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The Base Qusaiba Hot Shale, a highly variable source rock: Evidence from a study area in northern Saudi Arabia

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ABSTRACT

The Base Qusaiba Hot Shale (BQHS) is the most prolific source rock in Northern Saudi Arabia and has recently been targeted as a potential unconventional shale gas target. Hydrocarbons have been successfully flowed from the BQHS in spite of the limited geologic data available from historical, conventional exploration programs. Unconventional exploration commenced in recent years providing significant additional data, which has led to the recent advances in the geological understanding of Northern Arabia and the BQHS.
The initial phase of the Qusaiba sedimentation, BQHS, is characterized by a time transgressive, organic-rich, fine- grained basal hot shale. In outcrop, this is associated with the marine transgression of the previously glaciated land surface. However, in much of the shale gas exploration area in northern Saudi Arabia, the underlying Sarah was deposited in a glacio-marine environment so there was no local flooding of a land surface, rather a transition from glacially influenced to a non-glacial environment. The change in sedimentary style is progressively initiated due to the interplay of seafloor topography, circulation patterns and permanent sea ice.

Where the initiation of the non-glacial Qusaiba Member sedimentation in northern Saudi Arabia was not delayed, such as in this study area, then seven distinct chronostratigraphic units are identifiable within the BQHS. These include, in stratigraphic order: (1) a late Ordovician transgressive siltstone (QTSS); (2) an earliest Rhuddanian, early acuminatus- ascensus graptolite biozone, hot shale; (3) an early Rhuddanian, acuminatus-ascensus graptolite biozone, black chert (QBCH); (4) Rhuddanian, vesiculosus graptolite biozone, chert to shale transition zone (QCST); (5) a mid Rhuddanian to earliest Aeronian mid- vesiculosus to early triangulatus graptolite biozone, highly condensed/unconformity zone; (6) an early Aeronian, triangulatus to magnus hot shale; and (7) an early Aeronian (mid-magnus graptolite biozone) sediment influx.

The heterogeneity that has been identified within the BQHS as observed in the study area has important implications for source rock characterization as well as pay-zone identification. In this presentation the geological nature and possible paleo-environmental interpretations for these different chronostratigraphic units will be discussed.