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Evidence for generation and migration of hydrocarbons along thermally anomalous faults in the Los Angeles basin, California, USA

by
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ABSTRACT

The Los Angeles basin in Southern California (USA), with over 8.4 billion barrels produced to date, is one of the most prolific oil basins in the world. The basin formed in late Miocene time and has experienced accelerated periods of subsidence that have resulted in the accumulation of more than 9000 meters of sediments. The Los Angeles basin is also of particular interest because of the presence of complex, active fault zones to which most of the oil fields are associated. The Los Angeles basin is in general normally pressured and has a complex thermal regime associated with faulting, due to fluid movement along fault zones.

Petroleum generation and migration models confront special difficulties when applied to basins with high subsidence rates and complex thermal histories. Oil exploration and production in the Los Angeles basin have provided a wealth of subsurface data, which combined with the complex thermal and structural history of the basin, provide a unique setting on which to evaluate the effects of faulting on the geothermal gradient and hydrocarbon generation and migration.

Previous studies of organic matter maturation in the Los Angeles basin have assumed that oil generation takes place mainly on the deepest part of the central syncline, or structural lows, from Miocene age rocks, laterally migrating to fill the structural highs associated with complex fault zones. These previous studies, however, assume a simple thermal history and do not account for the complex thermal regime of the basin. The fact that most of the oil fields in the basin have very thick production intervals (over 2000 meters in some fields) with multiple stacked reservoirs, the association of oil accumulation with fault zones, and the compositional differences both vertically and horizontally of the oils, cannot be fully explained by existing oil generation/migration models.

The role of faults on heat distribution and the generation and migration of hydrocarbons have been assessed from temperature, oil geochemistry and C isotope data. Temperature data suggest that the fault zones are responsible for bringing deeper, hotter fluids to shallower depths causing the observed variations in geothermal gradient and the thermal anomalies associated with faulting. Results suggest that structural highs associated with complex fault zones and high geothermal gradient in the Los Angeles basin may act as secondary petroleum generation areas for overlying structures. Time-temperature modeling suggest that the onset of oil generation in anomalously high geothermal gradient areas can occur hundreds of thousand years earlier than in the cooler structural lows. Light hydrocarbon correlation plots of oils from similar production intervals throughout the basin, and formation water chemistry suggest that the fault zones may act as preferential vertical and lateral migration pathways. Biomarker data suggest that the vertical compositional differences of oils found in the Los Angeles basin fields may be the result of mixing of different groups of oils generated not only from Miocene age source rocks, but also from Pliocene age rocks. This study provides a new framework for the exploration of potentially productive areas not previously recognized in the Los Angeles basin, as well as other structurally complex basins.

BIOGRAPHY

Hilario Camacho received a B.S. degree in Geology from the Universidad de Granada, Spain, a M.S. degree from California State University, Long Beach, and obtained a Ph.D. from UC Santa Barbara, California. He is currently the

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