

Applications of Elemental Chemostratigraphy to the Definition of the Pre-Unayzah Unconformity, Eastern Saudi Arabia

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Abstract

The aims of the following study were to utilize inorganic geochemical data to define the Pre-Unayzah Unconformity (PUZU) in eastern Saudi Arabia. This formed in Permo-Carboniferous times and is time-equivalent to the Hercynian Unconformity. A total of 1228 core and cuttings samples were analyzed from 15 wells by ICP-OES (Inductively Couple Plasma - Optical Emission Spectrometry) and ICP-MS (Inductively Coupled Plasma - Mass Spectrometry), with data acquired for 50 elements in the range Na-U in the periodic table. In some wells, it is a relatively straightforward task to place the PUZU where there is a sand:shale contact or where there is good biostratigraphic control immediately below and above the unconformity. This is much more challenging, however, where a sand:sand contact exists, or where the boundary cannot be defined using sedimentological, wireline log or biostratigraphic criteria. Indeed, glacial erosion formed palaeovalleys in which the basal Unayzah Group was deposited in late Carboniferous times, but the glaciers eroded to different depths in different locations, so the PUZU overlies Devonian sediments in some wells, with Silurian, Ordovician and even Cambrian strata in others. To avoid complications relating to changes in grain sizes and bulk lithology, separate schemes were proposed for sandstone and mudrock samples. As with most chemostratigraphy projects, the schemes are based on a relatively small number of “key” elemental ratios. In this study, these include Zr/Ti, Nb/P, K/Al, Nb/Yb, Nb/U, Y/U, Nb/Th, Zr/Nb, Zr/P, U/Th and Yb/U, variations, which are largely dependent on changes in source/provenance. The sandstone scheme comprises a hierarchical order of four zones, six subzones, four divisions, and two subdivisions, while the mudrock framework consists of three zones and four subzones. To simplify the correlation, both were integrated to create a combined correlation scheme. Chemostratigraphy has been used in conjunction with palynology, sedimentology (from cored sections only) and lithostratigraphy to place formation and member boundaries, including the PUZU. The technique does not provide age dating and cannot be utilized to place stratigraphic boundaries when employed in isolation. The technique may be used for this purpose, however, if at least some of these boundaries have been placed in a minority of wells using lithostratigraphy, sedimentology and/or biostratigraphy. By comparing the placement of chemozone and stratigraphic boundaries, in wells where the latter have been defined, it is possible to place the same boundaries in wells where they are not.