Stratigraphic and Hydrocarbon potential of the Paleozoic succession in Jordan

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Introduction

Jordan is part of the Arabian platform in general 4-6 km of sedimentary rocks over line the crystalline basement, however the sedimentary section is up to 10 km thick. The section comprises sediments ranging in age from late Proterozoic to Holocene. The Paleozoic rocks of Jordan crop out in the south western of the country. The sediments are situated conformably on the basement and dip gently to the west. In the eastern part of the country the sediments sub crop the Hercynian unconformity and are buried to depth of some 2000 m or more.

Northwards, the lower Paleozoic is unconformable overlain by Cretaceous clastic deposits, which in turn are seceded by Tertiary sediments and volcanic rock in the NE Jordan

The Early Paleozoic (Cambrian to Silurian) rocks are croping in southern Jordan. These sediments are entirely penetrated in two wells in Wadi Sirhan and Jafr areas (WS-3 and JF-1) and penetrated partially in more than 50 wells in Risha, Wadi Sirhan, Mudawwara, Azraq and northern highlands areas in Jordan. More than 3500 m of continental and shallow marine clastics with minor, but remarkable, carbonate section of Early-Middle Cambrian age (Burj formation) were encountered. In the Eastern parts of Jordan, the sequence recorded much more thickness, indicated by seismic.

In the outcrop area, the Cambrian section consists mainly of arkosic sandstones of the Salib and Umm Ghada formations. The Salib is situated directly on the Basement. The Burj formation, which consists of dolomites and shale, overlies the Salib and Umm Ghada formations and constitutes and important seismic marker in the area.

The Burj formation is overlain by the Umm Ishrin formation, which mostly consists of sandstone. These Cambrian formations have not been penetrated in the Risha area but the Burj seismic marker, which can be correlated over a vast area of the Middle East, is present.

The Disi and Umm Sahm formations consist of mainly braided fluvial to deltaic sandstones intercalated by minor shale beds of more marine origin. These formations are Ordovician age.

The Hiswa formation, which consists of shale and siltstone often bioturbated and with ripple marks, attesting to its marine origin. The RH-3 well encountered the top of the Hiswa formation.

Above the Hiswa formation is the Dubeidib formation. In outcrop it consists of a lower fine grained sandstone with skolithos burrows, a middle part with channel fill and intercalated sandstone with hummocky bedding and an upper sandstone similar to the lower sandstone. The total thickness is 125 m in outcrop. The three units were deposited in a shallow marine environment.

The area constituted a major depositional center during the early Paleozoic Hercynian uplift reactivated fault in Jordan and Strike-Slip faulting created isolated high such as the Risha platform. The Risha Platform area was characterized by non-depositional and erosion during most of the Mesozoic and Tertiary time.

In the Risha area the Dubeidib formation is much thicker and much more Shaly. There it consists of basal sand, a lower Shaly Silty unit, a middle unit with sandstone beds often showing coarsening upwards log profile and a upper Shale/Silty unit with few Sandstone intercalations. Due to its more Shaly nature, it was probably deposited in a slightly deeper marine.

The Late Paleozoic (Devonian to Permian) rocks are cropping out in Northern and Northeastern Saudi Arabia. These sediments were penetrated entirely in Jordan, whereas, sediments from Devonian to Permian age were reported. In Jordan, sediments from Carboniferous and Permian ages were reported environment compared to the outcrops.

Hydrocarbon Potential

Hydrocarbon potential analysis indicates the presence of good source, reservoir and seal rock in Paleozoic sequences. The source rock layers are mature and oil prone with some part mature, immature layers. Entrapment mechanism of gas accumulation seems to be combination of stratigraphic digenetic and structural type, fault zones to fault controlled structure or sealing fault - attic and up- dip migration through Silurian - Ordovician unconformity is highly favorable.

Reservoir rock mainly predicated in Ordovician sequence (sandstone), good seal rock found in the Ordovician silty shale, Triassic tight carbonates and evaporate, Silurian shale plays both roles, source and seal.

Upper Dubeidib that in wadi Sirhan is syn glacial to sub aqueous deposits, the Sandstone intervals within Dubeidib may have improved reservoir development with enhanced porosity and permeability up flank of the basin due to less compaction effect. Reservoirs within structures situated along migration paths and with intact trapping mechanism. The Silurian Shale of the Mudawwara formation provide a regional seal for the Dubeidib.

In Risha area, the Risha formation is of sub glacial to sub aqueous deposits and proved to be bearing Gas. Gas shows were reported is deeper horizons wherever porosity exists. The porosity distribution within the Risha formation is complex and though to be controlled by depositional and digenetic processes.

In Risha area, the Mudawwara shale's of the Early Silurian are of considerable thickness in the east (1200 m). The Mudawwara formation is equivalent to the wideswpread Qusaiba formation in Saudi Arabia and considered a regional source rock. They thin westward as the Silurian becomes completely truncated below the widespread Pre-Mesozoic angular unconformity. The Mudawwara Shale's are considered potential source rocks as they contain intervals with rich organic content. They have been investigated and proved to be mature in WS-2, WS-3 and WS-4.