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Sequence Stratigraphy and 3D Modeling of a Pennsylvanian Distally Steepened Ramp Reservoir: Canyon and Cisco Formations, South Dagger Draw Field, New Mexico, USA

Abstract

Three-dimensional geologic models are often described as "products" of the reservoir characterization process, when in fact they might better be considered "tools" for reservoir management. For a 3D geologic model to be used as a reservoir management tool, it must be a reasonably accurate representation of the rock and fluid system in the earth volume of interest. Integrated 3D geologic modeling is a highly iterative, hierarchical process. Each step of the workflow builds and is dependent upon prior steps. Each data type used in reservoir characterization results from a unique experiment measuring different volumes of rock. Sophisticated, calculation-intensive algorithms, designed to run on powerful hardware systems, are now available to help integrate these different data types. However, hardware and software are only tools, and effective 3D reservoir modeling must involve an iterative process of geological interpretation, petrophysical analysis, seismic processing and inversion, and the application of mathematical algorithms. The iterative reservoir characterization process involves several significant challenges, including defining and adhering to a reasonable workflow, handling multiple data types to fill the interwell volume with petrophysical data that describe reservoir behavior accurately, and testing the 3D model interpretation.

South Dagger Draw field is presented as a case study to demonstrate our reservoir characterization workflow. South Dagger Draw is a Pennsylvanian reservoir located in southeast New Mexico. It produces from vuggy porosity formed along fractures and dominantly in algal mound complexes located at the ramp margin. A detailed sequence-stratigraphic interpretation of logs, cores, predicted facies, and 3D acoustic impedance data, guided by a depositional model derived from description of cores and outcrops, defined a series of complex sigmoid-oblique prograding clinoforms. This stratigraphic framework is the input for 3D geologic modeling.

Seismic and log data were integrated into a 3D geologic model using a new approach based on rock physics rather than geostatistics. The approach recognizes that acoustic impedance (AI) values, derived from accurate, iterative inversions of 3D seismic data, represent the only true measurements of the complete earth volume of interest. Therefore, instead of treating the AI measurements as "soft" data and conditioning the model results to the limited earth sample measured by well logs, the AI data are treated as valid, and the log data are conditioned to the seismic using nonlinear rock and fluid physical equations. The result is a 3D geologic model that acknowledges the error and scale differences inherent in the subsurface data (core description, core analysis, wireline logs, and 3D seismic) and attempts to integrate the data on the basis of physical principles, and provides a forward modeling approach to test the result.

Biographical Sketch

Currently, **Scott Tinker** is director at the Bureau of Economic Geology, The University of Texas at Austin, and state geologist of Texas. Previously he held the position of advanced senior Geologist at Marathon Oil Petroleum Technology Center in Littleton, Colorado. He has over 18 years of industry experience with Marathon, UPR, and Robert M. Sneider Exploration. His

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expertise ranges from designing, managing, and implementing multidisciplinary reservoir characterization studies, carbonate sequence stratigraphy, and 3D reservoir modeling. Recent achievements include SEPM award for Best Paper published in the *Journal of Sedimentary Research*, J.C. "Cam" Sproule Memorial Award for Best Paper published in AAPG by an author 35 years or younger, Marathon Achievement of Company Excellence Awards, and AAPG Distinguished Lecturer.

Scott graduated with a Ph.D. from the University of Colorado, and M.S. from the University of Michigan, and a B.Sc. from Trinity University. ■