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Mineralogical Characterization and Petrographic Classification of the Soil of Casablanca City

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Abstract**—**The treatment of the geotechnical database of the region of Casablanca was difficult to achieve due to the heterogeneity of the nomenclature of the lithological formations composing its soil. It appears necessary to harmonize the nomenclature of the facies and to produce cartographic documents useful for construction projects and studies before any investment program. To achieve this, more than 600 surveys made by the Public Laboratory for Testing and Studies (LPEE) in the agglomeration of Casablanca, were studied. Moreover, some local observations were made in different places of the metropolis. Each survey was the subject of a sheet containing lithological succession, macro and microscopic description of petrographic facies with photographic illustration, as well as measurements of geomechanical tests. In addition, an X-ray diffraction analysis was made in order to characterize the surficial formations of the region.

Keywords**—**Casablanca, guidebook, petrography, soil.

I. Introduction

THE petrographic description of the soil of Casablanca, as set out in the geotechnical reports, does not correspond to a homogenous classification; this will require a mapping of the fundamental soil in order to harmonize the nomenclature of the facies and produce cartographic documents useful for studies of pre-construction projects and any investment program.

The surveys carried out by the LPEE in Casablanca were studied with the aim of identifying and characterizing the lithological formations of the region. To carry out this study, we classified these facies into two groups; the soft surficial formations (Tufs, Limon, Clays...), of which, we have made a mineralogical identification using X-ray diffraction analysis and the hard formations (Sandstone, Schist, Quartzite), from which we have carried out the petrographic study and their presentations in technical sheets for each survey, to which are added the lithological succession, the macro and microscopic description of the petrographic facies with photographic illustration, as well as the measurements of the geomechanical tests.

II. Nomenclature of the Petrographic Variety of the Soil of Casablanca: Development of a Petrographic Sheet

The lands of the Casablanca region are mainly sedimentary, composed of Cambrian and Ordovician terrigenous deposits folded and fractured during the Hercynian orogeny.

The ensuing peneplaination has formed a resistant massif on which lie Quaternary formations deployed in the littoral sequence running along the western side of the Moroccan Western Meseta. In general, the lithological succession of the Casablanca region is characterized by [1], [2] (Fig. 1):

- A quaternary covering of thicknesses ranging from a few meters to twenty meters and consisting of clay, tuff, sand, limestone, conglomerate, calcarenite, and lumachellic sandstone.
- A Hercynian paleozoic base composed of schist and quartzite.

From the geotechnical studies available at LPEE, a database was produced, gathering more than 600 underground recognition surveys (Fig. 1) of the city. Data are processed using geomatics to meet the needs of a preliminary BTP draft and any investment program. Each survey was the subject of a systematic sampling of the different facies identified. The slightly altered samples, offering the maximum freshness, were selected for the preparation of thin sections and sometimes of polished sections for the characterization of the opaque phases. A specific sheet is then drawn up containing the lithological succession, the macroscopic and microscopic description of the petrographic facies with photographic illustration, as well as the measurements of the available geomechanical tests, in particular the pressiometric test (Fig. 3).

The petrographic designation adopted is based on a new nomenclature articulated around the constituents and the elements figured in each facies. (Fig. 4) The following examples illustrate this approach:

Calcarenite (Fig. 4 (A)) contains as figurative elements, detrital quartz which is very abundant, some grains of feldspar, foraminifera, bryozoa, lamellibranchs, gravels and pellets bound all by a microspartic cement. The rock is characterized by a porosity between 5% and 20%; therefore, the designation of this facies is Pellintrabiomicrosparite with detritic quartz.

The lumachellic sandstone (Figs. 4 (B) and (C)) is composed of foraminifera, lamellibranch, echinoderms, bryozoa and gastropods. The cement is microsparitic to sparitic. The porosity is between 10% and 30%; hence, the name of **biomicrosparite**.

