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Metallic Mineral Potential of the Western Interior Platform of the Northwest Territories

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Introduction

The Interior Platform consists of a relatively undisturbed sequence of sedimentary rocks that thickens westerly to over 6,000 metres. It is underlain and bordered on the east and north by the Canadian Shield. To the west, it is bounded by or covered by thrust faulted sediments of the Cordilleran Orogen. Physiographically, the Interior Platform of the Northwest Territories corresponds to the Northern Interior Plains, including the Great Slave, Great Bear, Anderson, Horton and Peel Plains as well as several smaller features such as the Colville Hills (Figure 1). The Great Slave Plain is developed across the northernmost Western Canada Basin. The northern four-fifths of the Northern Interior Platform is underlain by the Mackenzie Basin, a Paleozoic-Cenozoic sedimentary basin, which should not be confused with the drainage basin of the Mackenzie River.

All of the metallic mineral production from the Interior Platform (62 million tonnes from 48 deposits) has come from Mississippi Valley-type (MVT) deposits in the Pine Point Zinc-Lead District. All of the indicated inventory (greater than 27 million tonnes in 52 deposits) and most of the potential of the Western Interior Platform are also located in the district. Much of the remaining potential lies in adjacent areas of similar geology, around the west end of Great Slave Lake.

The adjacent and underlying Precambrian rocks include three geologic provinces, the Bear, Slave and Churchill, as well as undeformed Proterozoic sediments and volcanics. Nearby deposits and prospects include copper-silver deposits of the Coppermine Homocline, unconformity and fault-related uranium deposits of the Hornby Basin, uranium-silver veins of the Great Bear Batholith, the Sue-Dianne Cu-Ag-U breccia pipe, the Bigspruce carbonatite, and Lupin-style amphibolite gold deposits at Russell and Slemon Lakes. Potential for other types of base and precious metal deposits also exists.

To the west, important MVT deposits are found in platformal carbonates that are now part of the Cordilleran Orogen at Gayna River and Godlin Lakes. The metallic mineral potential of miogeosynclinal rocks of northeastern British Columbia also extends into this area in the form of sedex deposits of Howards Pass and MacMillan Pass, the Redstone River copper deposits, the Snake River iron deposits, the Cantung, Mactung and Lened tungsten skarns and diatreme breccia pipes (also see Nelson and MacIntyre, 1988, this issue p. 113-116).

Geology of the Pine Point District

Our knowledge of the geology of the Pine Point District comes from the definitive and classical papers of Campbell (1957, 1967), Skall (1975) and Rhodes *et al.* (1984), all of whom were or are Cominco [Ltd.] geologists whose experience and insight led to the discovery of many of the Pine Point deposits.

Mississippi Valley-type deposits have been characterized by Anderson and Macqueen (1982). Characteristic features include certain structural elements, karst development, dolomitization, lithology-stratigraphy, and a possible genetic association with evaporites and hydrocarbons. However, as Skall pointed out, facies development, tectonic movements, dolomitization and mineralization become mutually dependent events. They all come together at Pine Point, but normally one or more are absent from platformal rocks of the Interior Plains.

Faulting in MVT districts may be subtle, but is very important. This is especially true at Pine Point where it was recognized in 1936 that deposits known at that time fell along the projection of major faults exposed in the East Arm of Great Slave Lake. This led to a major exploration program that established the mineral potential of the district. It also has been suggested that projection of this fault system into northern British Columbia led to the discovery of lead-zinc deposits there. Federal government aeromagnetic maps have since confirmed that one or more faults related to this system pass through the Pine

