**Lower Palaeozoic Petroleum Systems of Western Iraq with Reference to Jordan**

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Abstract

The Lower Palaeozoic of northwest Arabia is characterised by similar major chrono-stratigraphic rock units, covering vast areas of eastern Jordan, northwest Saudi Arabia, eastern Syria and western Iraqi deserts. It is the most under-explored succession in Iraq, but it is considered to have significant exploration potential.

The Lower Silurian marine (hot) shale is the main proven source rock for the Palaeozoic hydrocarbons discovered in the area of study. However, some Upper Ordovician black shales (of the Khabour Formation of Iraq and its equivalent in Jordan) are also expected to be additional local source rocks within the region. Conversely, the Lower Ordovician Hiswah graptolitic shales of Jordan are originally lean, where analysed, and are not considered a major hydrocarbon source rocks. Similarly, preliminary geochemical results show that the Middle Cambrian Burj limestone does not have significant source potential in the marginal Jordanian wells, although it may have some potential where deposited in a more basinal settings such as in western Iraq.

Several promising sandstone reservoir rocks (of Cambrian, Ordovician, and Early Silurian ages) are present across the study area. However, the reservoir quality is a major exploration risk as most of these sandstones have been severely affected by quartz overgrowth and clay cementation. Only some Upper Ordovician Dubaydib subsurface sandstones of Jordan have chlorite-clay coatings, which prevented formation of the quartz overgrowth, preserving good reservoir quality. Seals are also available all-over the region both on local and regional scales; these include (but are not limited to) the shales and carbonates mentioned above as potential source facies.
The widespread occurrence of potential source, reservoir and seal rocks suggests that Lower Palaeozoic prospects below the deserts of western Iraq are quite promising frontiers for future hydrocarbon exploration.

References


Sharland, P.R., D.M. Casey, R.B. Davies, M.D. Simmons, and O.E. Sutcliffe, 2004, Arabian plate sequence stratigraphy; revisions to SP2: GeoArabia Manama, v. 9/1, p. 199-214.

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Abstract

The Lower Palaeozoic of northwest Arabia is characterized by similar major chrono-stratigraphic rock units underlying vast areas of desert in eastern Jordan, northwest Saudi Arabia, eastern Syria and western Iraq. In the most under-explored area in Iraq, it has still not been explored to any significant exploitation potential. The Lower Shurian marine flora fauna is the main preserved source rock for the Palaeozoic hydrocarbons discovered in the area so far. However, Upper Ordovician black shales of the Shurian Formation of Iraq and its equivalent in Jordan are also expected to be additional host source rocks within the region. Consequently, the Lower Ordovician-Howa Gap geologic time frame of these source rocks are organically and chemically immature, and are not considered to be major hydrocarbon source rocks. Similarly, preliminary geoscientific results show that the Middle Cambrian-Ball Limestone does not have any significant source potential in the marginal Jordan basin, even though it has an organic matter content considered to be deposited in a more lacustrine setting, such as in western Iraq. Several promising sandstone reservoir rocks of Cambrian, Ordovician, and Early Silurian ages are present across the study area. However, the reservoir quality in major exploration risk as most of these sandstones have been severely affected by quartz overgrowth and clay cementation when dominated by quartz grains and deeply baked. Only some Upper Ordovician Dolostone/sUbrafacies sandstones of Jordan have chlorite clay coatings, which prevented formation of the quartz overgrowth, and thus preserved good reservoir quality. Seals are also available all over the Jordanian Palaeozoic succession, and the magnesian carbonates and shales have been effective seals (apart from the very thin epicontinental sequences). The widespread occurrence of potential sources, reservoir and seal rocks suggests that Lower Palaeozoic prospects below the desert of western Iraq are quite promising for future hydrocarbon exploration.

The main objective is identification and characterization of the Lower Palaeozoic petroleum systems through:

1. Reconstruction of the depositional history and palaeogeographic maps.
2. Reconstruction of the diagenetic history to predict the reservoir quality, and
3. Reconstruction of the tectonic history to clarify the impact of tectonics in preservation of the Palaeozoic stratigraphy and hydrocarbon migration.

Study Area

A) Location map of NE Arabia Plate

Introduction

Almost two thirds of Iraq’s area has potential for the Palaeozoic prospects (Agrawi et al. 2011). Palaeozoic is the most under-explored succession in Iraq. Its megasequence stratigraphy although little known, appears similar to other major Arabian Plate megasequences (APs) in neighboring countries. One discovery (i.e. Akhis Field) was made in 1983 in the Palaeozoic of Western Arabian Desert (South-Sanandaj prodip from the Upper Ordovician and Lower Shurian sandstones, mostly gas but with some light oil). Only a few exploration wells have penetrated the Palaeozoic, but without reaching the Cambrian formations and or Precambrian Basement. In addition, few shallower basins (Khabur, etc.) that dip into the west of Iraq by the Geological Survey of Iraq for stratigraphic punctures have penetrated the Palaeozoic succession. Last August the 48-field Bibiting Reservoir was announced by Iraq Oil Co. for Exploration, in which many Blocks have potential for Palaeozoic. The Palaeozoic Plays

Potential Lower Palaeozoic Plays

Cambridge Play

Ordovician Play

Silurian Play


The speculative petroleum system of Lower Sequence of AP1

Source Rocks

• The Lower Shurian marine (hot) shale is the main proven source rock for the Palaeozoic hydrocarbons (particularly light oil) discovered in eastern Iraq. This interval is absent in the north of Iraq, due to erosion.
• Upper Ordovician black shales of the Shurian Formation are expected additional Lower Palaeozoic source rocks.

The speculative exploration Play may be an integrated petroleum system, although has not been proven in W & S W Iraq yet.

The penetrated Palaeozoic succession in well Atba 1 (Khalil et al. 2010 modified from Al-Fudaisi, 2009)

Lower Palaeozoic Source Rocks

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Targeted Reservoirs

- Medium-c electromagentic test of a single or medium test of oil are possible.
- There are large quartzose sandstones (15%) and clays (12%)
- Calcareous but some quartz overgrowths have developed due to compaction

Cross-section of TDC data against 32 yield for Jordanian Brian and 32 sample data

The majority map of the Lower Palaeozoic Stratigraphy (Lamoni and R. Gable, 2009)

Ordovician map, submitted below by S. Gable and C. Gable

Lower Palaeozoic Petroleum Systems of Western Iraq; Some conclusions

- The widespread occurrence of potential source, reservoir and seal rocks suggests that the Lower Palaeozoic plays and prospects are quite promising for future hydrocarbon exploration over NW, SW & SW Iraq Deserts.
- However, the reservoir targets would be controlled by the active regional/local active petroleum system, which is mainly defined geographically by areas of source rock occurrence / maturation and reservoir burial depth.

The process of Ordovician reservoir may have been affected by the Ordovician strata in the eastern basin. The basin was developed in a good portion and the reservoir has partly dissolved and eroded to clay, but the quartz grains have already developed some overgrowth, which is expected to increase with depth of burial.