EVALUATION OF SEISMIC ATTRIBUTES FOR PETROLEUM SYSTEM MAPPING, 3-D SEISMIC STUDY, COW CREEK FIELD, WYOMING

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ABSTRACT

The Cow Creek Field in south-central Wyoming is within the Atlantic Rim coalbed natural gas (CBNG) play, one of the significant recent unconventional discoveries in the Rocky Mountains. The field is on the shallow eastern margin of the Washakie Basin in Carbon County. The wells within the area target prospective coals in the Almond and Allen Ridge Formations of the Upper Cretaceous Mesaverde Group. The coal beds are very continuous across the field and produce gas immediately after small fracture stimulation. The production depth for the Almond coals varies between 1,000 and 2,000 feet at Cow Creek. The producing wells are on the east side of the Atlantic Rim structural hingeline that separates relatively flat layers on the east from steeply dipping beds on the west. Relatively high water production rates (up to 3,000 barrels of water per day per well) indicate that permeability is very good, probably due to fractures associated with this asymmetrical structural setting. The modern geological interpretation explains the play as a large stratigraphic trap, with the gas being held in place by down-dip flow of the meteoric water from the high Sierra Madre to the east. Geologists suggest that the Cow Creek coal reservoirs are continuously being re-saturated with thermogenic gas migrating from the deeper portions of the Washakie Basin to the west.

The goal of this three-dimensional (3-D) seismic study is to delineate structural elements that possibly control production of the Cow Creek coal reservoirs and to calibrate different seismic attributes with rock properties obtained through wire-line logging. Seismicto-well matching was established using a number of sonic logs from wells in the Cow Creek area. A unique aspect of this study is that seismic interval velocities were obtained continuously for the whole survey volume using an automated algorithm based on uncertainty analysis of reflection pre-stack data. This approach enabled the authors to directly correlate sonic-log velocities with seismic interval velocities without using synthetic seismogram calculations. A reliable time–depth transformation function was obtained based on these correlations. As a result, geological horizons were identified on seismic sections with great confidence, and seismic attributes were picked along these horizons. Based on seismic-velocity and impedance-horizon analyses, several potential gas reservoirs within the Lower Cretaceous–Mississippian-age formations were delineated. Structure maps derived from the 3-D data showed undrilled structural culminations not apparent in previously published maps. Multiple fracture trends were delineated with the reflections continuity attribute analysis. These fractures may be responsible for vertical gas migration as opposed to lateral gas migration in the Cow Creek area.

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