

The Mississippi Leadville Limestone Exploration Play, Utah, and Colorado— Exploration Techniques and Studies for Independents

DE-FC26-03NT15424

Program

This project was selected in response to DOE's Oil Exploration and Production solicitation (DE-PS26-03NT15391-2, February 2003), Advanced and Key Oilfield Technologies for Independents (Area 2 – Exploration) Program.

Project Goal

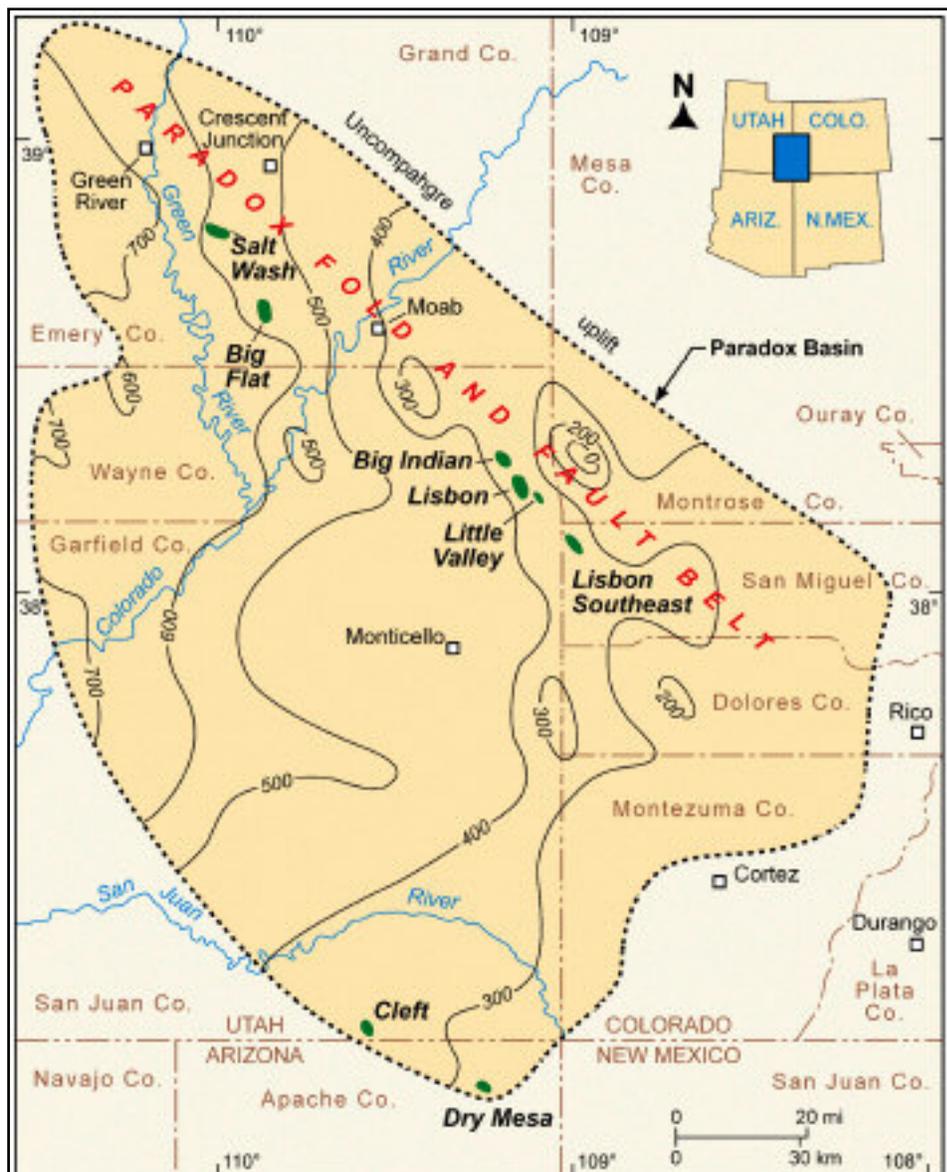
The overall goals of this study are to (1) develop and demonstrate techniques and exploration methods never tried on the Leadville Limestone, (2) target areas for exploration, (3) increase deliverability from new and old Leadville fields through detailed reservoir characterization, (4) reduce exploration costs and risk especially in environmentally sensitive areas, and (5) add new oil discoveries and reserves.

The project is being conducted in two phases, each with specific objectives. The objective of Phase 1 (Budget Period I) is to conduct a case study of the Leadville reservoir at Lisbon field (the largest Leadville producer), San Juan County, Utah, in order to understand the reservoir characteristics and facies that can be applied regionally. The first objective of Phase 2 (Budget Period II) will be to conduct a low-cost field demonstration of new exploration technologies to identify potential Leadville oil migration directions (evaluating the middle Paleozoic hydrodynamic pressure regime), and surface geochemical anomalies, especially in environmentally sensitive areas. The second objective will be to determine regional facies (evaluating cores, geophysical well logs, outcrop and modern analogs), identify potential oil-prone areas based on shows (using low-cost epifluorescence techniques), and target areas for Leadville exploration.

Performers

*Utah Geological Survey
Salt Lake City, UT*

*Eby Petrography & Consulting, Inc.
Littleton, CO*



Location of fields, including the Lisbon case-study field, that produce oil (green) from the Mississippian Leadville Limestone, UT and CO. Thickness of the Leadville is shown; contour interval is 100 feet (modified from Parker and Roberts, 1963).

