Potential for Exploration and Development Opportunities in Devonian, Silurian, and Ordovician Reservoirs in the Illinois Basin

DE-FC26-04NT15510

Goal

This project will implement a systematic basin analysis approach that is expected to encourage exploration of petroleum in lower Paleozoic rocks of the Illinois Basin. The study will compile and present a broad base of information and knowledge needed by independent oil companies to pursue the development of exploration prospects in overlooked, deeper play horizons in the Illinois Basin. All available geologic data relevant for the exploration and development of petroleum reservoirs in the Illinois Basin will be analyzed and assimilated into a coherent, easily accessible digital play portfolio using ArcIMS technology.

Performers

University of Illinois
Champaign, IL

University of Kentucky
Lexington, KY

Indiana University
Bloomington, IN

Results

Project workers have scanned more than 200 publications related to petroleum exploration and development (E&D) in Illinois. These scanned publications have been linked to the ISGS website for the public to view and download free of charge.

The team completed digital regional cross sections across the Illinois Basin and developed contoured structure maps on relevant formations in the basin.

Researchers have found that diagenetic alteration of limestone to dolomite is a key factor in forming highly porous and permeable Lower Paleozoic reservoirs in the Illinois Basin. Many existing Lower Paleozoic fields have pronounced structural closure. However, there are numerous examples of combination traps with a strong stratigraphic component such as the Mt Auburn trend along the Sangamon Arch. There is evidence of multiple periods of structural deformation. Some deformation is associated with the late Paleozoic Appalachian –Ouachita Orogeny. Many structures are attributed to Laramide style compressional deformation during late Mississippian –mid Pennsylvanian time. Lower Paleozoic units represent 50% of the rock volume of the Illinois Basin yet only 2% of all exploratory wells have penetrated these rocks. The Miletus Field discovery has produced over a million barrels of oil per year from Devonian reservoirs. Other Devonian production from both carbonate and siliciclastic plays across the Basin are significant models for further discovery and development. Silurian reef compartments and reef flank reservoirs are unexploited targets as are Buckhorn Field type non-reef plays. Trenton/Black River equivalent rocks in the Illinois Basin have hydrothermal and fault components similar to the high volume Ordovician age Trenton/Black River reservoirs established in the Michigan and Appalachian Basins. This play shows significant potential in the Illinois Basin. There have been significant new discoveries in Devonian, Silurian and Ordovician strata in the Illinois Basin since the inception of this study.

Benefits

There are no major oil companies operating in the Illinois Basin. This project is designed to benefit independent oil companies that are currently operating in the Illinois Basin or who are interested in evaluating the potential of exploration in Lower Paleozoic units in the basin. This project will use ArcIMS technology to deliver information pertinent to exploration in these units to all interested parties to encourage the development of new exploration plays and strategies. There has been an increase in exploration in

Lower Paleozoic units during the course of this project. There are examples of new discoveries in Devonian, Silurian and Ordovician strata since the inception of this project. The poster session presented at the National AAPG Meeting on April 11, 2006 in Houston, Texas was very well received and generated much interest among independent companies not currently operating in the Illinois Basin.

Background

There are no major oil companies operating in the Illinois Basin. Most oil wells in the basin only penetrate targets in Mississippian units, deeper units are rarely targeted. There is minor production in deeper Devonian, Silurian and Ordovician units and it is believed that new exploration strategies will lead to new discoveries in these under-explored units. Adjacent basins have had significant discoveries in similar Lower Paleozoic units and by assimilating available data and making it easily accessible, independent oil companies will be able to develop new exploration concepts for these units.

Summary

Devonian, Silurian, and Ordovician reservoirs account for about 8% of the petroleum produced in Illinois. These reservoirs represent a guideline to the potential for Lower Paleozoic production and the opportunity for new exploration targets in the basin. Devonian reservoirs, both siliciclastic and several types of carbonate, have been established though lightly explored. Silurian reservoirs, commonly associated with various reef settings, exhibit compartmental characteristics that extend both development and new-play production. Non-reef Silurian production also has been established. Ordovician reservoirs are limited to the Trenton carbonate, closed-structure fields, leaving the prolific hydrothermal play as a potential target.

