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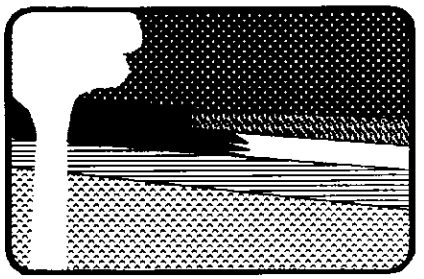

Metallogeny of Northeastern British Columbia

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Introduction

The metallic mineral potential of northeastern British Columbia includes the following deposit categories (Table 1 and Figure 1): (1) Sedimentary exhalative (sedex) Pb-Zn-Ag-Ba; (2) Carbonatites and kimberlites (Nb, Ta, rare earth elements, diamonds); (3) Mantos in platformal carbonates (Ag-Pb-Zn; Au); (4) Mississippi Valley-type Pb-Zn (-Ga-Ge-S) deposits in Middle Devonian (and possibly Silurian) platformal carbonates.

The first three types of deposits, sedex, carbonatites/kimberlites, and mantos, are related to long-lived crustal-scale rift systems that were periodically reactivated during Paleozoic extension and later Cretaceous to Eocene wrench faulting. All known deposits are confined to the deformed belt. In contrast, the carbonate-hosted stratabound sulphides are host-specific and appear to follow the Middle Devonian reef front; their apparent clustering east of the Tintina Fault in Figure 1 is a consequence of the surface exposure of Middle Devonian carbonates within the Rocky Mountains of northwestern British Columbia.

Deformed Belt Deposits

The northwestern margin of ancestral North America had an unusually long history compared with other passive margins such as the present eastern border of North America. The northwestern margin also was affected by episodic rift activity (Thompson *et al.*, 1987). Although initial rifting occurred in late Precambrian (Hadrynian) time, subsequent extensional events have been documented within the deformed belt throughout the Paleozoic. Evidence for these events includes: alkalic volcanism, emplacement of carbonatites and ultramafic diatremes, fault-controlled clastic wedges, and contemporaneous exhalative activity (Figure 2).

Table 1 **Deposit types and potential, including most significant past discoveries.**

Type	Commodities	Best Known Example	Tonnage	Grade
Sedex	Pb, Zn, Ag, Ba	Cirque	40 million tonnes	2.2% Pb, 7.8% Zn 47 g/t Ag
Mississippi Valley type	Pb, Zn; Ga, Ge?, S	Robb Lake	5.5. million tonnes	7.3% Pb-Zn
Carbonatite Kimberlite	Nb, Ta, REE	Aley	significant	1-1.5% Nb_2O_5
Manto	Ag, Pb, Zn	Midway	1.2 million tonnes	410 g/t Ag, 7% Pb, 9.6% Zn