Project Results

From Lisbon field core analysis, Leadville facies include open marine (crinoidal banks or shoals and Waulsortian-type buildups), middle shelf, and restricted marine (peloid and oolitic shoals). Rock units with open-marine and restricted-marine facies constitute a significant reservoir potential, having both effective porosity and permeability when dissolution of skeletal grains, followed by dolomitization, has occurred. There are two basic types of dolomite: very fine, early dolomite and coarse, late dolomite. Early dolomitization preserves depositional fabrics and has limited porosity development, except for limited dissolution of fossils, and exhibits very low per-

meabilities. Most reservoir rocks within Lisbon field appear to be associated with the second, late type of dolomitization and associated leaching events, which may have developed from hydrothermal events that can greatly improve reservoir quality. The result can be the formation of large, diagenetic-type, hydrocarbon traps.

Benefits

Project activities will reduce the risk taken by an independent producer in looking for Leadville oil, not only in exploring but in trying new techniques. For example, the independent would not likely attempt surface geochemical surveys without first knowing they have been proven successful

in the region. If we can prove geochemical surveys are an effective technique in environmentally sensitive areas, the independent will save both time and money exploring for Leadville oil.

Acquiring reservoir information or producing regional and reservoir characterization studies require manpower resources which independents simply do not possess or normally have available only for drilling. The technology, maps, and studies generated from this project will help independents to identify or eliminate areas and exploration targets prior to spending significant financial resources on seismic data acquisition and environmental litigation, and therefore increase the chance of successfully finding new accumulations of Leadville oil.

These benefits may also apply to other high-risk, sparsely drilled basins or regions where there are potential shallow-marine carbonate reservoirs equivalent to the Mississippian Leadville Limestone. A successful demonstration in the Paradox Basin makes it very likely that the same techniques could be applied in other basins as well.

Background

The Mississippian Leadville Limestone has produced over 53 million barrels of oil from six fields in the northern Paradox Basin region, referred to as the Paradox fold and fault belt, of Utah and Colorado. All of these fields are currently operated by small, independent producers. There have been no new discoveries since the early 1960s, and only independent producers continue to explore for Leadville oil targets in the region, 85 percent of which is under the stewardship of the federal government. This environmentally sensitive, 7500-square-mile area is relatively unexplored with only about 100 exploratory wells that penetrated the Leadville (less than one well per township), and thus the potential for new discoveries remains great.

Exploring for the Leadville Limestone is high risk, with less than a 10 percent chance of success based on the drilling history of the region. Prospect definition requires expensive, three-dimensional (3D) seismic acquisition, often in environmentally sensitive areas. These facts make exploring difficult for independents that have limited funds available to try new, unproven techniques that might increase the chance of

successfully discovering oil. Another problem in exploring for oil in the Leadville Limestone is the lack of published or publicly available geologic and reservoir information, such as regional facies maps, complete reservoir characterization studies, surface geochemical surveys, regional hydrodynamic pressure regime maps, and oil show data and migration interpretations.

The project is designed to address these issues and problems. All project maps, studies, and results will be publicly available in digital or hard-copy format and presented to the petroleum industry through a proven technology transfer plan.

Project Summary

Because Lisbon field in San Juan County, UT accounts for most of the Leadville oil production in the Paradox Basin project researchers selected Lisbon as the major case-study field for Budget Period I. They then achieved the following milestones:

- Described and photographed all available core from Lisbon field.

- Determined and described Leadville facies within Lisbon field.

- Geophysical well logs and core-plug porosity and permeability were tied to core.

- Sampled and described 64 thin sections to determine pore types and diagenetic history.

- Conducted scanning electron microscopy, epifluorescence, cathodoluminescence, fluid inclusion, and isotopic studies to further evaluate diagenetic history.

- Constructed field reservoir maps (isochore, structure, temperature, production, etc.) and stratigraphic cross sections.

Current Status (August 2005)

Budget Period II began July 1, 2005 and scheduled to be completed by June 30, 2007. Budget Period I began October 1, 2003 and ended June 30, 2005. It included two (2) no-cost extensions – one for 6 months and the other for 3 months.

Publications

Chidsey, T.C., Jr., Morgan, C.D., McClure, K., and Eby, D.E., 2004, The Mississippian Leadville Limestone exploration play, Utah and Colorado [abs.]: American Association of Petroleum Geologists, Rocky Mountain Section Meeting Official Program Book, p. 94.

Eby, D.E., Chidsey, T.C., Jr., Humphrey, J.D., and Taylor, L.H., 2004, Dolomitization of the Mississippian Leadville reservoir at Lisbon field, Paradox Basin, Utah [abs.]: Rocky Mountain Association of Geologists Hydrothermal Dolomite Symposium and Core Workshop Program, p. 31-32.

Chidsey, T.C., Jr., 2004, The Mississippian Leadville Limestone exploration play, Utah and Colorado: Rocky Mountain Association of Geologists, The Outcrop, v. 53, no. 10, p. 1 and 6.

Eby, D.E., Chidsey, T.C., Jr., Morgan, C.D., McClure, K., Humphrey, J.D., Moore, J.N., Taylor, L.H., and Weyland, V.H., 2005, Dolomitization of the Mississippian Leadville reservoir at Lisbon field, Utah [abs.]: American Association of Petroleum Geologists Annual Convention, Official Program with Abstracts, v. 14, p. A40.

Project Start: September 30, 2003

Project End: September 29, 2006

Anticipated DOE Contribution: \$267,828

Performer Contribution: \$267,828 (50% of total)

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