

Assessing the Potential for He Accumulation in Gas-Prone Petroleum Systems of the Middle East: A Predictive Framework

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Abstract

The demand for Helium (He) is growing and the Middle East remains one of the largest producers of this gas from the North Field of Qatar. The proportion of He preserved is very low (0.04%) but due to the enormous size of this field, the resource available is considerable. At low concentrations, He is commercially produced during the liquification of hydrocarbon gasses that increase its concentration tenfold. Elsewhere, higher concentrations of He are known from conventional Silurian-sourced gas fields within Khuff Formation equivalent reservoirs. These commonalities imply that He-prone gas-rich petroleum systems are more widespread than realized and that additional He resources could be strategically explored for. However, in order to do this, it is essential to understand the factors that control the accumulation of He in order to make predictive models for exploration.

In the subsurface, Helium is produced by the decay of radioactive minerals that are common in some basement and (clastic) sedimentary rocks. In stable geological domains, the continued decay of these mineral over 100s myrs allows the accumulation and concentration of He in porewaters (not least in Paleozoic sediments). On contact with migrating hydrocarbon-rich gases, He is partitioned into this fluid, is entrained and migrates towards the edges of petroleum systems where it can be preserved in traps. The later the timing of hydrocarbon charge relative to He accumulation the greater the volume of He that can be entrained within the migrating gases. It is suggested here that the discipline of play fairway analysis can be easily adapted to account for the additional processes required for He accumulation and as such be used to assess the risks.

Based on regional geological models for the Middle East, it is suggested that the regionally extensive Paleozoic clastic sediments will be the main source of He as they are intimately connected to the expansive charge systems migrating gases through the basins. In order to accumulate He, there are several key risks that will need to be assessed. These are: A) the impact of early gas generation and He entrainment from Silurian shales prior to the development of the Hercynian Unconformity; B) the impact of flushing of He from porewaters due to uplift associated with this unconformity; C) the time available for the accumulation of He in any of the Paleozoic rocks after the development of this unconformity and; D) the timing and effectiveness of any later process of hydrocarbon migration and He entrainment relative to trap formation in the region.

In this presentation, potential He-prone petroleum systems will be compared and evaluated based on these risks that will ultimately affect the likely proportion of He-prone gases in the subsurface.