Two Dimensional Burial History Model and Geochemical Evidence Shed Light on Petroleum Systems and Mixed Oil in the Vallecitos Area and Oil Field, San Joaquin Basin, California

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The Vallecitos Syncline is a westerly structural extension of the western San Joaquin basin. The Vallecitos field, comprised of eight separate producing areas in Cretaceous and Paleogene reservoirs, accounted for 5.4 MMB oil and 3.9 BCF gas through 2007. However, dispersed oil accumulations in the Vallecitos area make oil and gas exploration challenging. Our earlier 1D model indicated that there could be two active source rocks in the syncline: one is Eocene Kreyenhagen Formation and the other one is Cretaceous Moreno Formation. The results differ from early interpretations that the Kreyenhagen Formation was the only source rock in the Vallecitos Syncline. To better understand petroleum systems in the area, 2D burial histories through the deepest part of syncline were generated for the Vallecitos Syncline. Conventional and unconventional geochemical methods were used to infer the active source rocks in the syncline and to identify the mixed oils and deep source rocks which have been ignored in the past decade.

Conventional biomarker analysis has been conducted on the 15 oil samples from the syncline. Source-related and depositional-related biomarkers show two genetic groups, which may be sourced separately by two different source rocks. Diamondoids analysis results of those oil samples indicate mixed oils including oil window maturity and high maturity oils. A deep, high-maturity source in this area was strongly suggested based on the geochemical features of the samples.

A 2D line along a published cross-section through the deepest part of the syncline was selected to conduct thermal history, basin evolution, and migration analyses. Stratigraphic evidence and modeling suggest that several recent episodes of erosion are required due to the folding that removed significant overburden on its flanks. Thick (about 2km) overburden rock in the syncline pushed the shallow Eocene Kreyenhagen source rock into the oil window around 14 Ma. In contrast, the Cretaceous Moreno source rock reached an extremely high maturity (dry gas window) at same time.

Results suggest that in the Vallecitos Syncline the bottom and the top of the Cretaceous Moreno Formation reached thermal maturity at 37 Ma and 18 Ma, respectively. The synclinal Eocene Kreyenhagen Formation became thermally mature at 14 Ma. The 2D model results indicate that the Kreyenhagen Formation has a maximum transformation ratio (TR) of 50% at its base, whereas the Moreno Formation has TR~100% on present day cross-section. These results are supported by biomarker and diamondoid geochemistry, which indicate that the Kreyenhagen oils contain a high-maturity component that could originate from the Moreno Formation. The Moreno Formation could be a deep, previously undetected source rock contributing high-maturity components to most of the mixed oil samples in the syncline. The results are consistent with our earlier 1D burial history model results in the Vallecitos Syncline.

Migration analysis on our 2D profile indicates a hydrocarbon loss at both flanks of the cross-section. Effective traps are absent in the cross-section and most of the generated hydrocarbons probably migrated out of the model along-strike or perpendicular to it. A future 3D model could better explain the main migration pathways, if additional structural data at depth become available.