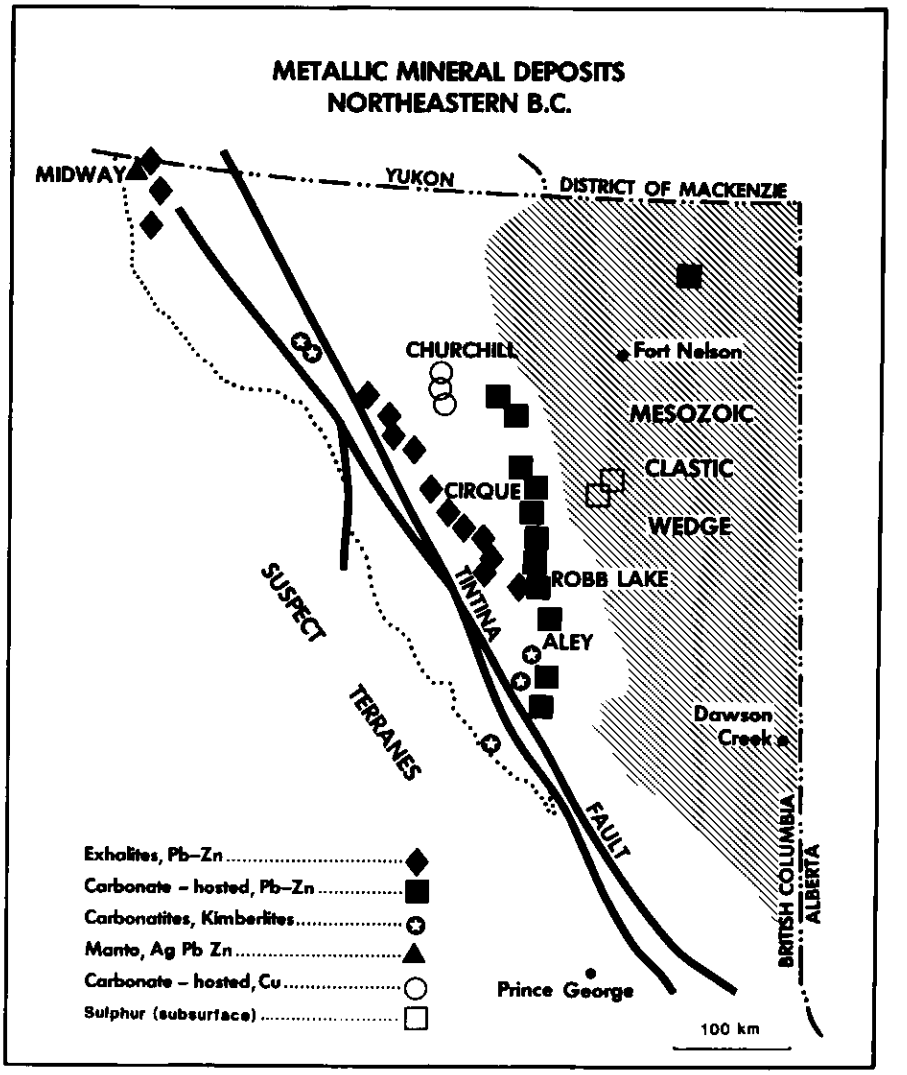

Figure 1 *Metallic and related mineral deposits in autochthonous rocks, northeastern British Columbia.*

Structural foci seem to control succeeding episodes; for instance, Late Devonian exhalite deposits of the Kechika Trough (*e.g.*, Cirque) overlie sections that include linear belts of rift-related Ordovician volcanics and sills. Although Ordovician and Silurian extensional events were important and did produce exhalative mineral deposits in the deformed belt (MacIntyre, 1983), by far the most significant episode to occur in northeastern British Columbia, both tectonically and from an economic standpoint, took place in Late Devonian to Early Mississippian time. A series of recent papers has documented its effects, many of which are shown on Figure 3. Earn Group (Devonian-Mississippian) clastic influxes were derived from block uplifts created by Devonian-Mississippian tectonic events, which exposed Hadrynian and Lower Paleozoic strata (Gordey *et al.*, 1987; McClay *et al.*, 1987), suggesting a rising landmass west of the Kechika Trough.

Sedex Deposits. The most significant sedimentary exhalative deposit found to date, the 40 million tonne Cirque deposit, and Cominco's new Nb-Ta (REE) discovery, the Aley carbonatite, lie virtually along the strike of the axis of the rift-related Kechika Trough. Such relationships point to the necessity of discovering and utilizing the paleogeographic and structural framework of Late Paleozoic extension to outline favourable targets for exploration. This is shown in Figure 3, with 450 km of dextral motion restored on the northern Tintina Fault (Tempelman Kluit, 1977). Deposition of coarse Earn Group clastics was restricted to trough areas and to the northern part of the Cassiar Platform. Sedex deposits are scattered throughout Earn Group exposures of the deformed belt, although the deeper basinal successions of the Kechika Trough have so far proved to be the most productive. This may be due to higher heat flow and more intense rift activity along the trough axis, and to more efficient pooling of brines. The largest sedex deposits of the Kechika Trough — the Cirque and the Driftpile — lie within earliest Late Devonian Earn Group strata (MacIntyre, 1983). In Mississippian time, further to the west and not shown on Figure 3, new oceanic crust was being generated, now preserved in the Slide Mountain Terrane and the Sylvester allochthon (Struik, 1987; Nelson *et al.*, 1988).