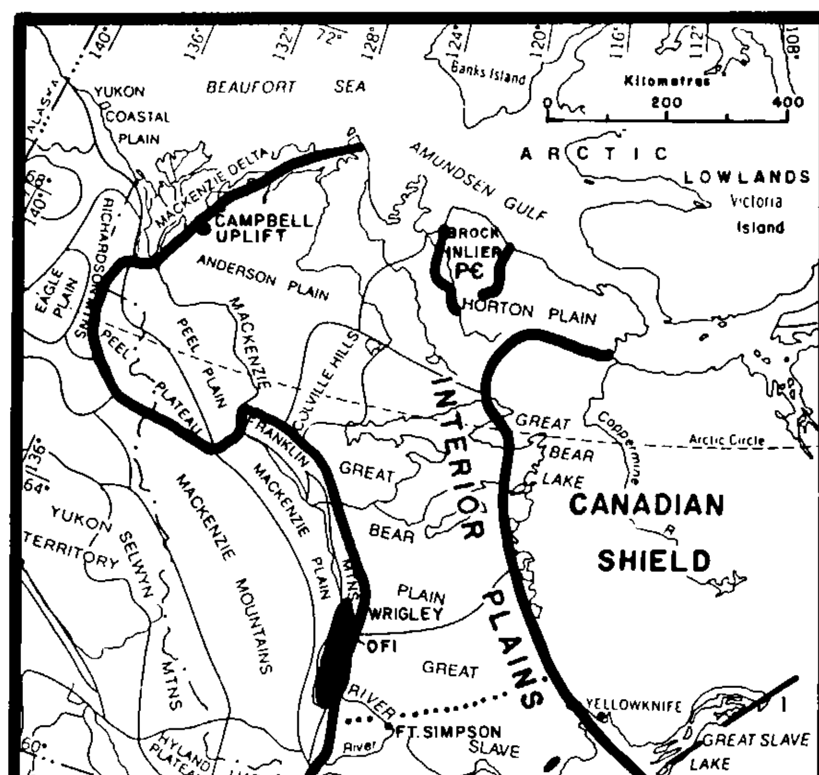

Figure 1 *Interior Plains, Northwest Territories.* **1,** *McDonald Fault system;* **2,** *Pine Point mining area;* **3,** *Tathlina structure;* **4,** *Rabbit Lake structure;* **P.Pt,** *Pine Point;* **OFI,** *Old Fort Island. Stipple marks area of known zinc potential. Dotted line in the vicinity of Fort Simpson marks natural boundary between Mackenzie Basin (north) and Western Canada Basin (south).*

Point area. However, aeromagnetic coverage is incomplete and correlation of basement faults with magnetic contours in this area is not straightforward.

ENE-trending normal faults of Middle Devonian age that initiated uplift and controlled reef building, karsting, dolomitization and mineralization are of much greater importance. Three of these faults parallel the reef complex and correspond to the North, Main and South Hinge zones of Skall (1975). Similar trends in magnetic contours, structural contours, isopach maps, facies changes and linear belts of coarse-grained secondary dolomite in other areas such as Tathlina Lake and Rabbit Lake are all believed to be part of a larger system of horsts and grabens that occupies the west end of the Great Slave Lake. Radar and Landsat lineaments intersect at some prismatic deposits, where they can be seen in pit walls at Pine Point as intersecting collapse zones.

At Pine Point, karst refers to surface and subsurface solution features and formation of caves and pore space. Several cycles of uplift and karstification have produced spectacular examples of both vertical (prismatic) and horizontal (tabular) solution-collapse structures or channels that serve as both conduits for solutions and the deposition sites for lead-zinc minerals. Karst is mainly developed in the porous barrier reef complex, particularly along the North and Main Hinge zones.

As in other MVT districts, dolomite is abundant and important. Three main stages of dolomitization are recognized. The first is a fine-grained, sucrosic dolomite that has been interpreted to be of reflux and primary origin. The second is a coarse-grained dolomite that normally has totally destroyed the original fabric and is known as Presqu'ile dolomite. A third type of dolomite, known as saddle dolomite, is precipitated in voids or as a replacement during the main mineralization (Krebs and Macqueen, 1984).

The porous, permeable, and soluble barrier reef complex is an ideal lithologic-stratigraphic unit for transport and deposition of zinc and lead. At Pine Point, it roughly corresponds to a large pipe-network, clogged with metal sulphides. Evaporites found in or near many MVT districts are commonly considered to be the source of sulphur, the precursor to extensive solution breccias or karsting, or the source of sabkha or reflux dolomite. Hydrocarbons, a common feature of MVT districts, are believed by some researchers to be related to metal transport. However, Macqueen and Powell (1983) have shown that there is no evidence for long-distance migration of oil or bitumen at Pine Point. They also point out that the presence of pyrobitumen confirms fluid inclusion data that indicates thermal anomalies related to dolomitization and sulphide mineralization.