The conglomerate (Fig. 4 (D)) is formed by centimeter elements of quartzite and litharenite linked by a bioclastic carbonate cement, composed of foraminifers, bryozoans and lamellibranchs. The porosity is between 20% and 25%. This facies is called **Microconglomerate with carbonate cement**.

The schist (Fig. 4 (E)) is characterized by a very fine matrix and fine quartz grains with the presence of oxides of iron and

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white mica. According to Dott's classification [3], the rock is classified as **Quartz-wacks**.

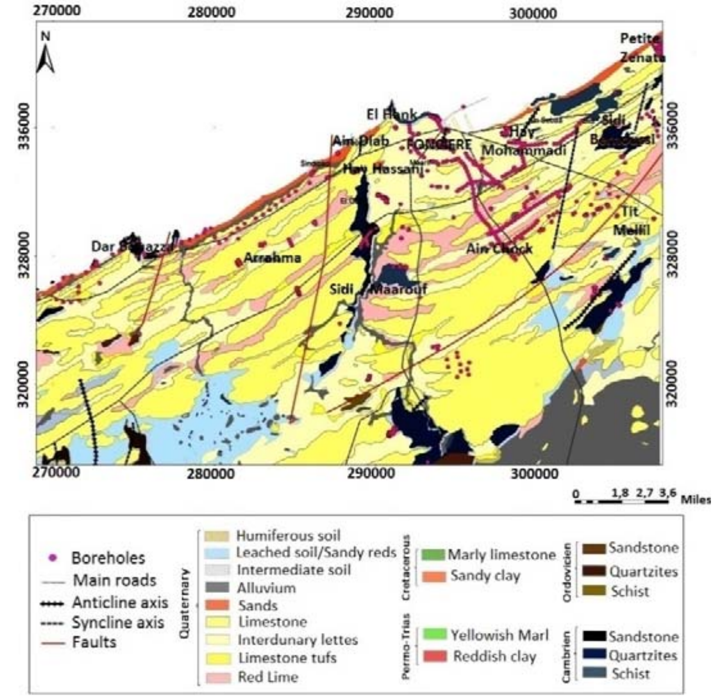


Fig. 1 Geological map of the region of Casablanca with the location of the collected surveys

