Regional Geology and Petroleum Potential of the lower Paleozoic Franklinian Succession, Canadian Arctic Islands

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ABSTRACT

Lower Paleozoic rocks of the Franklinian succession are exposed or occur in the subsurface through a more than 2000 km long belt in North Greenland and the Canadian Arctic Islands. Deposition of these strata began in about latest Proterozoic time, following a period of rifting and block faulting. Later, up to 5 km of Cambrian clastics and carbonates along a differentiated shelf edge accumulated on a rapidly subsiding continental margin. The basin continued to subside at lesser rates during the Ordovician, and a 3-4 km carbonate-evaporite succession formed a high-relief, rimmed carbonate platform. During the Silurian, however, basin configuration was greatly affected by Caledonian plate-margin deformation and changing plate-interior stresses. These events likely caused carbonate platform step-back and deposition of a thick synorogenic flysch succession. Organic-rich shales were deposited over drowned carbonate platforms, and these formed widespread source rocks. Plate interior stresses also formed a linear cratonic fold and thrust belt, the Boothia Uplift which shed voluminous synorogenic clastics, and it was fringed locally by reef-rimmed carbonate platforms. Farther north, a large, polydeformed allochthonous terrane, Pearya, collided with continental North America, causing extensive deformation and local metamorphism. Continental mollase and thick, stratigraphically complex volcaniclastic successions are associated with this event. The high burial temperatures inferred from conodont alteration indices and graptolite reflectance in the far north indicates little potential for hydrocarbon pools. By Middle and Late Devonian time, plate margin deformation encompassed most of the Canadian Arctic islands, and a thick foreland basin clastic wedge was deposited. During an early phase of foreland basin infill, the downlap surface of a markedly progradational carbonate platform succession formed the source rock of the only producing oil well in the Canadian Arctic Islands, the Bent Horn well. Production tests indicated that this well had the capability of producing about 5300 bbl/day of 43^0API oil. Reservoir porosity, however, is sporadic and the amount of recoverable oil is estimated at about 35 million barrels. Oil production from this well was thus recently suspended.

Carbonate buildups, such as at Bent Horn, are know to occur in may parts of the Arctic islands. Some have been identified in seismic profiles and remain untested. Prior to exhumation, some of the buildups occurred within the oil generation window. In at least one example, a more than 20 km long and 1.2 km thick buildup features a paleo-oil-water contact, and it may have contained several billion barrels of oil prior to exposure. In addition, large structural culminations have been identified in several 2D seismic lines in the central Arctic Islands and are attractive hydrocarbon prospects. However, the lack of infrastructure and the hazardous Arctic Ocean conditions has resulted in no exploration in this area for almost two decades. The vast unexplored areas of the Franklinian succession and younger Sverdrup Basin will almost certainly be an important oil and gas exploration frontier as we deplete more accessible sedimentary basins farther south.