

## **Unconventional Oil Petroleum Systems: Shales and Shale Hybrids**

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With a premium on energy resources as well as oil versus gas prices, it makes political and economic sense for further work to be undertaken to enhance the development of difficult resources such as those categorized as unconventional. Shale oil and shale oil hybrids are one such resource that already have had an impact on energy resources in North America.

Shale oil plays vary considerably from tight mudstones to shales with interbedded conventional reservoir lithofacies. Three basic play types are known that include fractured shale plays, such as the Monterey Shale in coastal California, tight mudstones such as the Mississippian Barnett Shale of the Fort Worth Basin, and the shale hybrid play, the Upper Devonian-Lower Mississippian Bakken Formation. Each system is comprised of a marine shale source rock with differences being in permeability and nearby associated lithofacies consisting of carbonates, sands, or silts.

Differences in shale permeability and lithofacies play key roles in ultimate producibility from these systems. Highly fractured areas of the Monterey Shale produce prodigious volumes of even low gravity crude oil. Hybrid systems flow large volumes of oil from conventional lithofacies due to increased storage capacity and certainly due to lower adsorption affinities in these rock types. While focus in shale gas has been on brittleness with high quartz contents, in shales in the oil window, high quartz content is associated with organic matter that has strong adsorption affinities for crude oil. On the other hand interbedded lithofacies often carbonates, but also sand or silt beds have little or no association with organic matter and adsorption does not restrict and ultimately occlude flow rates. In addition these lithofacies often have increased storage capacities due to increased matrix porosities, in carbonates thought to be derived from organic acids from kerogen that partially dissolve carbonates creating secondary porosity.

There are a variety of examples of shale oil systems including those listed above as well as with the following source rocks from various parts of the world: for example, Miocene Antelope Shale (California), Cretaceous Niobrara Shale (Colorado), Jurassic Kimmeridge Shale (U.K.), and Bazhenov Shale (Siberia). A comparison of all these plays provides insights into future shale oil resource plays.