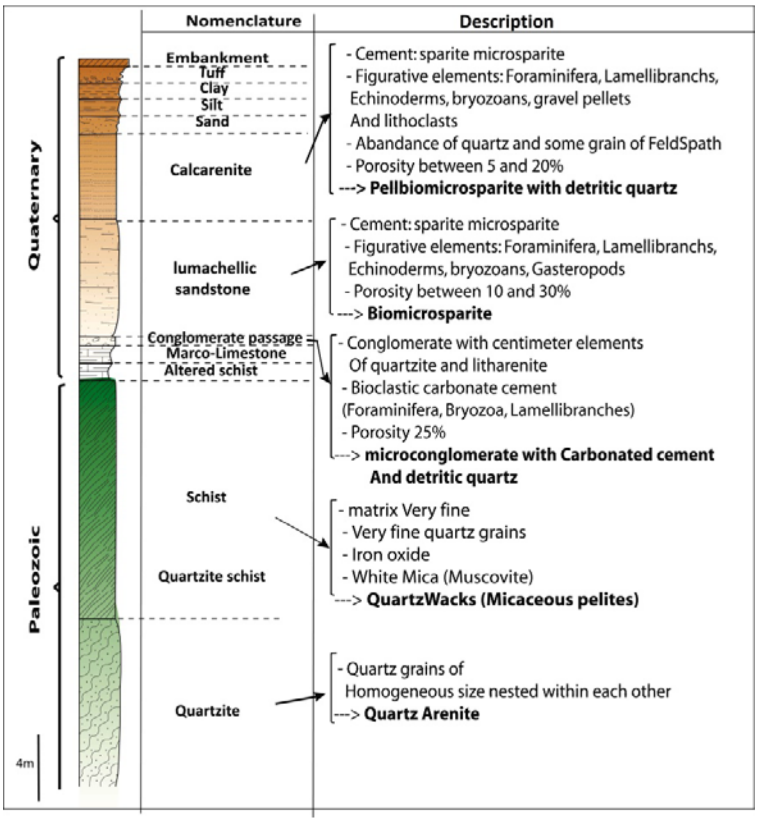


Fig. 1 Synthetic Stratigraphic Column of the soil of Casablanca

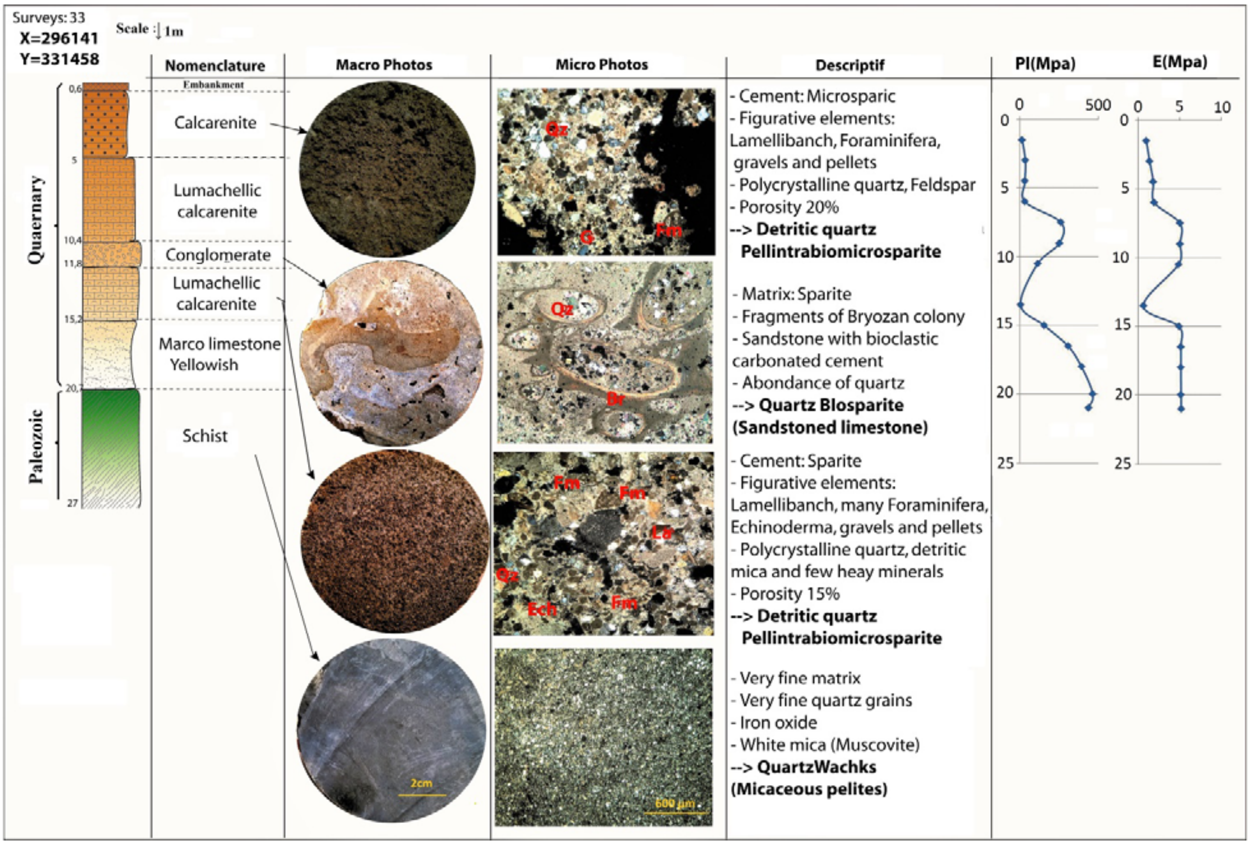


Fig. 3 Technical sheet of the survey

Quartzite (Fig. 4 (F)) consists homogeneous grains of quartz with imbricated texture. It is **Quartz-Arenite.**

