An Overview of Pre-Devonian Petroleum Systems – Unique Characteristics and Elevated Risks

Barry Jay Katz
Chevron, Houston, TX
BarryKatz@Chevron.com

Abstract

Conventional hydrocarbon resources have been associated with pre-Devonian petroleum systems across the globe, including the Neoproterozoic–Infracambrian Huqf Supergroup of the Oman basin, the Riphean - Vendian sequences of East Siberia, the Cambrian of the Sirte basin, the Ordovician of the Tarim basin, and the Silurian Qasaiba of Saudi Arabia. Although individual accumulations can be quite significant (e.g., Hassi Messaoud has proven reserves of ~6.4 billion barrels), the relative importance of pre-Devonian-derived oils is limited compared to the global conventional resource-base. With growing interest in unconventional resources, the relative importance of these systems is expected to increase as plays such as the Ordovician Utica Shale of the Appalachian basin, the Cambrian of China, and the Silurian of Central and Eastern Europe develop.

The ages of these systems result in unique properties and amplify risks that may exist in younger petroleum systems. Differences in the nature of the biomass contributing to pre-Devonian source rocks give rise to oils which may display unique geochemical characteristics. For example, there are some Precambrian oils where C29 steranes dominate even though land plants were absent. There are also Ordovician source rocks dominated by Gloeocapsamorpha prisca, a primitive prokaryote, which yield oils containing limited amounts of C20+ components and nearly lack pristane and phytane.

The potential for unconventional reservoirs in pre-Devonian systems may also be highly dependent upon the age of the system, as biological evolution influences the availability and nature of biogenic silica, an important factor controlling brittleness and fracability. Literature has shown that biogenic silica from different sources displays varying degrees of resistance to diagenesis, which builds the silica network and influences brittleness. For example, radiolaria developed during the Cambrian are more resistent to diagenesis than diatoms, which did not evolve until the Jurassic.

Risks associated with preservation of hydrocarbons may be amplified in pre-Devonian petroleum systems. Many such systems have been exposed to significant thermal stress resulting in cracking of oil and wet gas. Others have had complex tectonic histories potentially resulting in breaching of seals or changes in PVT conditions that may result in gas loss. Gas loss may also occur through diffusion from conventional reservoirs as a result of long residence times.