The Lower Paleozoic units have not been extensively explored, in part because of the greater drilling depths and the practice of penetrating deeper horizons mostly in fields where shallower production has been established. This strategy has brought sporadic results because structural closure may shift with depth and numerous traps in Lower Paleozoic units are stratigraphic in nature.

An Illinois Basin Consortium project funded in part by DOE focuses on existing petroleum reservoirs and the potential for discoveries in Lower Paleozoic units. Major tasks for this project include creating a digital catalogue of existing reservoirs and developing models of the stratigraphic and structural framework of Lower Paleozoic units with available subsurface data. These products will be available in digital format on an ArcIMS website. Preliminary results suggest that applying new exploration strategies to the Illinois Basin can result in significant new discoveries in Lower Paleozoic units.

The project team has made substantial progress on the catalogue-of-field studies task. Field studies have been completed for Middle Devonian, Lower Devonian, Middle Silurian, Lower Silurian, and Ordovician Trenton reservoirs. Thousands of well files have been interpreted and pertinent data entered into the ISGS well data file. Detailed maps have been constructed that provide new understanding of play trends in Lower Paleozoic units in the Illinois Basin.

Researchers completed construction of 5 digital regional cross sections across the Illinois Basin. Contoured structure maps on the Beech Creek Barlow Limestone, Ste. Genevieve Limestone, and New Albany Shale top and base at 100-and 20-foot con-tour intervals.

Over 100 publications in the Illinois State Geological Survey Circular Series and 128 publications in the Illinois Petroleum series related to Illinois petroleum E&D were scanned and linked to the ISGS website. A considerable amount of information pertinent to E&D of Lower Paleozoic reservoirs is contained in these publications.

Researchers completed gas chromatography analyses of oil from 4 Trenton reservoirs, 4 Silurian reservoirs, and 3 Devonian reservoirs have been completed for the source rock-oil correlations studies.Using the technology of gas chromatography coupled with mass spectrometry, petroleum samples from any given reservoir can be analyzed and a wide range of compounds can be recognized.

Detailed stratigraphic study and mapping of producing horizons has shown that the region for discovery of additional Devonian Dutch Creek reservoirs is much larger than older maps have illustrated. Detailed maps and cross sections of the central Illinois Basin region show excellent potential for additional discoveries in a Middle Devonian to Upper Silurian sub-crop play trend. Findings were presented at the National AAPG in Houston, TX, on April 10, 2006. The poster session was very well received and generated much interest from independent producers currently operating outside of Illinois.

There has been a significant increase in permits issued to drill to Lower Paleozoic units in the last year. Staff at all three participating surveys have fielded numerous requests for information and advice regarding exploration and development in Lower Paleozoic units. Numerous test wells have been drilled in the last six months with significant discoveries in the Mt Auburn trend in Illinois and in other areas.

Current Status (June, 2006)
The project started September 30, 2004.

Funding
The project was selected in response to DOE's Oil and Gas Master Solicitation DE-PS-03NT15450, focus area Advanced Diagnostics and Imaging Technology.

Publications
Grube, J.P., Seyler, B., Huff, B.G., and Crockett, J.E., Trenton Oil Fields and Potential Production in Illinois, presentation with abstract, American Association of Petroleum Geologists 33rd Annual Eastern Section Meeting, Columbus, OH, 2004, pp. 78-79.

Leetaru, H.E., Trend Surface Analysis of the Trenton, presentation, Illinois Oil and Gas Association Meeting, March 2005, at Evansville, IN.

Seyler B., Grube, J.P., Crockett, J.E., Johanek, P.M., Huff, B.G., Knepp., R.A., Gustison, S.R., Lipking, R.D., 2005, Petroleum Potential for the Lower Paleozoic Strata in the Illinois Basin, Eastern Section American Association of Petroleum Geologists Annual Meeting, Morgantown, WV, September 18-20, 2005, abstracts volume, pp. 32-33.