Empirical exploration methods and philosophy used in the Pine Point District have been drastically revised and the district enlarged by discoveries of large, high-grade deposits. Discovery in October, 1966 of a large, high-grade deposit by Pyramid Mining Co. touched off the largest staking rush in northern Canada to that time, with more than 80 companies involved. Pyramid established induced potential (IP) as an effective exploration technique in the area and proved the potential of non-Presqu'ilized sections of the reef. Discovery in 1976 of the X-25 deposit by Western Mines Ltd. in an area west of Pine Point Mines' claims, where the main hinge zone/reef complex plunges below shales of the Hay River Formation, extended the Pine Point district well to the west. A large part of the west end of Great Slave Lake was staked (Figure 2), and more than $40 million was spent on exploration between 1976 and 1987.

West End of Great Slave Lake

The Pine Point barrier complex extends at depth west of Great Slave Lake and time equivalent patch reefs are present to the north. This area is broken into a series of horsts and grabens by a series of late Middle Devonian faults that parallel or subparallel to the Macdonald Fault and Great Slave Lake Shear Zone. These faults, reefs associated with abundant Presqu'ile dolomite alteration, carbonate-shale facies boundaries and solution collapse structures were extensively explored for MVT deposits between 1977 and 1983.

Between 1978 and 1980, Gulf Minerals Ltd. explored a Presqu'ilized section of the Tathlina Fault, a shale-carbonate facies front, and a pinnacle reef in an area where an abandoned oil test had intersected minor zinc and lead mineralization. An electromagnetic (EM) survey helped define the facies front. Drilling intersected Presqu'ile dolomite, minor galena and sphalerite and geochemically anomalous carbonate.

Cominco Ltd.'s Hay West project drilled 42 holes (19,422 m) from 1979 to 1981, and was able to define the approximate limits of the Muskeg Formation evaporite facies, distinctive back reef and main reef trends of the barrier, and the approximate position of the Pine Point Formation and Sulphur Point Formation facies change to shale, as well as test collapse structures identified in seismic surveys. Western Mines Ltd.'s West Reef and Great Slave reef projects drill tested the barrier complex between Hay River and Pine Point from 1976 to 1980.

On the northern shore of Great Slave Lake, between Windy Point and Slave Point, known zinc showings in Presqu'ile dolomite were staked, explored and drilled in 1955 and 1965. In 1975-1980, Cominco Ltd. conducted IP surveys and drilling (3,000 m). Sparse and irregular patches of coarse-grained galena and traces of sphalerite were found in Presqu'ilized, brecciated and karsted carbonates of the Slave Point Formation. Near Moraine Point, 30 km to the north, Cominco Ltd. identified a zinc lake-sediment anomaly in 1976, and 1980 drilling intersected trace to minor amounts of galena and sphalerite in karsted dolomite.

