Liard Basin, Northeast British Columbia: An Exploration Frontier

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ABSTRACT

The focus of this study is on the character, origin and petroleum potential of the Liard Basin region and is jointly sponsored by the Geological Survey of Canada and the New Ventures Branch, Ministry of Energy and Mines of the Government of British Columbia. Liard Basin in northeast British Columbia is beginning to receive closer industry attention and several gas discoveries (e.g. the West Patry b-097-A/94-O-5 well) have recently been made here. However, little baseline geological information for Liard Basin and the surrounding area is publicly available and basic questions concerning the character of this basin and its internal stratigraphic and structural architecture remain unanswered.

Well and seismic data reveal that Liard Basin was a late Paleozoic (Carboniferous Mattson/Stoddart) as well as a Cretaceous depocenter. Bovie Fault, marking the east side of the basin (*Fig. 1*) appears to have had several stages of movement, but with a major pre-Triassic, or possibly even Carboniferous-aged component of westward-verging contractile motion. No strike-slip motion along Bovie Fault is apparent. In contrast to the high angle reverse Bovie Fault, the subsurface Mattson Formation (~2500 m depth) displays numerous late Paleozoic-aged normal fault-bounded grabens on seismic profiles. These subsurface faults may extend downwards into Paleozoic carbonates and provide targets for deep hydrothermal dolomite reservoirs. Bovie contractile faulting may have slightly predated the syn-depositional Mattson extensional normal faulting.

The dominant structural feature of the Liard Plateau-Trout Plain region is the north-trending Bovie Structure. This feature separates a thicker Paleozoic-Mesozoic succession in the Liard Basin to the west from a thinner succession in the Interior Plain (*Fig. 2*). Some Paleozoic units, such as the gas-bearing deltaic sands of the Mattson, are almost entirely contained within Liard Basin.

Structure maps at the top of the Middle Devonian carbonates (Nahanni-Keg River), may approximate the pre-Mattson configuration of Liard Basin, although well control at this deep level is sparse. However, aeromagnetic and seismic data indicate that the deeper Bovie Fault continues northward in the subsurface to about 61° north latitude and southward to about 59° north latitude. Several gas pools (J-72 and C-76) occur in dolomitized Nahanni-Slave Point strata along the northern end of the Bovie Structure mapped on surface (*Fig. 1*). Very few wells have penetrated the Nahanni-Slave Point sequence anywhere near the Bovie Structure south of these gas pools towards British Columbia. The

presence of the large Maxhamish Cretaceous gas field close to the southward continuation of the Bovie Structure (*Fig. 1*) indicates that gas pools may also occur in dolomitized Nahanni-Slave Point in British Columbia.

Rapid subsidence west of Bovie Structure formed a westward-thickening sedimentary prism in early Paleozoic time. By late Paleozoic (post-Keg River) time Liard basin had developed a steep northwest flank extending from the Northwest Territories into British Columbia. This coincides with an exploration fairway of enhanced Manetoe dolomitization in the Nahanni and Dunedin formations. Major hydrothermal dolomite gas field reservoirs (North Liard, Pointed Mountain, Kotaneelee, Beaver River and Crow) are strung out along this fairway of totally dolomitized Nahanni-Landry and Dunedin (*Fig. 1*). These gas fields occur primarily as structural traps along the crests of faulted folds. Farther south along this dolomite fairway in British Columbia are several recent significant gas shows along the west side of Liard Basin. Areas adjacent to the dolomite fairway may also be prospective for Nahanni reservoirs in partially dolomitized, combined stratigraphic/structural plays.

Erosional truncation of the Mattson sands, which filled Liard Basin beneath Permian and Cretaceous strata, may have formed stratigraphic plays in northeast British Columbia. This erosion occurred during development of the westward-verging, high angle reverse fault component of the Bovie Structure, which extends upwards from the Proterozoic through to the Mississipian causing development of a narrow west-dipping monocline in overlying Mesozoic strata. Laramide compression in Early Tertiary time generated a thin-skinned, eastward-verging thrust, the Bovie Thrust Fault, within the Banff Formation. This low-taper intercutaneous thrust wedge was deflected upward at this subsurface monocline and intersected the deeper reverse fault. This thin-skinned thrust merges westward with the Liard Thrust immediately west of Liard River. Upright subsurface folds related to the development of the Bovie Thrust Fault form a structural trap for the gas field at the F-36 well near Fort Liard. Large dune and/or barrier bar sandstones imaged in seismic may be another potential Mattson play type.

Permian and Triassic strata are less prospective, however, Triassic strata in the southern part of Liard Basin may include some porous, hydrocarbon-bearing strata. Farther south, the Triassic Baldonnel Formation, contains numerous gas fields in northeast British Columbia north of Peace River Arch.

