

Petroleum Systems Framework of Significant New Oil Discoveries in Arctic Alaska

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ABSTRACT

Three discoveries in Arctic Alaska announced since October 2015 each have recoverable oil potential of 300 to >3,000 million barrels (MMBO). The discoveries occur in the distal part of a giant, Lower-middle Cretaceous clinothem comprising bottomset and foreset seismic facies in the Torok Formation and topset seismic facies in the Nanushuk Formation. The most thoroughly tested discovery (Pikka), in the Nanushuk Formation at 4,100 ft depth on the Colville River delta, is estimated to hold 497 to 3,758 MMBO (30° API). Another Nanushuk discovery (Willow), at similar depth in northeastern National Petroleum Reserve in Alaska, is estimated to hold at least 300 MMBO (44° API). Seismic and nearby well data suggest that both accumulations are stratigraphically trapped in lowstand shelf-margin delta systems. The third discovery is in the Torok Formation at 5,000 ft depth in Smith Bay, about 95 mi west of the Pikka discovery. In-place resources of 6,000 to 10,000 MMBO (40-45° API), with possible recovery factors of 30-40%, are estimated by the operator based on 3-D seismic data and two exploration wells. Operator statements, plus seismic and nearby well data, indicate the accumulation is stratigraphically trapped in lowstand, basin-floor fan deposits. The three discoveries lie on or near the Barrow Arch, a regional structure that focused oil migration from the south (Colville Basin) and from the north (Canada Basin rifted margin). Fetch areas include high quality, oil-prone source rocks in Triassic, Lower Jurassic, and Lower Cretaceous strata. Source rocks range from thermally immature to mature on the arch to overmature in deep areas north and south of the arch. This favorable potential for multiple sources, local charge, and distant charge from two directions likely accounts for thick oil columns reported in two of the discoveries. Shelf-margin trajectories with deeply erosional sequence boundaries likely contributed to favorable reservoir quality at the shelf margin (wave winnowing) and toe-of-slope (sand delivery). Basinwide, diagenesis of Nanushuk and Torok sandstones mainly involved compaction of ductile components, and shallow maximum burial along the arch favored the preservation of good reservoir quality. Previously, only minor oil accumulations were discovered in this clinothem. Thus, these discoveries demonstrate the potential for a significant and virtually unexplored play fairway covering at least 8,000 sq mi, including onshore and shallow offshore areas.