Geology and Geochemistry of Carbonate-hosted Nonsulphide Zn-Pb Mineralization in Southern and Central BC

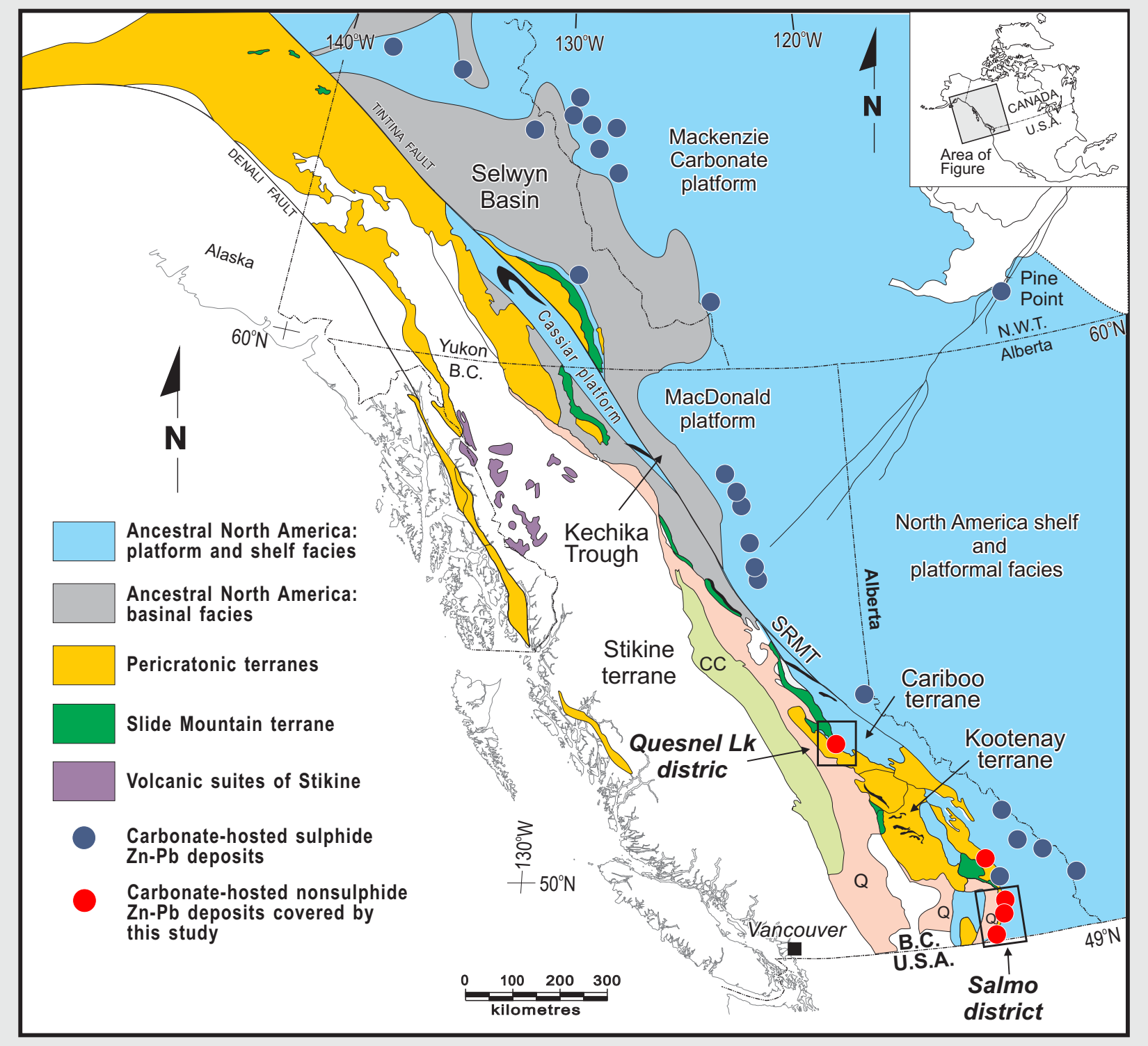
Suzanne Paradis[1,4], George J. Simandl[2,4], Halley Keevil[3], Mati Raudsepp[3]

1. Geological Survey of Canada, Sidney, BC
2. British Columbia Ministry of Forests, Mines and Lands, Victoria, BC
3. Earth and Ocean Sciences, University of British Columbia, Vancouver, BC
4. University of Victoria, School of Earth and Ocean Sciences, Victoria, BC

Abstract

Carbonate-hosted, nonsulphide base metal deposits are derived from sulphide mineralization (i.e., MVT, SEDEX, Irish-type, vein-type deposits and skarns) by supergene processes. Several carbonate-hosted sulphide deposits in the Kootenay terrane (Salmo district), adjacent Cariboo terrane (Quesnel Lake district), and elsewhere in BC have near-surface Zn- and Pb-bearing iron oxide-rich gossans. Such gossans form when carbonate-hosted, base-metal sulphide mineralization is subject to intense weathering and metals are liberated by the oxidation of sulphide minerals. The metals can be trapped locally, forming direct replacement, nonsulphide ore deposits ("red ores") or they can be transported by percolating waters down and away from the sulphide protore, forming wallrock replacement nonsulphide deposits ("white ores"). Wallrock replacement deposits can be located in proximity to protore or up to several hundreds of metres away.

