Petroleum Generation Modeling for Cook Inlet Basin, Alaska

Lillis, Paul G.[*1]; Stanley, Richard G.[2]
(1) U.S. Geological Survey, Denver, CO.
(2) U.S. Geological Survey, Menlo Park, CA.

The oil fields in Cook Inlet Basin, Alaska, reside mainly in structural traps that formed during the late Tertiary and Quaternary and contain petroleum derived from Middle Jurassic Tuxedni Group source rocks. Previous studies, using one-dimensional (1-D) burial history models of the Tuxedni petroleum system in the upper Cook Inlet, have proposed Paleocene to Miocene oil generation, migration and entrapment, followed by remigration beginning in the late Miocene. In the lower Cook Inlet oils recovered from drill-stem tests migrated from Upper Triassic and Middle Jurassic source rocks during the Late Cretaceous to early Tertiary. In our study, we modeled vitrinite reflectance maturation and the timing and extent of oil generation based on hydrous-pyrolysis Type-II kerogen kinetics using 1-D burial history software. Models were constructed using mixed lithology estimates for thermal conductivity calculations, and were calibrated to drill-stem test and petrophysical log temperatures and vitrinite reflectance data from several exploratory wells.

Our results show that the Cook Inlet Basin is relatively cool with heat flow values between 23 and 40 mW/m^2 (geothermal gradient, 19 to 27°C/km). Peak oil generation (0.9% vitrinite reflectance in the Tuxedni interval) in the deepest part of the basin was reached about 15 Ma, whereas peak oil generation along the eastern and southern margins of the basin has yet to be reached. In contrast, the Upper Triassic Kamishak Formation source rock, if present in Cook Inlet Basin, would have passed through the oil window prior to the Late Cretaceous. Thus, a contribution of the previously proposed Triassic-sourced oil type in Late Cretaceous and younger reservoirs seems unlikely. The implications of our 1-D models are that in the deeper parts of the basin some of the Tuxedni oil charge may have been lost prior to trap formation, whereas the Tuxedni in much of the basin is currently at or near peak oil generation and the oil charge does not require remigration as suggested in earlier studies.