Preservation of High Porosities within Glaciogenic Sandstones of the Sarah Formation, Northwest Saudi Arabia

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ABSTRACT

The Upper Ordovician Sarah Formation is a sand-prone glaciogenic succession that forms an important tight-gas reservoir in northwest Saudi Arabia. Sarah sandstone reservoirs are typically found within sub-parallel, NE-trending channels which traverse proglacial submarine outwash fans. These reservoirs comprise clean, quartz-rich very fine to fine grained sandstones that show porosities of typically less than 5% and permeabilities of less than 0.1 mD. During burial, depositional porosities were drastically reduced by the effects of compaction, quartz overgrowth cementation and the local precipitation of pervasive calcite cement. Production relies on hydraulic fracture stimulation. However, the tight sands are frequently interbedded with thin, discontinuous/isolated and highly unpredictable sandstone lenses that show anomalously high porosities (>25%) and permeabilities (>3 darcies) and contrasting textural and diagenetic properties. These porous sandstones show good sorting, medium grain size and well rounded quartz grains. An important feature of the sandstones is the presence of early chlorite rims. Chlorite occurs throughout the Sarah interval but within the porous sandstones it forms distinct radial coatings on detrital grains. These chlorite coatings are uniform and show excellent surface coverage, a factor that seems critical in restricting the development of quartz overgrowths and possibly retarding the chemical compaction process. Although the chlorite coats have had a positive impact on reservoir quality, the physical and geochemical conditions required for their formation seem to have been only locally favourable within the Sarah braided outwash fan system. As a result their distribution is limited to discrete intervals within the Sarah subsurface. Other possible reasons for the preservation of high porosities include leaching of an earlier calcite cement and overpressure.