A Poster Session entitled "Petroleum Potential of Under-Explored Lower Paleozoic Strata in the Mature Illinois Basin" was presented April 11, 2006 at the Annual Meeting of the American Association of Petroleum Geologists held in Houston, Texas. Beverly Seyler was the presenter, Co-authors are John P. Grube, Joan E. Crockett, Steve Gustison, Randy Lipking, Bryan Huff, Philip Johanek and Rex Knepp. The poster was well received and generated much interest in the deeper potential of the Illinois Basin

A talk was presented by Beverly Seyler "Potential of Under-Explored Lower Paleozoic Strata in Illinois" at the April 20, 2006 meeting of the Illinois Geological Society at Mt. Vernon, Illinois.

Project Start: October 1, 2004
Project End: September 23, 2007

Anticipated DOE Contribution: $800,000
Performer Contribution: $400,000 (33% of total)

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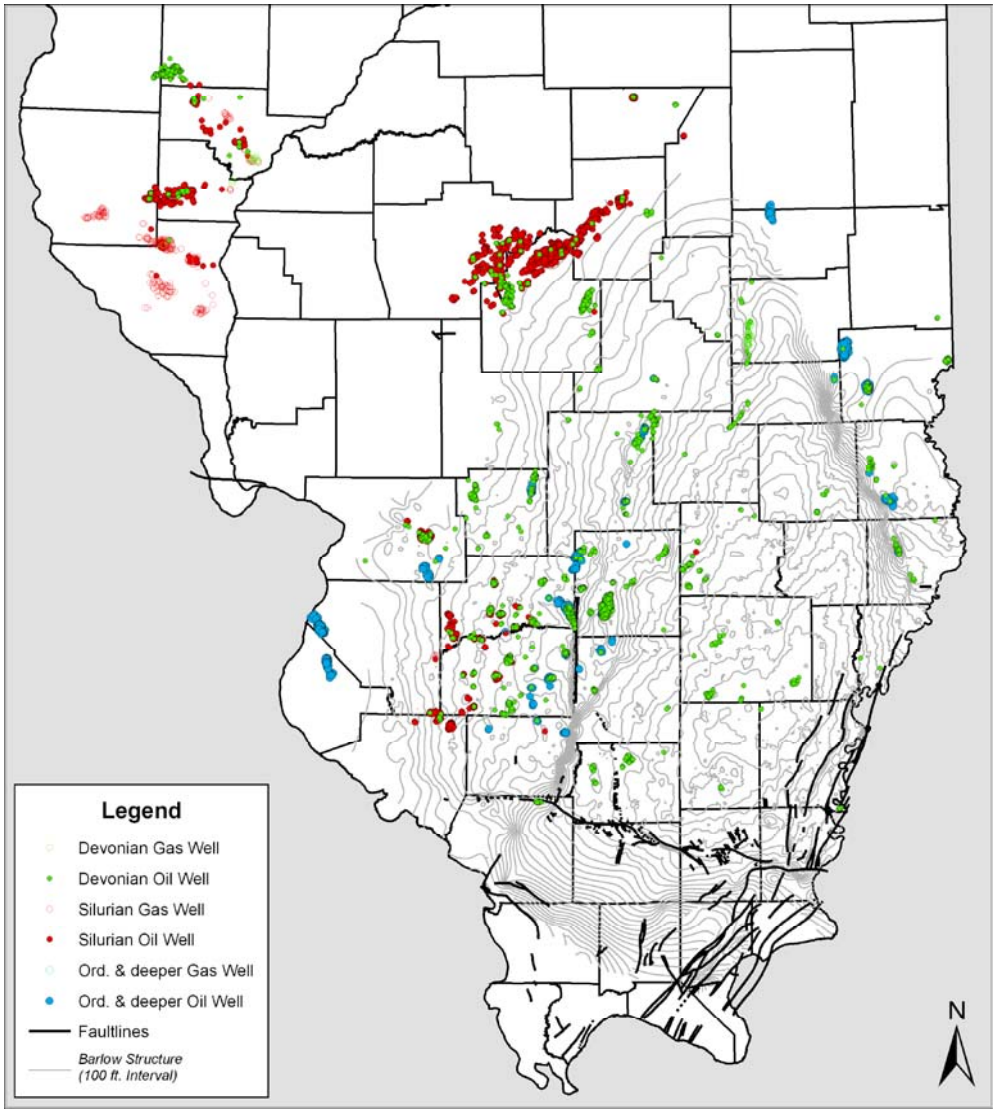
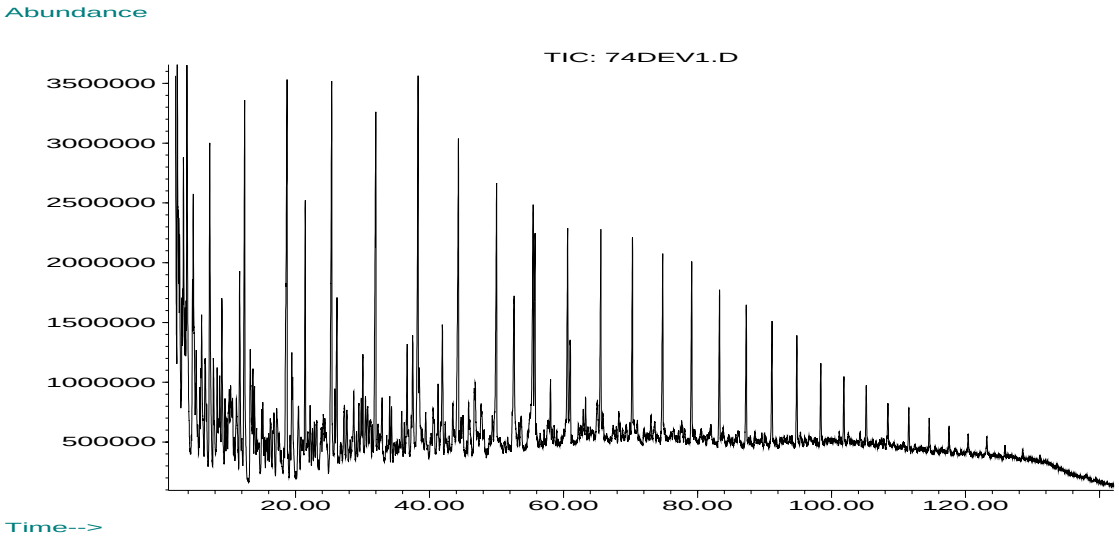
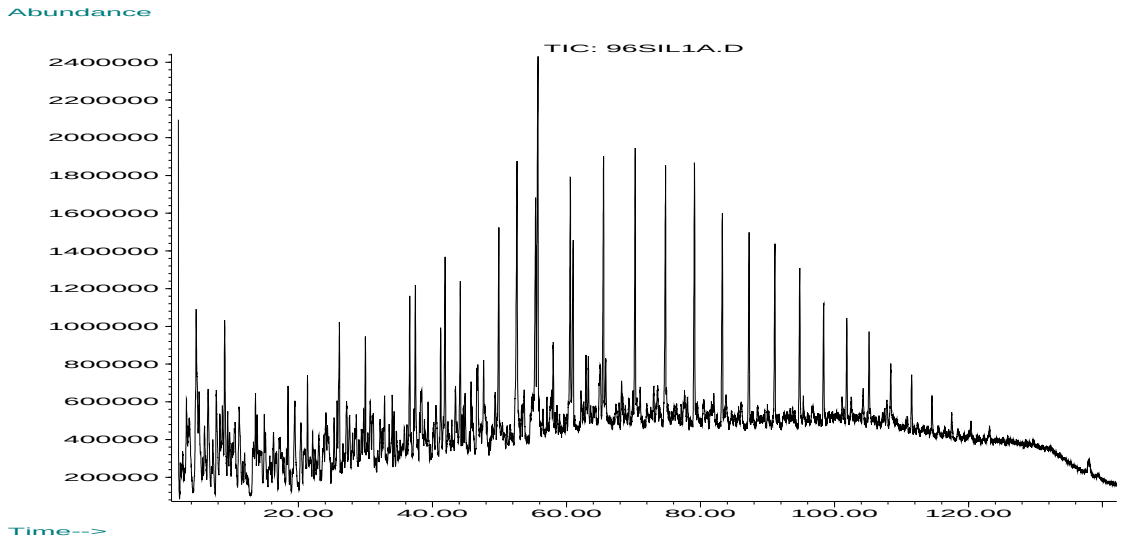


