Improving Geologic and Engineering Models of Mid-continent Fracture and Karst-Modified Reservoirs Using New 3-D Seismic Attributes

DE-FC26-04NT15504

Goal

The project goal is to develop innovative seismic-based methodologies and workflows for the incremental recovery of hydrocarbons from karst-modified carbonate reservoirs within the onshore continental United States. The project objectives are: 1) to calibrate new multi-trace seismic attributes for improved imaging of hydrocarbon reservoirs; 2) to develop attribute-based, cost-effective workflows to better characterize karst-modified carbonate reservoirs and fracture systems; and 3) to improve accuracy and predictiveness of geomodels and reservoir simulations.

Performers

University of Kansas Center for Research
Kansas Geological Survey
Lawrence, KS

University of Houston
Allied Geophysical Laboratories
Houston, TX

Results

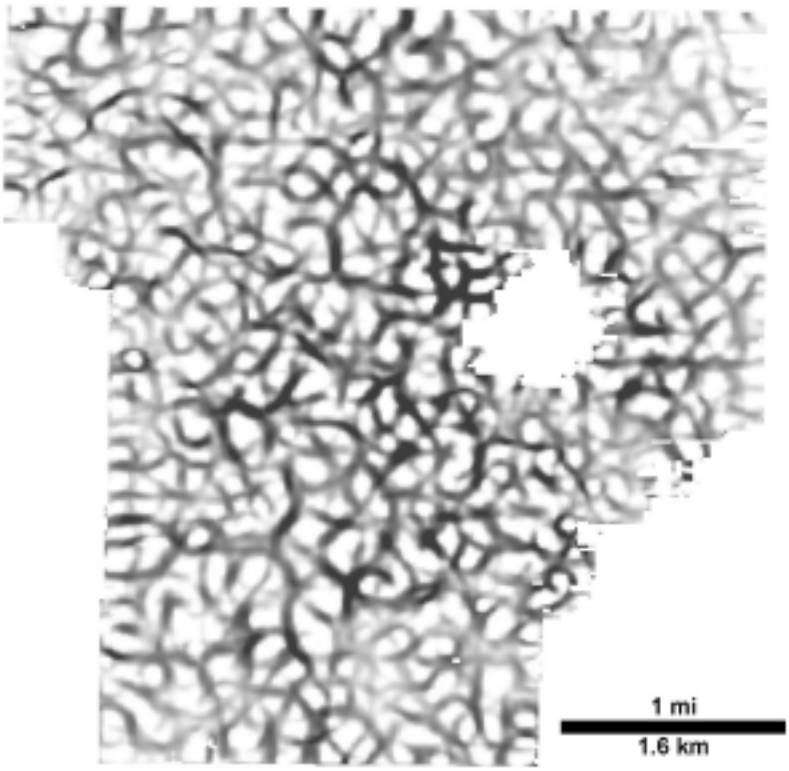
The project achieved the following:

- A catalog of karst features imaged with 3-D seismic attributes and calibrated with geological and engineering data is being developed, providing analogs to other karst-modified reservoirs. It's available online at http://www.kgs.ku.edu/SEISKARST/catalog.html.

- Integrated workflows are being developed to effectively utilize new seismic attribute technology in the exploration, development, and management of karst-modified reservoirs.

Benefits

Successful application of the new workflows developed in this project has the potential to increase incremental recovery of hydrocarbons from karst-modified reservoirs within the onshore continental United States and may allow more accurate assessment of karst-modified reservoirs elsewhere in the world.



Volumetric curvature attribute showing polygonal features geomorphically similar to cockpit karst.

Background

Karst-modified carbonate reservoirs account for 30-50% of the hydrocarbon production in the U.S. Midcontinent. These reservoirs are often characterized by low matrix permeability, fluid control problems, and low hydrocarbon recoveries. Fractures are one of the most important controls on development of permeability and hydraulic flow units in karst reservoirs. New technology is critical to the optimization of karst-modified reservoirs, and the project's new multi-trace, geometric seismic attributes have the potential to image karst sinkholes, field-scale fracture systems, and other usually elusive subseismic features in relatively low-cost, conventionally acquired 3-D seismic surveys. In order to advance this imaging technology for the development and management of karst-modified reservoirs, these attributes must be calibrated at the reservoir scale. In this project, researchers are calibrating attributes from three Midcontinent karst-modified reservoirs (in West Texas, Colorado, and Kansas) that represent a wide diversity of karst types and will validate their results through reservoir simulation.

Summary

The following results were obtained during the first year of the project:

- Interpretation of multi-trace seismic volumetric curvature attributes in the study areas has revealed a variety of karst features (including collapse features and geomorphologies that appear to be related to mature, cockpit landscapes), which provide the building blocks for a seismic attribute catalog of karst features.

- A catalog of karst features displays initial results of the 3-D seismic attribute analysis for the study areas, augmented with examples from other areas. The catalog illustrates the utility of volumetric curvature attributes to reveal previously unknown features in the seismic data or to provide enhanced visibility of karst features compared with other seismic analysis methods.

- In all study areas, seismic curvature attributes illuminate lineaments that appear to be related to joint and fracture systems controlled by regional structure.

