

# QUANTITATIVE XRD BULK AND CLAY MINERALOGICAL DETERMINATION OF PALEOSOL SECTION OF UNAYZAH AND BASAL KHUFF CLASTICS IN SAUDI ARABIA

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Quantitative XRD analysis was performed on 172 samples containing the paleosol section of Unayzah and Basal Khuff clastics taken from the cores of one well drilled by Saudi Aramco. Quantitative XRD bulk mineralogical determination was achieved using Rietveld refinement method whereas Quantitative XRD clay mineralogical determination of clay-size fraction was obtained using RIR method. The accuracy of the results was reasonable according to the accuracy checking and quality control by the test of artificial mixture samples of standards. The XRD results indicate that the samples from paleosol section consist mainly of quartz and feldspar (microcline and albite) as framework constituents. The cement minerals are dolomite, hematite, anhydrite, siderite, gypsum, calcite, and pyrite. Hematite mainly occurs in the section with depth of 8617.2-8649.1ft, in which the rocks are in red color and usually contain relatively high content of clays. Hematite is a common mineral of paleosol in many cases. It is generally considered to be formed in the climate of warm and humid, which facilitates chemical weathering (Blatt et al, 1980). Clay minerals are important constituents in paleosols. The XRD results show that clay minerals in the samples are illite, mixed layer illite/smectite, kaolinite, and chlorite. No discrete smectite is present in the samples. Based on comparison of the data from XRD bulk mineralogy and XRD clay fraction analysis, it is noticed that the total percentage of clay minerals (illite, I/S mixed layer clay, kaolinite, and chlorite) determined from XRD bulk analysis is usually bigger than clay-size fraction using separation technique. This is because some clay minerals (especially kaolinite) may be larger than clay size (<2 microns). The total clay data from XRD bulk analysis indicate that clay content is variable with an average of 11.4% (0-43.5%), in which there are 5.0% of kaolinite (0-28.9%), 4.9% of illite and I/S (0-28.1%), and 1.5% of chlorite. In the case of paleosol section of Unayzah and Basal Khuff clastics, kaolinite amount is more if compared to some of the findings in other studies. Considering the likely low demand for potassium of microbes and early land plants, unlike that of forests, illite-rich soils could have been much more widespread in the distant geological past than they are today (Weaver, 1989). An additional explanation for the illitic composition of many paleosols is the alteration of smectite to illite during burial, a process now widely documented from studies of boreholes. In this study, the samples of paleosol section are collected within the depth of 8596.9-8988.7 ft, which is the temperatures being favor to the transition of smectite to illite through mixed layer illite/smectite. The mixed layer illite/smectite in these samples shows that the smectite layer percentage is 10-30%, which indicates the type is ordered illite/smectite. The clay mineral associations in these samples of paleosol section can be classified into three types: Type-I: illite and mixed layer illite/smectite dominated; Type-II: kaolinite dominated; Type-III: illite, mixed layer illite/smectite, and kaolinite associated. Most samples are of Type-I, in which illite and mixed layer I/S predominate whereas kaolinite is less than 30%. Type-II mainly occurs in the interval with depth of 8612.3-8618.5 ft that is the main and pure paleosol interval, in which the relative percentages of kaolinite are more than 50%. Type-III mainly occurs in the intervals with depth of 8609.2-8610.9 ft and 8915.8-8988.7 ft, in which illite and mixed layer I/S are still major constituents, but kaolinite is more than 30%. The change of clay mineral association type with depth can indicate the change of paleoclimate and paleoenvironment. For example, kaolinite usually forms under strongly leaching conditions: abundant rainfall, good drainage, and acid waters. Therefore, XRD mineralogical data of paleosol section is important for petroleum geologists to study paleoclimate and paleoenvironment and predict the reservoir quality of the associated rock formations. However, the interpretation of clay mineral association should consider all factors including provenance and diagenesis.