In the Casablanca area, the cover is composed in addition to the soft soil, of calcarenites, lumachelles and lumachellic sandstones. The petrographic classification underlined above makes it possible to recognize microfacies of the type; Pellintrabiomicrosparite, Intrabiosparite, Biomicrosparite, and Biosparite. These latter are part of a polycyclic sedimentary dynamics. Each cycle corresponds to a deposition sequence with a regressive tendency, beginning with intertidal facies (crushed lumachelles, bioclastic conglomerates) with supratidal (marine biocalcarenites) and ending with dune calcarenites and colluvial deposits [4]-[6].

Carbonated microfacies are contaminated by detritic quartz which was transported by the wind (round and mat) and sometimes angular. The origin of this silicoclastic component is probably related to the surrounding Paleozoic massifs. The relative abundance of quartz grains, vacuolar porosity of dissolution, biophase and associated diagenetic crystal morphologies, indicate a marginolittoral deposit medium under continental influence.

The Paleozoic basement contains mainly quartz-wacks and quartz-arenites. The associated sedimentary structures (HCS, skolitos-type bioturbation) show a deposit of tempestite.

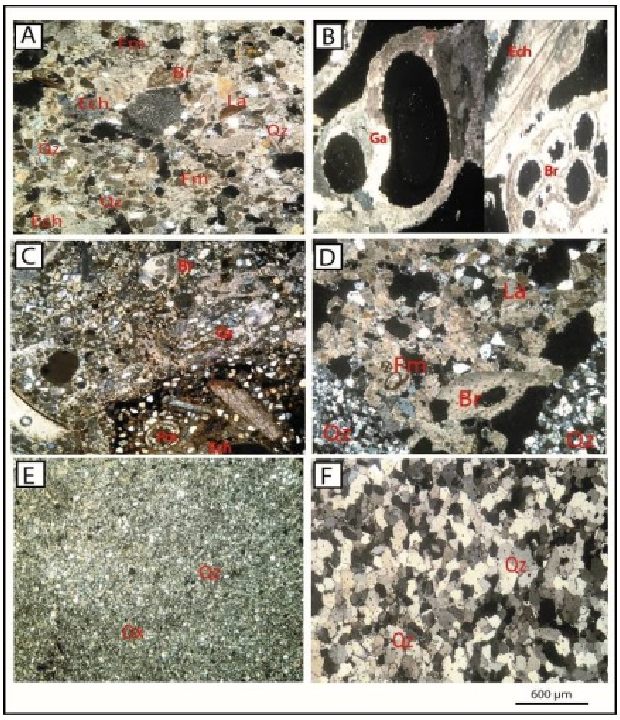


Fig. 4 Microphotographs of thin sections of the main petrographic facies composing the soil of Casablanca. A: Calcarenite, B: Lumachelle, C: Lumachellic sandstone, D: Conglomerate, E: Schist, F: Quartzite

