.

The fields of application can be:

- Environment: water quality and pollution, soil contamination, soil assessment, etc.
- Mineral and energy resources: exploration, analysis and control of natural resource exploitation
- Geology: elemental analysis for geological prospecting and mining, the study of rocks and minerals, etc.

Sulphate precipitation in an acid mine drainage (AMD) stream (Rio Tinto, Spain)

3.4.3 Geochemical assessment using X-ray fluorescence

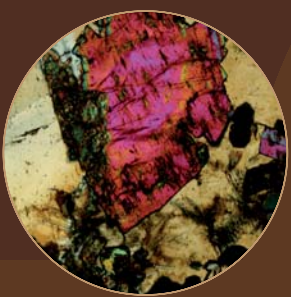
The analysis of major and trace elements in geological materials by X-ray fluorescence is commonly used in all fields of applied geology. X-ray fluorescence (XRF) spectrometer is an X-ray instrument used for routine, relatively non-destructive chemical analyses of rocks, minerals and sediments. Combined with other petrographical techniques, it allows a deep comprehension of mineral and geochemical composition of rocks.

Silicious sinter at Porcelain springs. (Yellowstone NP, USA)

3.4.4 Porosity characterization. Nitrogen adsorption porosimetry (BET determination)

The analysis of medium porosity is of great interest in many fields. The nitrogen adsorption porosimetry is one of the most reliable methods. Sample preparation and analysis of results is used to determine the specific surface (BET), density and porosity of any type of material.

Sandstones and mudstones present different values of porosity (Zumaia flysch formation, Basque Country, Spain)

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