Gas Shale Reservoir Characteristics from the Pennsylvanian of Southeastern Utah, USA

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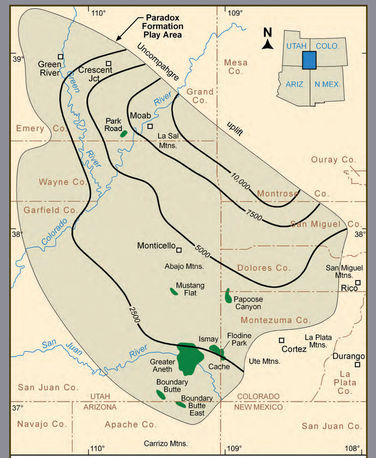
ABSTRACT

Calcareous, organic-rich, dark brown-gray mudstones from the Paradox Basin of southeastern Utah are now recognized as gas-productive. These comparatively thin deposits (less than 80 feet each based on log analysis), belonging to the Hovenweep, Gothic, and Chimney Rock shales of the Paradox Formation cycles, possess modest TOC values (1-2%) and appear transitional (oil to gas window) in terms of locally-pertinent thermal maturation. Nonetheless, gas production has been obtained through vertical stimulations in several wellbores.

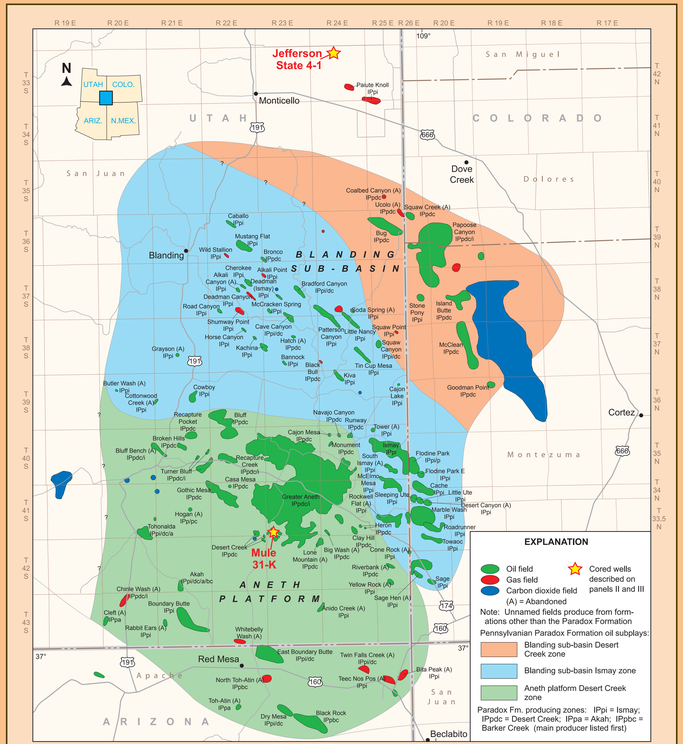
Several cored intervals are beset by multiple types of subvertical, calcite-lined fractures that commonly propagate into stratigraphically-proximal brittle limestones or into silty dolostone interbeds. Because the mudstones themselves possess modest (2-3%) gas-filled porosity and nanodarcy permeability values in comparison to other well-known Middle to Upper Paleozoic black shale gas reservoirs, the hydrocarbon recoveries are perhaps greatly aided by natural fractures, and by the modest, but still substantial (3-5%), intercrystalline voids found in the associated dolostones. Thin section work and scanning electron microscopy have visually verified the quantitative results obtained through core-based, petrophysical methods.

As part of this study, rock mechanics data have also been assembled for a multitude of purposes, including calibration for logging-prediction, potential development of an optimal vertical stimulation program, as well as future design of horizontal and/or deviated drilling and completion methodology. Considerable work was accomplished in terms of measuring standard moduli (Young's modulus, Poisson's ratio) and ultrasonic wave velocities through triaxial compression testing.

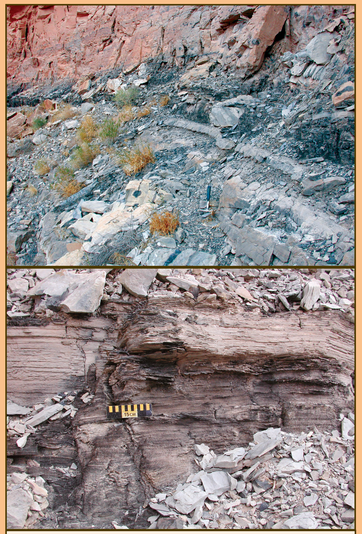


Pennsylvanian Paradox Formation play area and major fields, Utah, Colorado, and Arizona. Thickness of the Pennsylvanian rocks shown in feet.

LOCATION

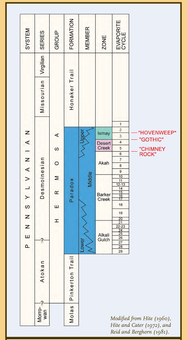


Location of the Paradox Formation Blanding sub-basin Desert Creek zone, Blanding sub-basin Ismay zone, and Aneth platform Desert Creek zone subplays, southeastern Utah, southwestern Colorado, and northeastern Arizona

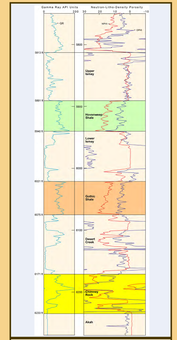


Gothic shale in the Pennsylvanian Paradox Formation exposed along the Honaker Trail, San Juan River Canyon, Utah.

PANEL I



Pennsylvanian stratigraphic chart for the Paradox Basin; informal zones with significant production are highlighted with colors. Red text represents organic-rich shale intervals.



Gamma-ray and neutron-density log of the Jefferson State 4-1 well in section 4, T. 33 S., R. 24 E., illustrating the general aspects of the shale units.

Slabbed, continuous segments of core (6027-6042 feet) taken from the Gothic shale (Jefferson State 4-1). Note presence of subvertical calcite-lined fractures in apparently monotonous calcareous mudstones. Some fractures appear open but likely have resulted from core relaxation during recovery.