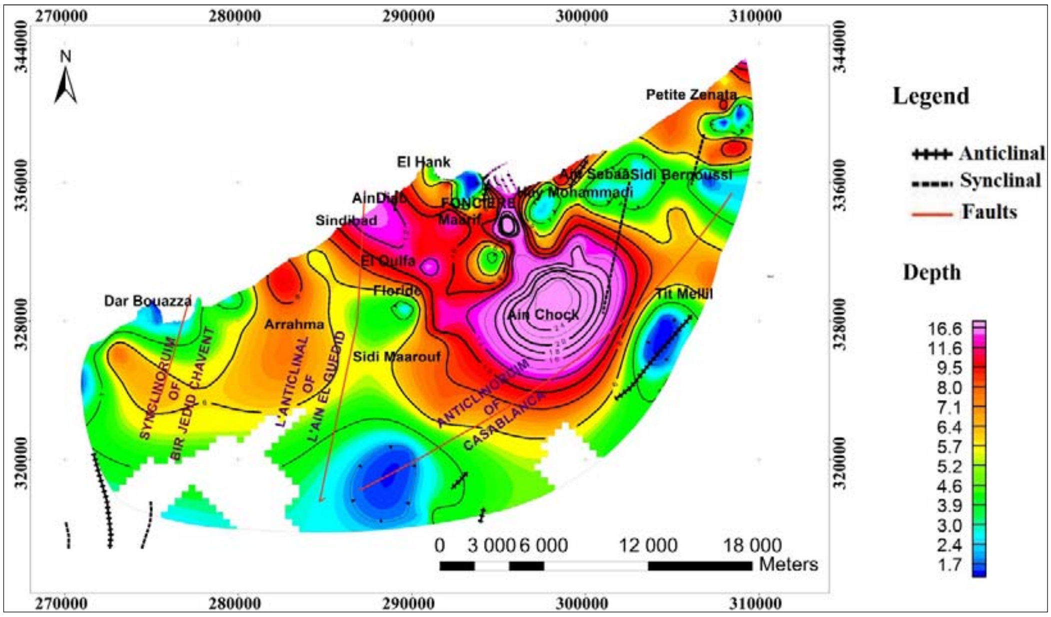
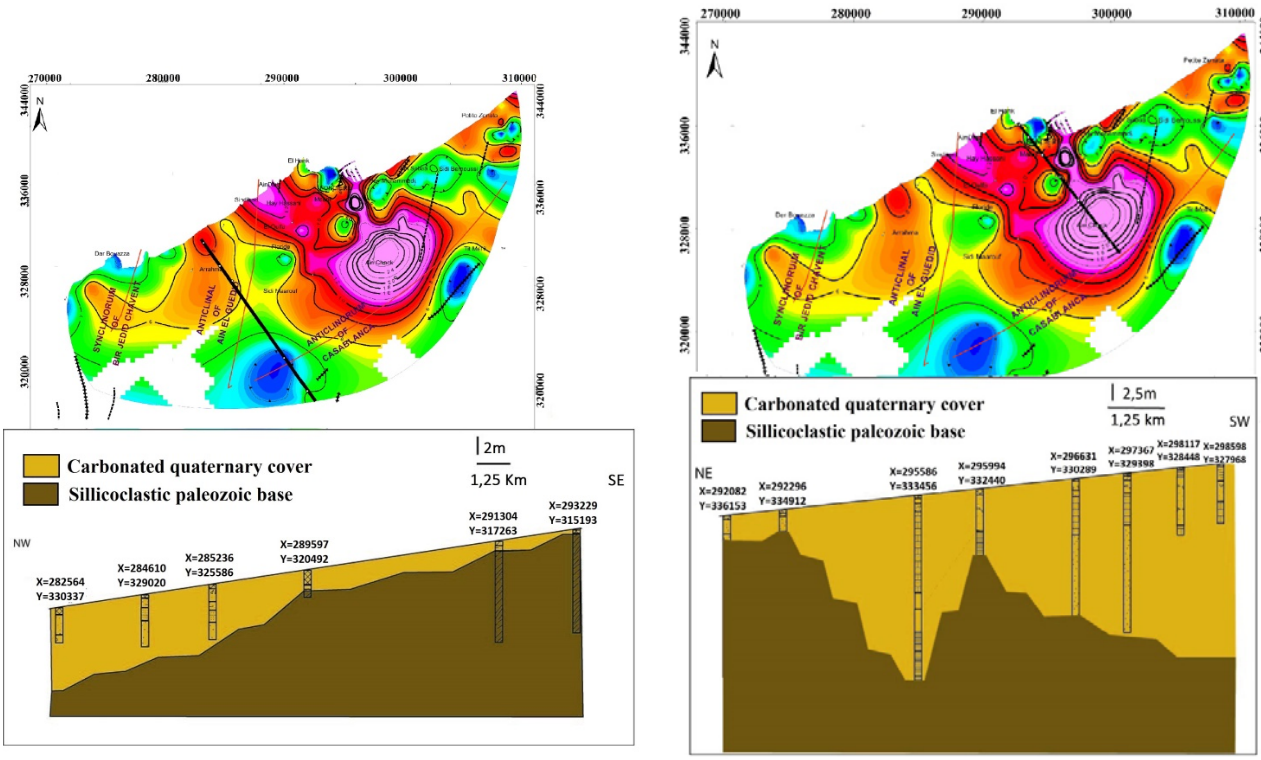
