

## Oil and Gas Exploration in Nenana Basin, Interior Alaska: Drilling, Stratigraphy and Basin Analysis

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### ABSTRACT

Recent exploration in Nenana basin of central Alaska has defined a deep basin with excellent source and reservoir rocks for hydrocarbons. Deep wells have numerous shows of thermogenic oil and wet gas, and indicate significant potential for hydrocarbon accumulations. Three deep wells plus one sidetrack are located in the basin deep, and two older and shallower wells are located on the basin margin. None of the wells found commercial quantities of hydrocarbons. The three deep wells (Nunivak #1, Nunivak #2 and Toghotthele #1) were drilled in 2009, 2013 and 2016 to Tvd depths of 11,136', 8625' and 11,375', respectively. The wells contain variable thickness of Nenana Gravel overlying Usibelli Group non-marine, fluvial sediments rich in coal. On the basin flanks, the oldest sediments overlying Late Paleocene basement are Miocene in age, but ~2750' of Oligocene sediment was drilled in the basin center in Tog #1. The Oligocene sediment contains abundant and attractive source and reservoir rocks similar to the overlying Miocene Healy Creek Formation. It is possible rocks of Eocene age are also present in the basin center below drilled horizons. Of the three wells, two had oil shows, sometimes abundant, and one contained abundant wet gas, but at low saturation. Both the oil and wet gas shows are migrated, thermally-generated hydrocarbons. Potential source rocks include coal and coaly shale while shale itself has very low source potential. The source rocks show variable hydrocarbon potential depending on TOC content and samples were concentrated for analysis by hand picking and density separation. Shale with 0-4% TOC is lean and gas-prone with average HI values ~155 (RockEval). Coaly shale with TOC from 4-12% is an excellent source rock with average HI values ~350. Coal with TOC from 20-70% is very good source material with average HI values ~255. Both coaly shale and coal from Nenana have higher HI values than comparable rocks from the analog Gippsland Basin, Australia, where ~5 BBO sourced from coaly rocks has been discovered. Nenana coaly shale and coal routinely generate high gravity oil in the lab during dry pyrolysis. Although the literature suggests uncertainty whether coal can efficiently expel oil, coaly shaly could have better expulsion dynamics than coal. Healy Creek Formation (Usibelli Group) sediments of Miocene and Oligocene age contain thick, porous sandstone reservoir beds and are probably amalgamated fluvial channel sands. Sand beds reach a maximum of 120' thick and are quartz-rich in composition. Healy Creek sands above ~8500' are friable and SWC's disaggregate when spun to extract formation fluids. Deeper sand from 9000 to 11,375' Tvd in the Tog 1 well range from 15-18% porosity and 20-125md permeability, considerably better than Cook Inlet sands at comparable depth. Vitrinite reflectance (Ro) in Tog #1 reaches 0.91 at 11,350' Tvd, and Ro depth trends from Tog #1 imply about 3000' of recent uplift in the central basin. Uplift increases to the south, but is minimized northward where the Nenana basin is deepest. A recent basin-wide geohistory and hydrocarbon endowment analysis concludes coal and coaly shale in the Nenana basin can generate and expel billions of barrels of oil and many Tcf of gas. While issues remain, such as efficiency of hydrocarbon expulsion from coal and identification of structurally intact traps, potential remains high for oil and gas discoveries in the Nenana basin.