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Robert Kidney[1], John Arestad[2], Anne Grau[3], Robert Sterling[4] (1) EOG Resources, Inc, Denver, CO
(2) ExplorTech, Littleton, CO (3) EOG Resources Inc, Denver, (4) EOG Resources, Denver, CO

Delineation of a Diagenetic Trap Using P-Wave and Converted-Wave Seismic Data in the Miocene McLure Shale, San Joaquin Basin, California

North Shafter and Rose oil fields, located in California's San Joaquin Basin, produce hydrocarbons from a subtle stratigraphic trap within the Miocene Monterey Formation. The trap-reservoir system was created during the burial process of a thick diatomaceous shale sequence that forms various diagenetic facies. Integration of well and 2-D p-wave seismic data shows that a significant amplitude anomaly is present over both the reservoir (quartz) and seal (Opal-CT) facies, making delineation of the updip edge problematic. The porosity of the Opal-CT and reservoir quartz facies ranges from 50% to 24%.

From petrophysical analysis and seismic modeling the following conclusions can be drawn. The Opal-CT and hydrocarbon-saturated quartz have nearly the same acoustic impedance. The Opal-CT is low density while the hydrocarbon-saturated quartz is low velocity. The presence of gas-saturated oil in the quartz reduces the interval velocity in a manner similar to the Gasmann effect in high porosity sandstones. The down-dip wet quartz interval is not associated with a seismic amplitude anomaly since its impedance is similar to the bounding shales. Finally, converted-wave data, which primarily images lithology rather than fluids, can be used to delineate the low density Opal-CT from the higher density quartz.

Based on the above conclusions, 2-D converted-wave data were acquired to complement the p-wave data. From these data sets the regional Opal-CT to quartz phase transformation boundary was mapped and a matrix of amplitude signatures verses facies was constructed. This work then formed the basis for mapping the hydrocarbon saturated quartz facies.