Three-Dimensional Petroleum Systems Modeling of the Greater Green River Basin, Wyoming, Colorado, and Utah

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Abstract

From 2023 to 2025, the U.S. Geological Survey (USGS) conducted multiple, geology-based assessments of undiscovered oil and gas resources in the Greater Green River Basin (GGRB) also referred to as the USGS Southwestern Wyoming Province-spanning parts of Wyoming, Colorado, and Utah. To support this assessment, a three-dimensional (3D) petroleum systems model was developed to characterize the regional heat flow and the major source rock intervals within the basin, with a focus on their distribution and thermal maturation history.

Interpretation of 17 lithostratigraphic horizons on >6,500 wells with geophysical logs was used to construct regional stratigraphic grids from the surface to the basement. The model is anchored by a regionally extensive stratigraphic surface at the top of the Mesaverde Group, which serves as the primary datum for basin-scale correlation and analysis.

The basin model evaluated four total petroleum systems (TPS): (1) the sub-Cretaceous Phosphoria TPS, (2) the Cretaceous Mowry Composite TPS, (3) the Cretaceous Niobrara TPS, and (4) the Cretaceous-Cenozoic Composite TPS. The source rocks contributing hydrocarbons to these TPS include the Phosphoria Formation, Mowry Shale, Niobrara Formation, coal beds and organic-rich mudstones within the Mesaverde Group, marine mudstones of the Lewis Shale, and coal beds in the Lance Formation.

Calibration of the 3D basin model using present-day bottom hole and drill stem test temperature data reveals that heat flow across the Greater Green River Basin varies between 30 and 70 mW/m^2. The highest heat flow is observed in the Sand Wash Basin of Colorado, particularly near the margins of the Colorado Mineral Belt, while the lowest occurs in the western side of the province along the Uinta uplift and the paleo-Sevier thrust front. Thermal maturation modeling suggests regions of oil- and gas-prone maturity for the studied source intervals, with maturation timing dependent on the Cenozoic uplift history of the basin.