Numerous northeast-trending fault zones cross the study region in and around Liard Basin. Gas shows at the Nahanni-Keg River to Slave Point level tend to occur along some of these, such as the Trout Lake gas pool in the Northwest Territories along the Trout Lake Fault Zone (*Fig. 1*). Numerous gas shows also occur in the Carboniferous Debolt Formation along the southern part of the Bovie Structure south of its intersection with the Trout lake Fault Zone. Hydrothermal dolomite gas reservoirs, such as at Sikanni Field in northeast British Columbia,

are analogs for potential Debolt gas pools in Liard Basin. Other Devonian platform carbonates, such as the Tetcho Formation, may also be prospective for hydrothermal dolomite gas reservoirs in this basin.

Liard Basin is a frontier basin whose potential is only just beginning to be appreciated. Large parts of this basin, particularly at the deeper stratigraphic levels, remain totally undrilled.

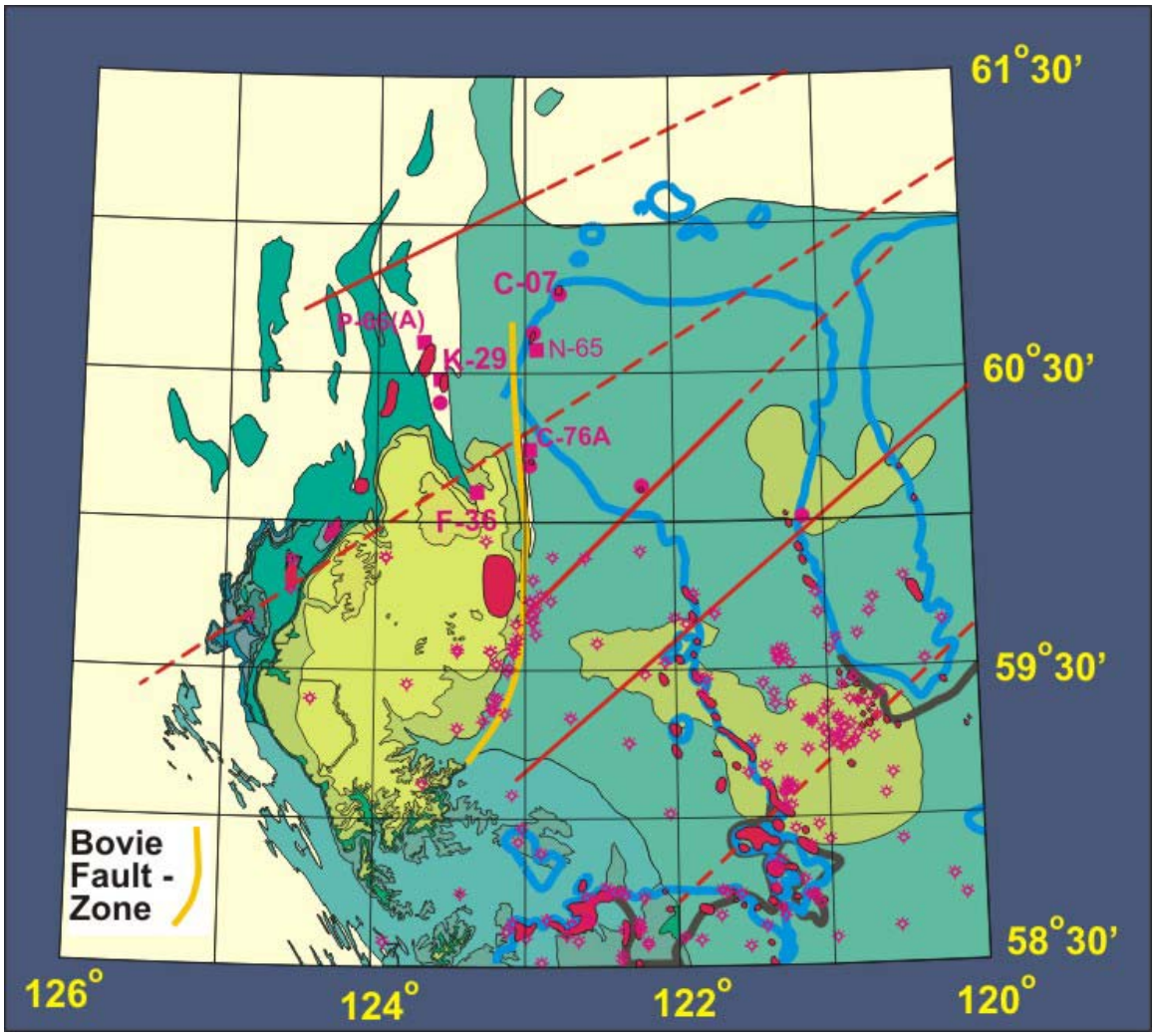

Fig. 1. Map of northeast British Columbia showing Liard Basin west of the Bovie Fault Zone. Cretaceous cover is shown in shades of green. Gas shows, pools and fields are illustrated in red. Also, the northwest limit of the Slave Point (Presqu'ile Barrier) is shown.