Carbonatite and Kimberlite-hosted Deposits. Carbonatite and kimberlite emplacement peaked in Late Devonian – Early Mississippian time, and is further evidence for incipient rifting in what is now the deformed belt. The restored configuration of Figure 3 shows a strong clustering of carbonatites and kimberlites south of the Kechika Trough. This area may be a structural nexus formed by the intersection of the ancient MacDonald Fault with continental margin structures (Pride *et al.*, 1986).

Mantos in Platformal Carbonates. Cretaceous to Eocene-aged manto deposits are associated with small intrusions and wrench fault systems (Abbott, 1983). The young faults are in part reactivated Paleozoic fractures, as is shown by the coincidence of the Late Cretaceous Midway Ag-Pb-Zn manto deposit with a zone of coarse Earn Group clastics, a linear belt of Late Devonian to Early Mississippian sedex occurrences, and Late Devonian faulting (Bradford and Godwin, 1988). Thus, exploration programs aimed at manto targets also have the potential for finding sedex deposits or carbonatites as well.

Deformed Belt/Interior Platformal Deposits

Mississippi Valley-type Deposits. These may be expected along the Middle Devonian reef fronts from Robb Lake to Pine Point, NWT, including the Interior Platform. Two deposits encountered in the subsurface of northeastern BC bear out this trend: the Texaco TSEA petroleum exploration well (6-48-K, 94P/5), northeast of Fort Nelson, which intersected 14 m of galena and sphalerite; and three petroleum exploration wells near Trutch, 100 km south of Fort Nelson (Figure 1), in which significant amounts of elemental sulphur were encountered near or at the facies boundary between the Middle Devonian Sulphur Point reef and the Muskeg evaporite basin (K. McAdam, *pers. comm.*, 1986).

Lead isotopic data from the Robb Lake type deposits (Morrow and Cumming, 1982) suggest a progressive mixing between fluids in equilibrium with a lead isotopic composition on the shale curve of Godwin and Sinclair (1982) and highly radiogenic lead in sandstone aquifers of the Muncho McConnell Formation. The least radiogenic end of the "Robb Lake Trend" on Figure 4 intersects

