

## **Chemostratigraphy and provenance of the Carboniferous-Permian Unayzah Formation and Basal Khuff Clastics deposits encountered in Central Arabia**

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### **ABSTRACT**

The Carboniferous to early Permian Unayzah Formation generally is represented in the subsurface of central Saudi Arabia by three members. The lower member (Unayzah C) is interpreted to have been deposited in large glacial valley systems evidenced by deformed glacial outwash sands and gravels, overlain generally by the Unayzah B Member, which reveals the general aspect of melting during terminal retreat of the Upper Carboniferous Ice cap. The Unayzah A Member represents, in contrast arid continental setting with ephemeral streams or aeolian deposits. Toward the top, alternating sandstones, shales, and thin carbonate layers defining the Basal Khuff Clastics Member (BKC) are unconformable. This study is performed on 1,521 core and cuttings samples and aims to produce a basin scale correlation scheme, trying to differentiate the Unayzah A and the BKC boundary.

The scheme is based on specific changes in some ratios dealing with glaciogenic, fluvial, aeolian and coarse-grained sediments. The key ratios utilised are:  $Zr/Nb$ ,  $Nb/U$ ,  $(Rb+Cs)/La$ ,  $Al/(Ca+Mg+K+Na)$ ,  $(Zr*Hf)/(Nb*Ta)$ ,  $(Zr*Hf)/Nb$  and  $Zr/(Nb*Ta)$ . The generated schemes comprise a hierarchical order of three zones (C1 to C3), four subzones and seven divisions. Zones C1 and C3 are characterized by the lowest values of  $Zr/Nb$  and  $Zr/Th$  while the intervening Zone C2 is characterized by high  $Nb/U$ . The Subzone C2-1 produces higher values of  $Zr/(Hf*Ta)$  ratio than in the overlying C2-2 subzone. Two subzones are associated with the zone C3 (C3-1 and C3-2) based on variation in the  $(Rb+Cs)/La$  ratio. Divisions C3-1a, C3-1b, C3-1c and C3-1d are being based on the variations in  $(Zr*Hf)/Nb$ . Compilation of the sedimentological and palynological data, together with the generated chemozones, helped to arrange and adjust the Unayzah subdivision. Zone C1 is recognized in Unayzah C, subzone C2-1 is recognized in Unayzah B, subdivision C2-2 through subdivision C3-1 are recognized in Unayzah A, and finally subzone C3-2 defines the BKC. The chemozones and subzones defined demonstrate generally quartzarenites except the Zone C1 and subzone C3-2, which plot in arkose to wacke intervals respectively.

Provenance study shows that Unayzah Formation is mainly derived from upper crust and typical igneous composition (felsic source) and trends toward illite-muscovite and kaolinite-chlorite structure. A passive margin origin for the Unayzah sandstones is indicated by the discriminant function diagram.