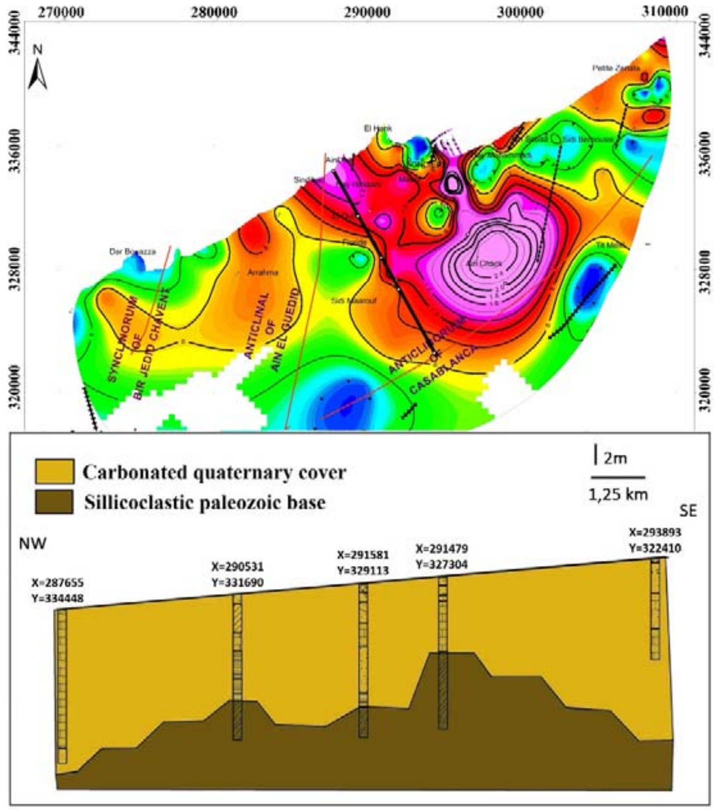