The direct replacement nonsulphide deposits consist predominantly of Fe-oxyhydroxides, goethite, hematite, hemimorphite, and minor smithsonite, hydrozincite and cerussite. In the Salmo district, direct replacement deposits contain 0.8-23% Zn, 0.7-5% Pb, and >20% Fe. They form oxidation zones over carbonate-hosted zinc-lead sulphides in which they replace (pseudomorph) the sulphide aggregates. They mainly occur as large irregular replacement masses, encrustations, or open-space fillings. Direct replacement deposits of the Quesnel Lake district consist of pervasive fine-grained sulphide and nonsulphide disseminations and aggregates forming pods and masses, sulphide- and nonsulphide-bearing quartz (±calcite) veins, and crackle breccias. Sulphides are galena, sphalerite, and trace amounts of pyrite. Nonsulphides are smithsonite, hemimorphite, cerussite, hydrozincite, and possibly anglesite. Grab samples assayed 17.3-51.0% Zn, 0.1-1.5% Pb, and 0.4-0.8% Fe. In most occurrences, the spatial continuity and/or the close spatial relationships in combination with morphological similarities between sulphide and associated nonsulphide zones suggest direct replacement of sulphides by nonsulphide base metal-bearing minerals. The wallrock replacement deposits were observed only in the Salmo district. They consist mainly of hemimorphite, smithsonite and hydrozincite, and minor Fe-oxyhydroxides and carbonates. They contain 31.5-49.8% Zn, 0.13-0.19% Pb and <3% Fe.