- Integrated reservoir characterization studies, making use of complementary seismic, geological, petrophysical, and engineering data, are in progress for all study areas.

- Synthesis of seismic attribute analysis with core, production, and tracer data in the west Texas study area indicates that in this reservoir, lineaments imaged by curvature attributes are related to late stage fracturing and dissolution of anhydrite-cemented karst fractures and can be correlated with localized high volumes of water production.

- The project website (http://www.kgs.ku.edu/SEISKARST) provides timely, wide-audience dissemination of information related to the project.

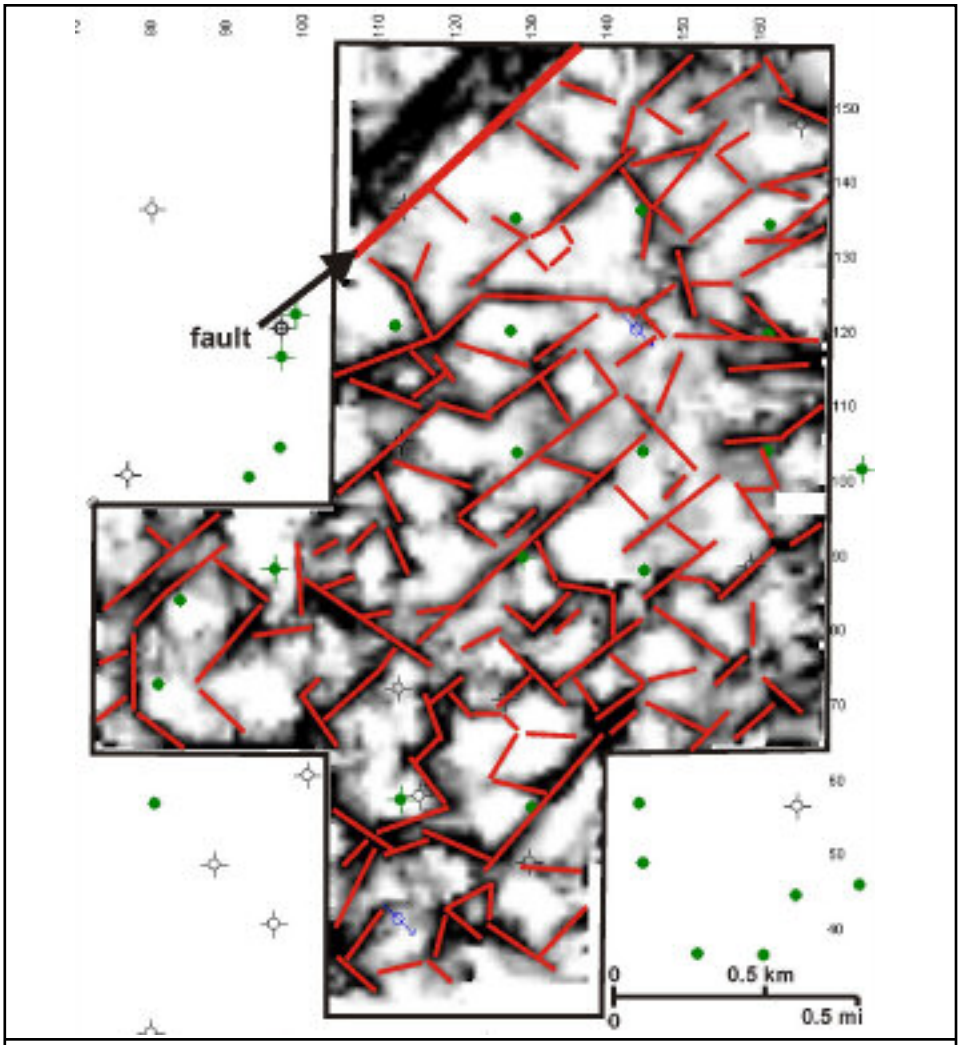
- Abstracts have been submitted for presentations at regional and national conferences.

Current Status (January 2006)

The second year of a three-year project began in October 2005.

Funding

This project was selected in response to DOE's Oil Exploration and Production solicitation DE-PS26-04NT15450-2A.



Volumetric curvature attribute showing oriented lineaments related to fracture systems paralleling regional structural trends.

Publications

Dou, Q., Sullivan, E.C., and Marfurt, K., Seismic Geomorphology of Unconformities in the Guadalupian (Permian) Grayburg and San Andres Formations, Eastern Central Basin Platform, West Texas, USA, abstract, AAPG 2006 Annual Convention.

Givens, N.B., and Nissen, S., Karst and fracture features affecting reservoir performance in a Mississippian reservoir, Cheyenne County, Colorado, abstract, AAPG 2006 Annual Convention.

Nissen, S.E., and Sullivan, E.C., Semi-annual Scientific/Technical Report – April 2005, http://www.kgs.ku.edu/SEISKARST/DE_FC26_04NT15504_April05_semi-annual.pdf.

Project Start: October 1, 2004
Project End: September 30, 2007

Anticipated DOE Contribution: $799,833
Performer Contribution: $297,770 (27% of total)

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