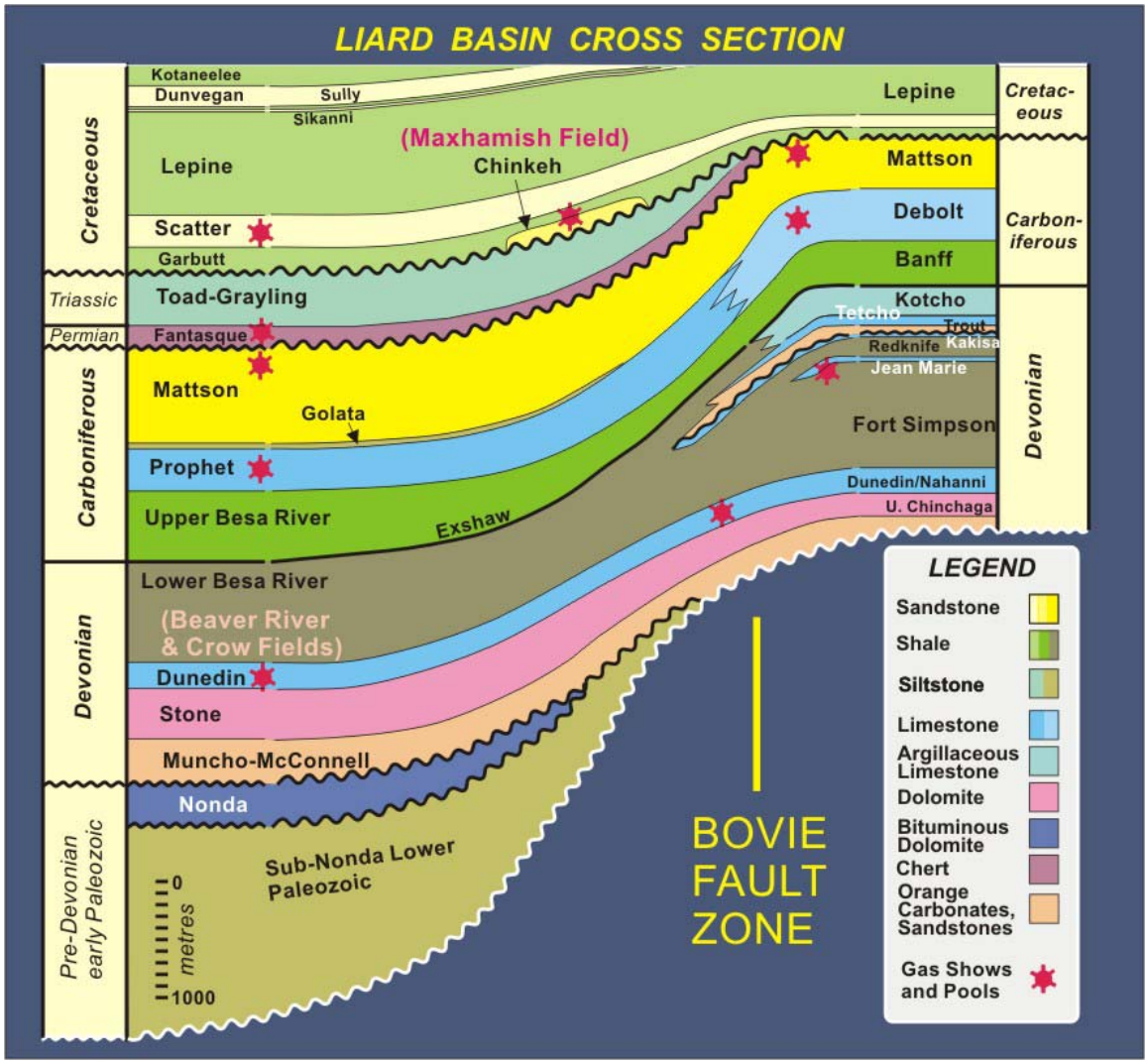

Fig. 2. East-west stratigraphic cross section across the east flank of Liard Basin. Major gas accumulations are shown.