

Organic and Inorganic Surface Expressions of the Lisbon and Lightning Draw Southeast Oil and Gas Fields, Paradox Basin, Utah, USA

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Exploration for Mississippian Leadville Limestone-hosted oil and gas reservoirs in the Paradox Basin is high risk in terms of cost and low documented success rates (~10% based on drilling history). Only 100 wells have penetrated the Leadville over an area of 7,500 square miles (19,400 square kilometers), which equates to about one well per township. The potential for more hydrocarbon reserves is thus enormous, but the high cost of threedimensional (3-D) seismic exploration methods in environmentally sensitive areas deters small independents from exploring for Leadville hydrocarbon reservoirs.

This study was therefore initiated to evaluate the effectiveness of low-cost, innovative, non-invasive, surface geochemical methods for predicting the presence of underlying Leadville hydrocarbon reservoirs. Lisbon field, San Juan County, Utah, was chosen for testing because it is the largest Leadville oil and gas producer in the Paradox Basin, and a nearby Leadville field (Lightning Draw Southeast) with nearly virgin reservoir pressure is also available for comparison. In comparison with Lisbon field, Lightning Draw Southeast field, San Juan County, Utah, is smaller, with more nitrogen and helium, and has productive intervals in the overlying Ismay zone of the Pennsylvanian Paradox Formation.

The main conclusion of this study is that certain surface geochemical methods can discriminate between productive and non-productive subsurface reservoir areas. Variables in surface soils and outcrop joint soils that best distinguish productive and non-productive areas are light (methane, ethane propane and n-butane) alkane and heavy (C₂₄+) aromatic hydrocarbons. The volatile and liquid hydrocarbons presumably ascend to surface along faults within and at the margins of the fields. Discriminant functions developed for both fields predict one another, suggesting a compositional link between the Lisbon and Lightning Draw Southeast Leadville Limestone fields.

Helium and carbon dioxide anomalies in free-soil-gas over and adjacent to the Leadville reservoirs are the most diagnostic indicators of underlying Leadville reservoirs. These gases are enriched in Leadville reservoirs as compared with overlying productive intervals of the Ismay zone of the Paradox Formation. Anomalous hydrocarbons, carbon dioxide, and hydrogen in free gas over the Lightning Draw Southeast field may be derived from productive intervals within the Ismay zone, Leadville Limestone, or a combination of both reservoirs.

Heavy metals (U, Mo, Cd, Hg, Pb) are possibly indirect indicators of hydrocarbon microseepage and they could be derived from the oil itself or eroded from outcropping mineralization and fixed in organic-rich microseepage areas.