Integration of Chemostratigraphy, Sedimentology, Borehole Image and Seismic Data to the Correlation of the Sarah Formation, Northern Saudi Arabia

Neil Craigie[1], Andrew Rees[1], and Keith Macpherson[1]

[1]Saudi Aramco (Exploration Department)

ABSTRACT

The Upper Ordovician Sarah Formation in Northern Saudi Arabia was deposited as sand-dominated glacial outwash sediments, comprised of turbidite channels and fans. The present study focuses on the chemostratigraphic correlation of this interval encountered in 11 wells. To gain a comprehensive understanding of the correlation and attain maximum levels of resolution, the chemostratigraphic scheme was integrated with the results of seismic interpretation, sedimentological data, and paleoflow directions (acquired from borehole images). Data were acquired for 50 elements in the range Na-U in the periodic table by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry) and ICP-MS (Inductively Coupled Plasma – Mass Spectrometry), though the scheme is based on variations in the following key element ratios: Zr/Y, Zr/Lu, Th/Nb, Th/P, Ta/P, Cr/P, P/Lu, Th/Ti, Cr/Yb, and Th/Ta. Changes in these parameters are largely linked to variations in sediment source/provenance, and the definition of chemozones relate to specific values of individual ratios. Zone JL1, for instance, is identified at the base of the Sarah Formation and yields higher Zr/Y (> 30) and Th/P (> 35) than in the overlying zone JL2. Similarly, the three subzones of JL2, labelled JL2-1, JL2-2 and JL2-3 in ascending stratigraphic order, are differentiated by Ta/P and Cr/P ratios in precise ranges. Based on sedimentological and seismic data, the basal part of the Sarah Formation comprises submarine channel sediments oriented in a range of directions, though these are not recognized in all of the study wells. The channel sands are succeeded by northerly trending turbidite fan sediments, which extend across this area. Significantly, the same chemozones are often recognized in channel and fan deposits in adjacent wells, and this would have resulted in erroneous correlations had chemostratigraphy been applied in isolation. By employing the aforementioned multidisciplinary approach, however, such errors were avoided and a robust high resolution scheme could be proposed. The top of the Sarah Formation in the majority of these wells takes the form of shallow marine (shoreface?) sandstones, derived from the erosion and reworking of underlying turbidite fan deposits. Being defined by elevated Si/Al ratios, these sandstones are mineralogically mature, but are otherwise very similar to the underlying sediments in terms of both geochemistry and mineralogy.