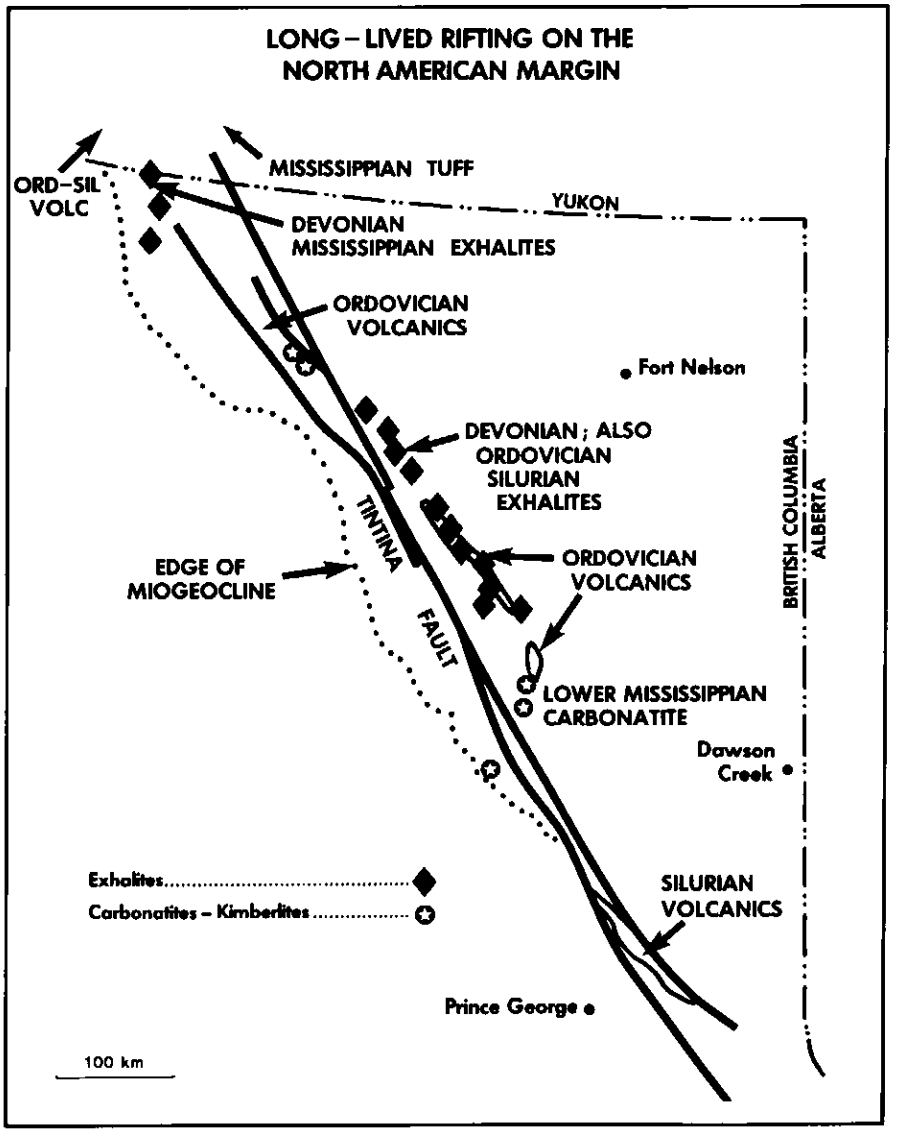

Figure 2 *Evidence for long-lived, episodic Paleozoic rift activity on the North American continental margin.*

