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Petrography and Sedimentary Geochemistry of the Lower Miocene Al Wajh Formation, Midyan Peninsula, Red Sea Region, Saudi Arabia : Implication for Provenance and Weathering.

M.M. N. Islam (1), O. Abdullatif (2), K. Al-Ramadan (2), and A. Kumar (3)

(1) Department of Geology, University of New Brunswick, Fredericton, Canada (z1x61@unb.ca), (2) Earth Sciences, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia , (3) Research Institute, Center for Petroleum & Minerals, King Kahd University of Petroleum & Minerals, Dhahran, Saudi Arabia

The Al Wajh Formation (Lower Miocene) has not been studied in detail in the past and various aspects of this formation make it more worth to be part of inclusive investigation. The Formation is exposed at many localities in the northern part of the Ifal Basin (Midyan Peninsula, Red Sea Region, Saudi Arabia) as well as in the subsurface. The Formation is a syn rift related siliciclastic sequence. In the study area, a complex structural history is due to Red Sea Oligocene-Miocene extension tectonics, and Pliocene-Recent anti-clockwise rotation of the Arabian Plate relative to Africa on the Dead Sea Transform Fault. Also, siliciclastic sediments of the Al Wajh Formation are deficient in biocomponents in surface exposure; hence elemental chemistry data can be an effective tool for studying these formations to unravel the source area.

Petrographycally, the Al Wajh Formation is mainly composed of arkosic sandstone and sandy conglomerate. The formation is characterized by some textural variation but negligible mineralogical variations. The mineralogical phase dominated by quartz and feldspar with subordinate amount of lithic fragments, iron oxide, clay mineral etc. Porosity is very high and mainly interpartical in nature. Grain size analysis of the Al Wajh Formation mainly shows bi-modal to poly-modal sediment distribution indicates the matrix-rich conglomerates domination. Calculated sorting value falls largely within the poorly sorting to very poorly sorting area; however, skewness of the samples shows some variations. The formation is in early stage of diagenesis and dissolution of framework grain is the major diagenetic process observed. Iron oxide is the dominant cementing material. Overall petrography shows the immature character of the Formation.

Provenance analysis based on modal composition in the ternary (Q-F-L) diagram shows that the Al Wajh sandstones derived from the transitional continental to the craton interior region. This indicates to derivation of the sandstones from stable parts of the craton, with perhaps a subordinate contribution from recycled orogens, shedding quartzose debris of continental affinity into the basin. Provenance analysis based on sediment geochemistry suggests the Al Wajh Formation derived from felsic to mixed felsic/basic source. In Co/Th vs. La/Sc plot, the data display low and relatively constant Co/Th ratios with an average of 1.36 but high and considerably variable La/Sc ratios, also suggesting dominantly felsic source rocks. In La/Th vs. Hf plot, most data fall in the felsic source to mixed felsic/basic source field. The high Al_2O_3/TiO_2 ratios indicate continentally derived sediments. The high contents of Fe_2O_3 with respect to the low contents of Cr, Ni, and V may be explained by syngenetic and early diagenetic precipitation of iron oxides in the sediments.

The geochemical classification of the Al Wajh sandstones using major oxide provides subarkose to arkosic type, thus reflecting their mineralogical immature character. Major and trace element concentrations indicate a low to moderate weathering history in the source, in the rocks of the Al Wajh Formation. The SiO_2/Al_2O_3 ratios for the formation is low (average 8.5) and indicate a low degree of maturation of the sediments. Samples plotted in the Th/U vs. Th diagram have variable but generally high Th/U ratios, typically above the upper crustal value of 3.8, suggestive of moderate weathering. The average CIA values for the Al Wajh Formation (59.4) is higher than those of basaltic andesites (CIA = 56), and lower than andesites (CIA = 60) and rhyolites (CIA = 61) of the upper Jurassic Andean magmatic arc. The Petrographic study is consistent with a more important role for mechanical weathering than for chemical weathering. Similarly, petrographic evidence of subangular to subrounded grains

might be indicative of poor weathering in their source rock which is also supported by the absence of kaolinite clay (form by later stage of diagenesis). The geochemical and point count data as well as CIA values suggest that the effect of weathering had not reached to the stage where alkali and alkali earth elements are substantially removed from the clay minerals.