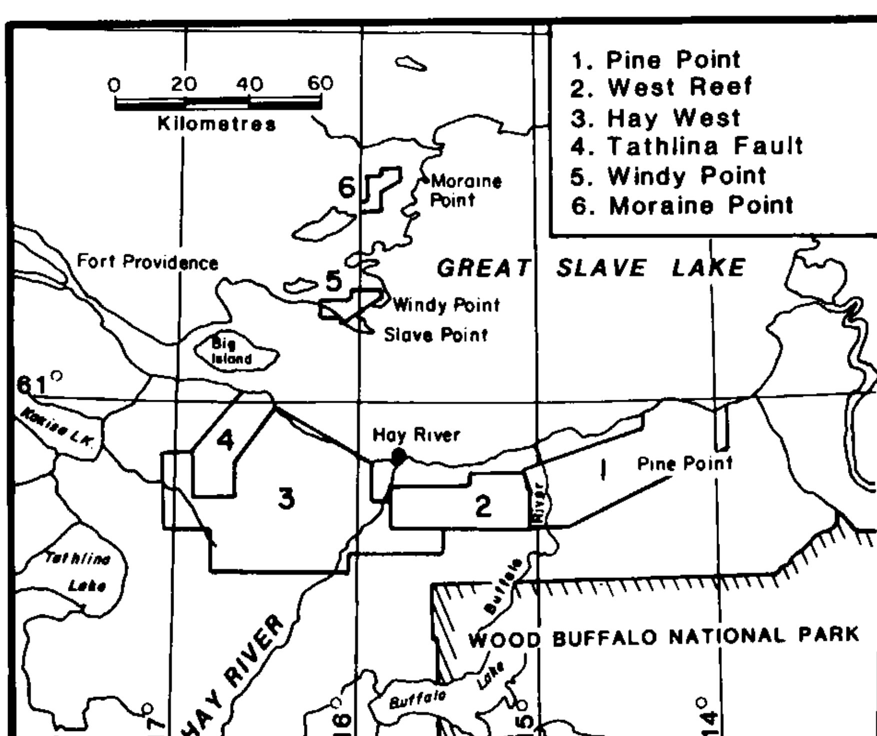

Figure 2 *Mississippi Valley-type lead-zinc deposit exploration projects in the Great Slave Lake area. Positions of most of the individual deposits of the Pine Point property are shown in Rhodes* et al. *(1984, fig. 18).*

Upper Mackenzie River

Lead-zinc showings on Old Fort Island in the Mackenzie River have been known for many years. Many showings of sphalerite, galena and minor smithsonite, cerussite and fluorite, are found in karsted, brecciated and silicified veins and lenses in the cores of anticlines in the Camsell overthrust. This folded thrust forms the Camsell Range of the southern Franklin Mountains along the western margin of the Interior Plains between Wrigley and Fort Simpson. Most of this area was tested with drilling, IP and geochemical surveys between 1970 and 1974, apparently without success. In 1988, some of these prospects were shown to have germanium and gallium potential.

Northern Mackenzie Basin

Small lead and zinc deposits became known in carbonate rocks of the Campbell Uplift, between Inuvik and Campbell Lake, as early as 1900, and there are stories of Russian whalers using galena from this area for ship ballast. In 1967, a sample of galena collected from a beaver dam near the outlet of Todd Lake assayed 54.8% lead and 82.3 g/t silver.

The Horton Plain, Anderson Plain and the Colville Hills areas all contain oil and gas seeps, a thick Lower Paleozoic platformal sequence with important evaporites, solution collapse breccias, numerous sinkholes and unconformities that may be favourable for mineral exploration. Though poor accessibility and sparse outcrop preclude cost-efficient exploration for MVT lead-zinc deposits, an expected increase in oil and gas exploration in this area could lead to lead-zinc discoveries.

Discussion

Pine Point Mines Ltd. has been one of the most successful mining operations in the history of North America. Between 1966 and 1986, 334 million dollars of dividends had been paid on reported after-tax earnings of $329 million. Production from 48 deposits has provided employment for thousands of people and contributed substantially to the local, regional and national economies.

On 15 January 1987, Pine Point Mines Ltd. announced plans to shut down mining operations at Pine Point. Exploration and mining ceased at the end of June, 1987, milling continued until April 6, 1988, and final concentrates are to be shipped by the end of 1990. According to the company president, "the operation is going out in fine style as a healthy producer". Others feel that the company is "high-grading" the operation.

There is no shortage of zinc or lead at Pine Point as proven resources and exploration potential. More than 15 million tonnes grading over 7% zinc plus lead (about five years of normal production) was deleted from the 1985 and 1986 ore reserves (Pine Point Mines Ltd. Annual Reports for 1985, 1986). Decreased zinc demand, increased production from other deposits and imminent production from very large high-grade deposits in Alaska and Australia have made the used equipment at Pine Point more valuable than five years of zinc production. One can only conclude that the exploration or geological potential of the Northern Interior Platform, particularly the Pine Point District, is good, but the economic potential is poor at present. It will be even poorer when the rail line between Pine Point and Hay River is removed after 1990.

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