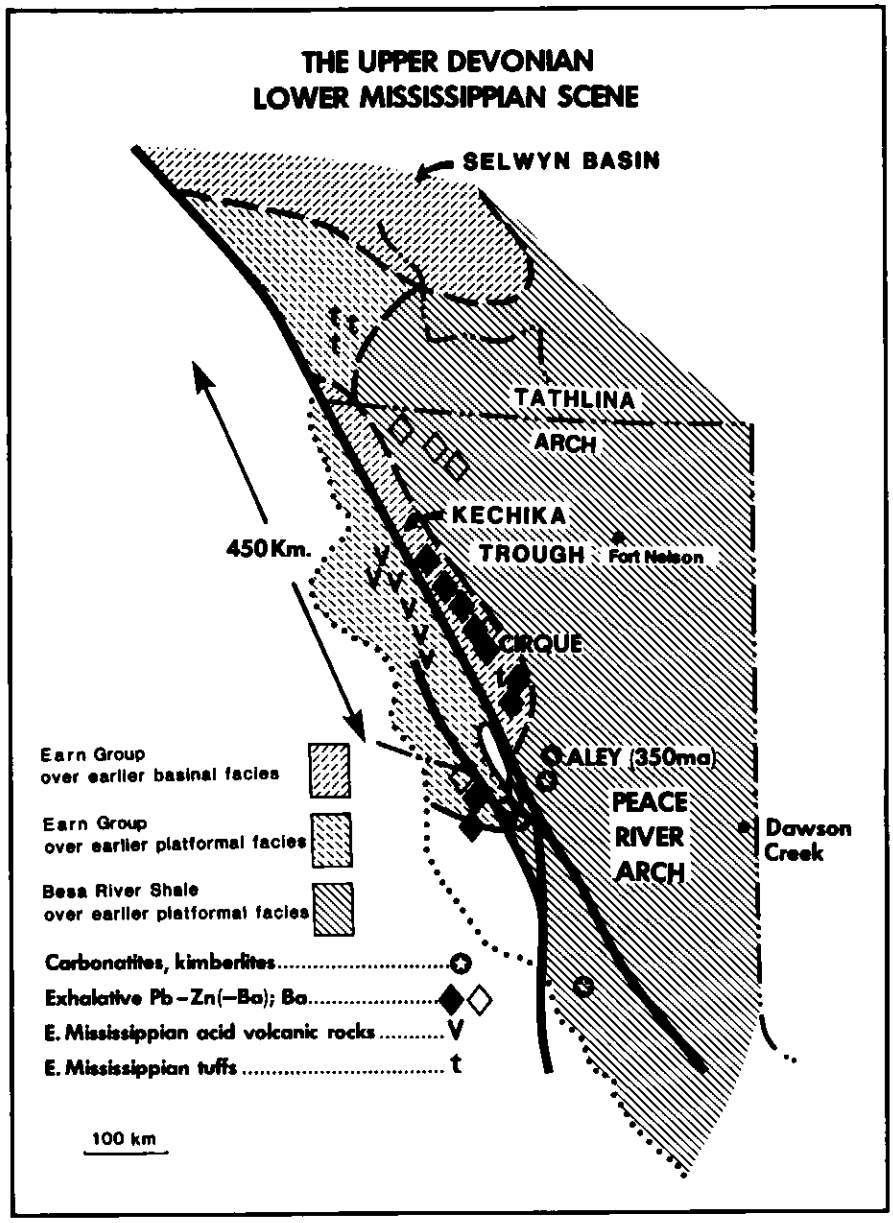

Figure 3 *The continental margin in Late Devonian – Early Mississippian time.*

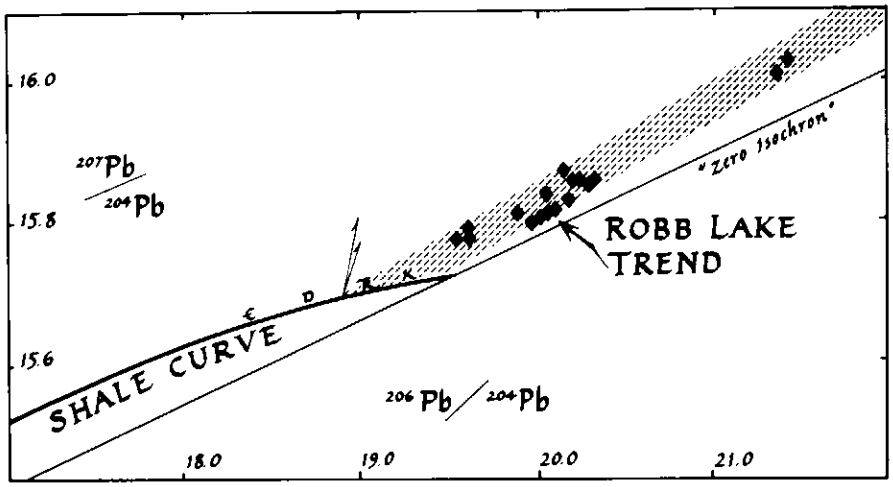

Figure 4 *Lead isotopic data from carbonate-hosted lead-zinc deposits in northeastern British Columbia.*

the shale curve in its Mesozoic age range. Thus, fluids arising from Kechika Trough shales in Mesozoic time seem to have become progressively evolved toward "future" lead signatures during their passage through the platformal sandstones further east, which underlie the carbonate hosts of the lead-zinc orebodies. This pattern could be produced by eastward, gravity-driven flow caused by Laramide uplift, as proposed by Garven (1985). Although significant carbonate-hosted Pb-Zn mineralization is undoubtedly present in the subsurface of northeastern British Columbia, exploration for it has been and will continue to be daunted by the extreme thickness of the Laramide clastic wedge. At present, the possibility is being investigated of pumping sulphur to surface in liquid form, from the wells near Trutch (Figure 1).

Conclusions

Major metallic deposit types and thus major metallic mineral potential of northeastern British Columbia is confined to the deformed belt. Knowledge of the tectonic framework, particularly the effects of Devonian-Mississippian tectonism, is fundamental to mineral exploration programs. In the Interior Platform, Mississippi Valley-type lead-zinc deposits may occur in proximity to carbonate-shale facies changes of several levels in the subsurface Devonian succession, or along major basement faults. Depth to such deposits is a major drawback to both location and exploitation of deposits.

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