Revisiting the Great Basin, Part 2: Petroleum System Insights

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Integration of a comprehensive geochemical data set (>5000 source rock and >100 oil analyses) into a palinspastically restored structural framework (2D and 3D) provides a unique opportunity to critique the prevailing petroleum system paradigm for the Great Basin. The results indicate that Miessner’s mid-90’s local charge paradigm has not been critically reevaluated as new data have been published. Specifically, issues are identified with the thermal maturity profile extrapolation, local Chainman source rock organic facies do not match produced oils, and produced oils are more thermally mature than the local source rocks from which the oils were allegedly generated. As such, a critical reexamination is warranted in order to establish a revised paradigm.

The paradigm revision focuses on lateral migration vectors driven by the structural development described in part 1 of the paper. This scenario creates numerous opportunities for both conventional and unconventional hydrocarbon prospecting. Key concepts that indicate enhanced exploration opportunities in the Great Basin include:

- structural restoration shows excellent quality oil-prone Chainman, Pilot, and Woodruff source rocks extend further into the Roberts Mountain footwall than previously believed, and generated hydrocarbons will charge both footwall traps and foreland structures;
- well-documented immature Woodruff and Vinini oil shales in the hanging wall of the Roberts Mountain Thrust will generate hydrocarbons from the footwall of the Sonoma Thrust;
- an exhumed paleotrap containing mature Vinini oil is identified in the Roberts Mountain footwall, mere feet from immature Vinini source rock in the hanging wall;
- preferential expulsion of hydrocarbons from the base of the Chainman (i.e., downward) necessitates testing Devonian reservoirs;
- hydrocarbon expulsion from the top of the Chainman has increased seal risk;
- excessive thermal maturity from tectonic loading and contact with igneous rocks is present, but large expanses of immature to mature Chainman, Woodruff, and Vinini source rocks are identified for unconventional prospecting;
- Railroad Valley and Pine Valley oil fields are preserved segments of laterally charged hydrocarbons migrating into paleo-high traps that were preserved, despite a Tertiary graben overprint that likely facilitated a local remigration event;
- Pilot-sourced oils are also produced in Railroad Valley, and mixing Pilot and Chainman oils account for molecular variation in those Paleozoic reservoired oils;
- intrusives impose less influence to the Paleozoic section, compared to the Tertiary, as the rock sequences already experienced peak temperatures during sedimentary and/or tectonic loading;
- proximity to intrusives does not appear to significantly diminish prospectivity, as demonstrated by Railroad Valley and Pine Valley accumulations;
- hydrocarbon content preservation is an important component of the risk analysis process, but it is a manageable task;
• geochemical data is best used to build a converging interpretation, such as the integration of reflectance, transmission, chemical, and molecular data to assess thermal maturity; and
• Tertiary sourced oils are dominantly generated from source rocks deposited in hypersaline lacustrine systems that are source rock volume limited.

While the Great Basin may not rival Saudi Arabia in terms of resources, the new paradigm provides a basis for a new awakening of exploration in the region.