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Chemostratigraphy of the Sarah Formation, Northern Saudi Arabia: an integrated approach to reservoir correlation

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ABSTRACT

The Sarah Formation of Northern Saudi Arabia is mainly in the form of glacial 'outwash' sediments comprising turbidite channels and fans. The present study focuses on the chemostratigraphic correlation of this interval encountered in 11 wells. It was necessary to integrate the chemostratigraphic scheme with the results of seismic interpretation, sedimentological data and paleoflow directions (acquired from borehole images) to gain a comprehensive understanding of the correlation of reservoir sandstones.

Although ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry) and ICP-MS (Inductively Coupled Plasma – Mass Spectrometry) were used to acquire data for 50 elements, the scheme is based on changes 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. Chemozones are defined by distinct values of key element ratios. For example, zone JL1 (occurring at the base of the Sarah Formation) is generally characterized by higher Zr/Y (< 30) and Th/P (< 35) ratios than in the overlying zone JL2. Similarly, the three subzones identified within JL2, labelled JL2-1, JL2-2 and JL2-3 in ascending stratigraphic order, are differentiated by specific values of Ta/P and Cr/P. Variations in the aforementioned ratios mainly reflect changes in source/provenance.

The seismic and sedimentological data indicate that the basal part of the Sarah Formation takes the form of submarine channel sediments, though these are not recognized in all of the study wells. The channel deposits are overlain by turbidite fan sediments which extend across this area. It is significant that 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 adopting the aforementioned multidisciplinary approach, it was possible to produce a robust high resolution correlation scheme. The top of the Sarah Formation in most of these wells comprises shallow marine (shoreface?) sandstones derived from the erosion and reworking of underlying turbidite fan deposits. These sandstones are mineralogically mature, shown by their high Si/Al ratios, but are otherwise very similar to the underlying sediments in terms of both mineralogy and geochemistry.