Applying Natural Gas Compositions from Large Tight-Gas-Sand Fields to Reservoir Filling Models

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Tight gas sand reservoirs differ fundamentally from conventional reservoirs, characterized by low permeability and absence of a distinct top seal. These relationships suggest that gas fills tight-gas-sand reservoirs through a mechanism substantially different from conventional reservoirs. Three mechanisms appear to be possible: (1) gas forces its way upward by fracturing through the intermediate seals; (2) gas diffuses upward through a series of low permeability, intermediate seals; (3) gas migrates vertically through permeability pathways such as faults or fracture systems and then diffuses laterally.

We are testing models for gas migration into these reservoirs with an extensive study of gas compositions from three fields in the U.S. Rocky Mountains: Jonah (Green River Basin); Rulison - Parachute - Grand Valley (Piceance Basin); and Greater Natural Buttes (Uinta Basin). Our premise is that each of the three models described above should leave a distinctive record in the gas composition, expressed in terms of 13C and D-H isotopes, with lighter compositions in shallower horizons as 12C and hydrogen diffuse more rapidly through seals than 13C and deuterium and possibly small atomic-radii gases such as helium in preference to larger molecules such as the hydrocarbon gases and CO2.

The extensive analytical database will be combined with hydrous pyrolysis experiments on likely source rocks to determine the composition of gases entering the reservoir and with modeling of gas compositions with the migration simulator MPath. Initial data from Jonah and Rulison-Parachute-Grand Valley show gas compositions become enriched in heavier gases with depth but also become isotopically lighter, suggesting multiple waves of gas expelled by different source rock units.