Tectonic Influences on Thermal Maturation History of Arctic Alaska and the Southern Part of the Canada Basin

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Burial and thermal history modeling of Arctic Alaska (including the Chukchi and Beaufort shelves) and the southern Canada Basin indicates that regional patterns of thermal maturity and timing of petroleum generation reflect geologic processes associated with rift-opening of the Canada Basin and response of the Arctic Alaska foreland to tectonic events in the Chukotka and Brooks Range hinterlands during Jurassic-Tertiary. The base of the Cretaceous-Tertiary Brookian sequence provides a regional reference horizon because most oil generation occurred as the result of Brookian burial.

In Arctic Alaska, basal Brookian strata on the Alaska (Beaufort) rift shoulder grade from immature in the west (Chukchi) to overmature in the east (Arctic National Wildlife Refuge). From the axis of the rift shoulder, thermal maturity of basal Brookian strata increases southward into the oil window on the north flank of the Colville foreland basin and into the gas window in the foredeep. A >200 mi-wide area of immature to mature strata beneath the Chukchi shelf narrows towards the eastern North Slope, where the Brooks Range tectonic front impinged upon the rift shoulder. These patterns reflect generally low Jurassic to Tertiary sediment accommodation on the rift shoulder, larger Cretaceous-Tertiary sediment accommodation in the Colville Basin, and northward impingement of the Brooks Range onto the eastern part of the rift shoulder during the Tertiary. Hinterland tectonics and their effect on sediment flux into the foreland are reflected in the timing of maturation across Arctic Alaska. Rapid maturation during the Early Cretaceous in most of the Colville foredeep and the western part of the northern flank of the foreland basin was controlled by rapid and voluminous sediment influx from tectonic highlands in Chukotka and the ancestral Brooks Range. Slow maturation in the central part of the foreland basin during the Late Cretaceous reflects reduced sediment influx due to tectonic reorganization in the hinterland. Rapid maturation in the eastern foreland basin and the Beaufort rifted margin during the Tertiary reflects rapid burial due to sediment influx from renewed uplift and northward migration of the Brooks Range.

Limited geologic data in the Canada basin increases the uncertainty in thermal modeling. Projection of stratigraphy from the rift shoulder, reconstruction of regional sediment dispersal patterns, and consideration of source rocks in Arctic Alaska and Canada suggest the potential for four source rocks in Cretaceous and Paleogene strata. All four source rocks are modeled to be mature or overmature across much of the southern Canada basin. Highest thermal maturity occurs in depocenters immediately north of the rift shoulder and on the eastern margin of the study area, which is the distal Mackenzie delta. Lowest thermal maturity occurs at the northern limit of the model, more than 200 mi north of the rift shoulder and on the western margin of the study area, adjacent to the Chukchi borderland, which was tectonically isolated from regional sediment dispersal systems. A potential source rock in the Lower Cretaceous likely matured during the Early Cretaceous in a western depocenter related to sediment by-pass of the Chukchi shelf. Maturation of all source rocks elsewhere occurred during the Paleogene when

sediment dispersal systems from the Brooks Range and northern Cordilleron overstepped the inactive and subsiding rift shoulder to deliver large volumes of sediment to the passive margin.