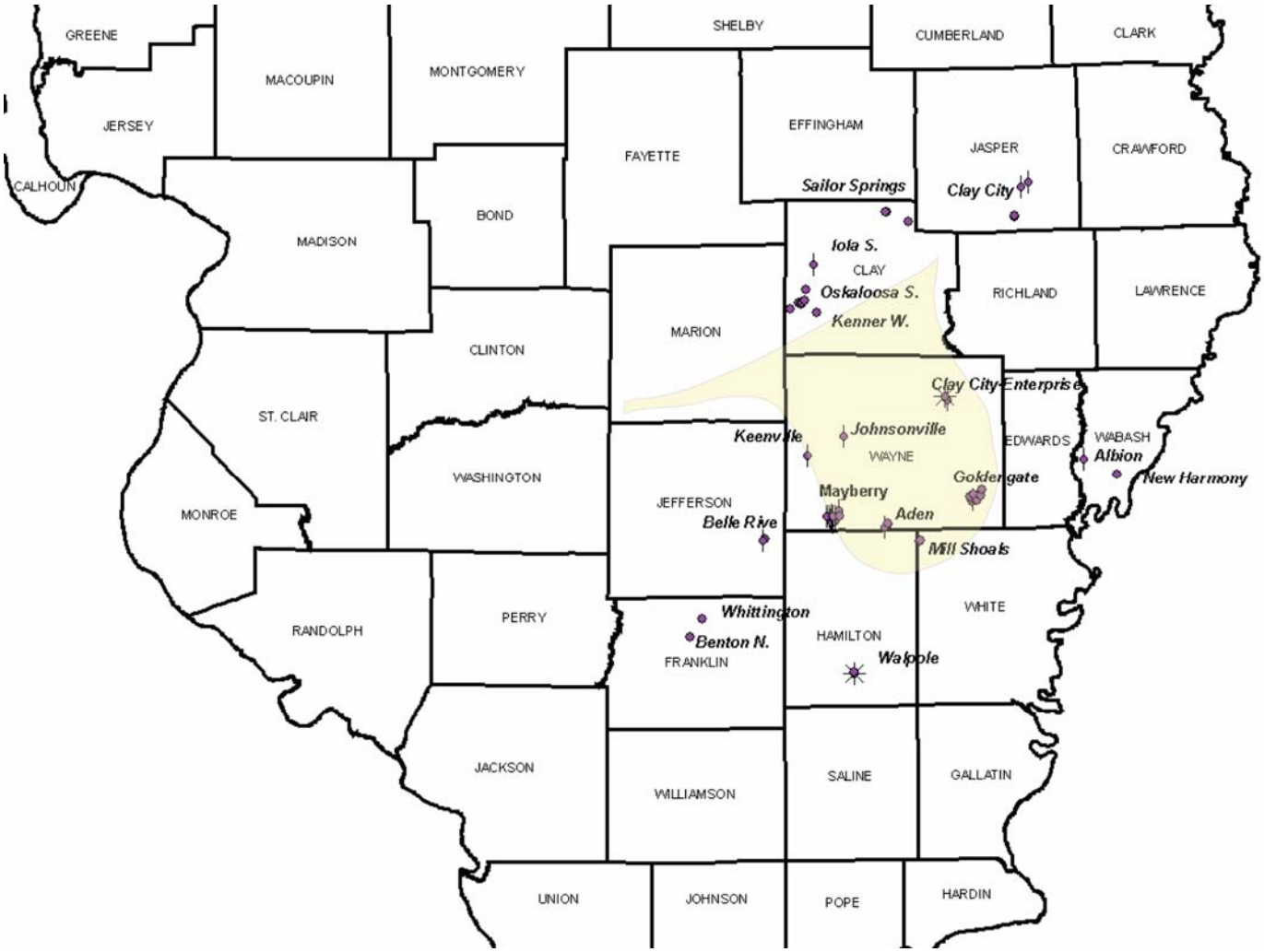
Wells with production from Lower Paleozoic horizons in Devonian, Silurian, and Ordovician strata.



Gas Chromatograph of Devonian oil sample from Weaver Field in Clark County in eastern Illinois.



Gas Chromatograph of Silurian oil sample from Wapella Field in Dewitt County Illinois.



Dutch Creek production is shown in purple. Fields located outside of the yellow tongue are expansions of the Dutch Creek facies as mapped by previous researchers.