

Improved Modeling of a Shallow Shelf Carbonate Reservoir using 3-D Seismic Attributes, Welch Field, Permian Basin, Texas

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OXY USA Inc. and the U.S. Department of Energy are partners in an advanced technology demonstration project (DE-FC22-93BC14990) at the West Welch Unit in the Welch Field in Dawson County, Texas. The project requires detailed characterization of reservoir properties to create a three-dimensional geological model to simulate fluid flow within the reservoir under carbon dioxide (CO₂) flood. Oil production at the Welch Field is from a stratigraphic trap in a low permeability San Andres reservoir of Permian age. Post depositional diagenesis, mostly anhydritic cementing, has created a high degree of variability in the porosity and permeability distributions across the field. The single biggest challenge for the reservoir modeling effort is defining the reservoir properties in the inter-well space. A modern 3-D seismic data volume was contributed by OXY to assist the effort and a method was developed to integrate the seismic data with the well data at the reservoir level. This method was successfully applied to the San Andres reservoir in the West Welch Unit.

The methodology uses statistical correlation of reservoir properties to seismic attributes to estimate reservoir properties in the seismic volume. Structure, amplitude and phase were used to estimate the porosity at the seismic bin locations. These seismic-guided porosity values tie to the well data accurately, provide detailed variations of the reservoir in the inter-well space and reveal extensions of the reservoir beyond the well control. Ten new wells were drilled since the seismic-guided porosity map was produced. The predicted seismic-guided porosity values lie within one porosity unit of the log measured porosity at the new well locations, which is within the accuracy of the log measurement itself. The method has used seismic measurements to shape the inter-well geologic variability. A porosity-to-permeability conversion relationship was developed from the core data and applied to the seismic-guided porosity values to acquire permeability values at each seismic bin location.

Reservoir simulation runs were applied to two versions of the reservoir characterization model: 1) well data only, and 2) well data integrated with 3-D seismic data. The runs with the well data required many modifications in porosity and permeability across large areas to achieve a history match. The runs using the seismic enhanced model required no porosity or permeability changes to establish a relatively good history match.