Petroleum Plays in Upper Cenozoic Strata in the Beaufort-Mackenzie Basin, Arctic Canada

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The upper Cenozoic sedimentary succession in the Beaufort-Mackenzie Basin includes two major depositional sequences: the Pliocene-Pleistocene Iperk Sequence and the latest Pleistocene-Holocene Shallow Bay Sequence. The Iperk and Shallow Bay sequences have a combined thickness of up to 4000 m in the northern Beaufort-Mackenzie Basin. Iperk strata were deposited in delta plain, shelf and deep-water settings, with Plio-Pleistocene shelf margins prograding northward by distances up to 120 km. The early phase of Iperk sedimentation included widespread lowstand deposition of base-of-slope turbidite fans. In the western part of the basin, deep-water mini-basins developed in the lower Iperk Sequence, adjacent to paleo-seafloor highs above lower Tertiary fold structures. The Shallow Bay Sequence includes fluvial and marine sediments deposited in a deeply incised paleo-valley system in the Mackenzie Trough area of the western Beaufort-Mackenzie Basin. Potential hydrocarbon reservoirs in the Upper Cenozoic succession include turbidite sandstones deposited in mini-basin and submarine fan settings, and a widespread, thin carbonate hardground unit at the base of the Iperk Sequence. Upper Cenozoic strata are thermally immature but may contain migrated hydrocarbons from lower Tertiary or Upper Cretaceous source rocks. Subsidence-maturation modeling indicates hydrocarbon generation occurred from middle to late Cenozoic time in northern parts of the basin. One of the Beaufort Sea wells drilled during the early phases of offshore exploration, Nektoralik K-59, provided direct evidence of hydrocarbon charging in a Pliocene reservoir. Natural gas and condensate were recovered from the basal Iperk carbonate unit in a drill-stem test in this well. Indirect evidence of hydrocarbon migration through upper Cenozoic strata is observed in the Kopanoar M-13 well, where a high temperature anomaly is present in the Iperk Sequence, above an overpressured zone and below a pingo-like feature on the sea floor. The development of pingo-like seafloor features in the Beaufort Sea shelf has been linked to gas venting. Geophysical indications of hydrocarbons in upper Cenozoic strata include bright spots, flat spots and gas chimneys imaged in seismic reflection profiles. Future petroleum exploration in the unexplored deep-water areas of the northern Beaufort-Mackenzie Basin may include plays and prospects in upper Cenozoic strata.