Fig. 5 Map of the isobaths of the surface of the Paleozoic basement of Casablanca



(A) (B)



(C)

Fig. 6 Geological sections show the variation of the subsoil of the city (A, B, C)

A. Mapping of the Paleozoic Basement

The variation of the basement level is due to Hercynian movements, whose NNE-SSW fold axis is well marked by the alignments of the El Hank quartzites, and the various Paleozoic sandstones or quartzites crests that emerge in the plio-quaternary covering. The anticlinorium of Casablanca is the consequence of this early structuring [7].

The arrangement of the outcrops shows a series of synclinal depressions in the interior of the anticlinal formed by Acadian schists. The term anticlinorium is justified by the presence of at least two or three synclinal folds.

The isobaths map of the surface of the Paleozoic (Fig. 5) confirms this morphostructure which is summed up by a juxtaposition of zones in depressions and zones in surrection. Depressions show the presence of a syncline where the base is at an important depth (> 20m) below the quaternary sedimentary filling. On the other hand, the low quaternary covering thicknesses coincide with the raised areas.

The overlay and comparison of the isobaths map with the profile carried out based on the distribution of the surveys in the region, confirms the variation of the roof of the basement presented by the map.

III. Mineralogical Analysis by X-Ray Diffraction of a Few Samples of Casablanca Soil

A mineralogical characterization by X-ray diffraction has been carried out on the fine clay tuffitic facies of the surface formations as well as on the micaceous (quartz-wacks) pelites which highlight the transition towards the cover formations.

The spectrum of quaternary calcareous tuffs reveals the presence of calcite and quartz in large proportions with the presence of accessory feldspar (Fig. 7 (a)).

The underlying clay levels are rich in illite, quartz and muscovite (Fig. 7 (b)). They show a variable plasticity index (9% to 20%) which gives them a little plastic character.

The micaceous pelites of the Paleozoic basement have an arkosic composition dominated by Quartz, Illite and Feldspar. This composition reflects the crystalline nature of the Precambrian substrate of material in the Cambrian basin (Fig. 7 (c)).

IV. Conclusion

In this study, we present the approach taken into account to develop a practical guide for the identification of the soil of Casablanca through "facies sheets" based on petrographic and geomechanical aspects. The objective being to comply with a common geological name for geological surveying, which allows geologists technicians to adopt the same lexicon.

The geotechnical data are added to define the physical and mechanical properties of the soil which can provide information on its capacity to be exploited in the fields of construction.

The compilation of morpho-litho-stratigraphic and geotechnical data in a geographical information system (GIS) is a decisive tool for decision-making concerning urban development projects.

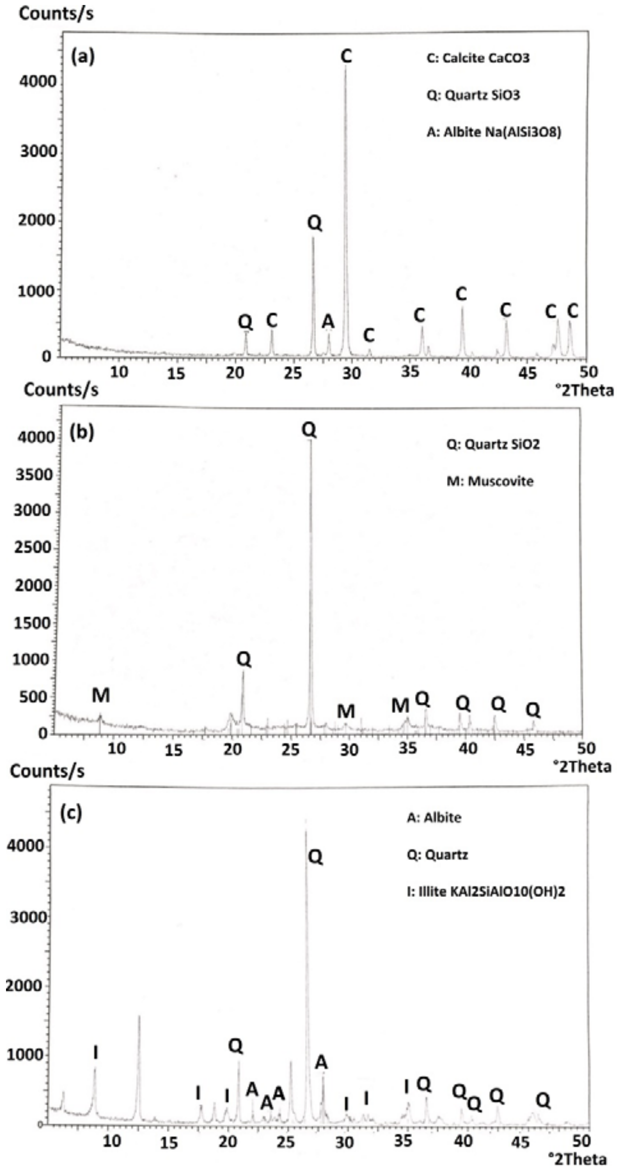


Fig. 7 X-Ray Diffraction analysis of some samples: a: calcareous tuffs, b: sandy clay, c: quartzwacks

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