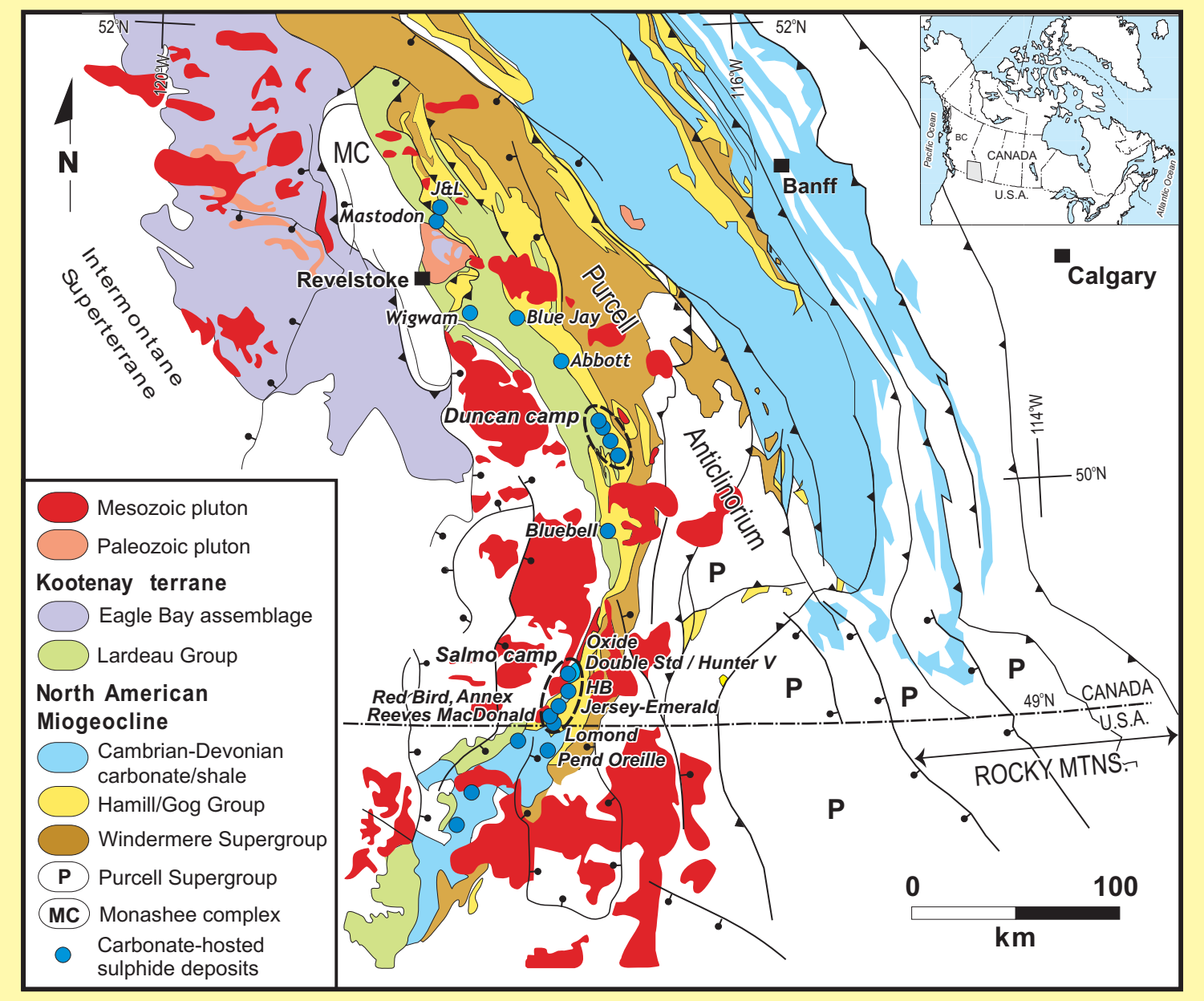


Location of the project areas with respect to other significant carbonate-hosted sulphide and nonsulphide occurrences in the cordillera, south-central BC (modified from Nelson et al., 2002, 2006). Abbreviations: CC - Cache Creek, Q - Quesnel terrane, SRMT - southern Rocky Mountain trench.

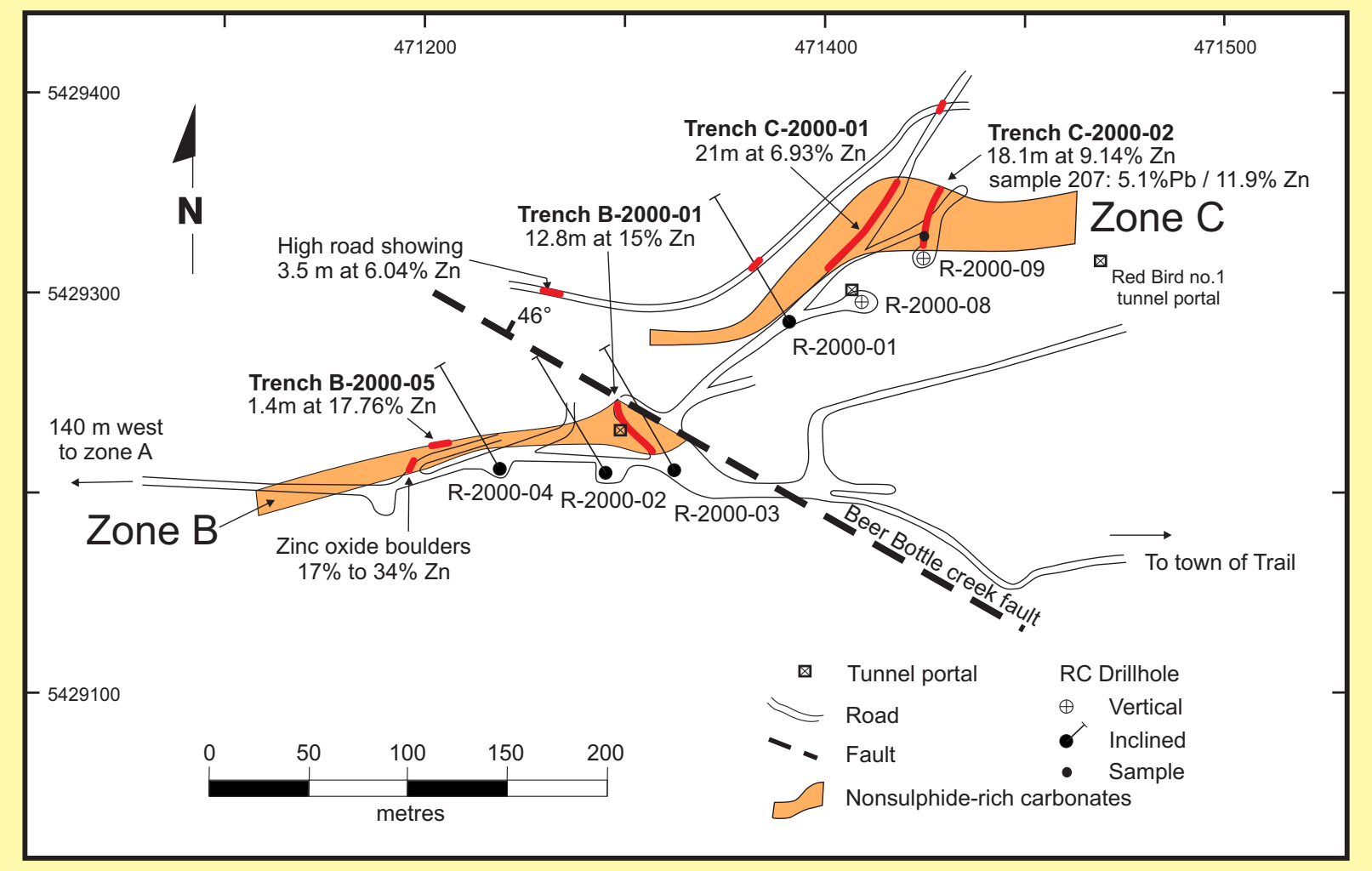
Suggested reference:

Paradis, S., Simandl, G.J., Keevil, H., and Raudsepp, M. (2011): Geology and geochemistry of carbonate-hosted nonsulphide Zn-Pb mineralization in southern and central British Columbia; British Columbia Ministry of Forests, Mines, and Lands; Geofile 2011-4, poster.

Salmo district



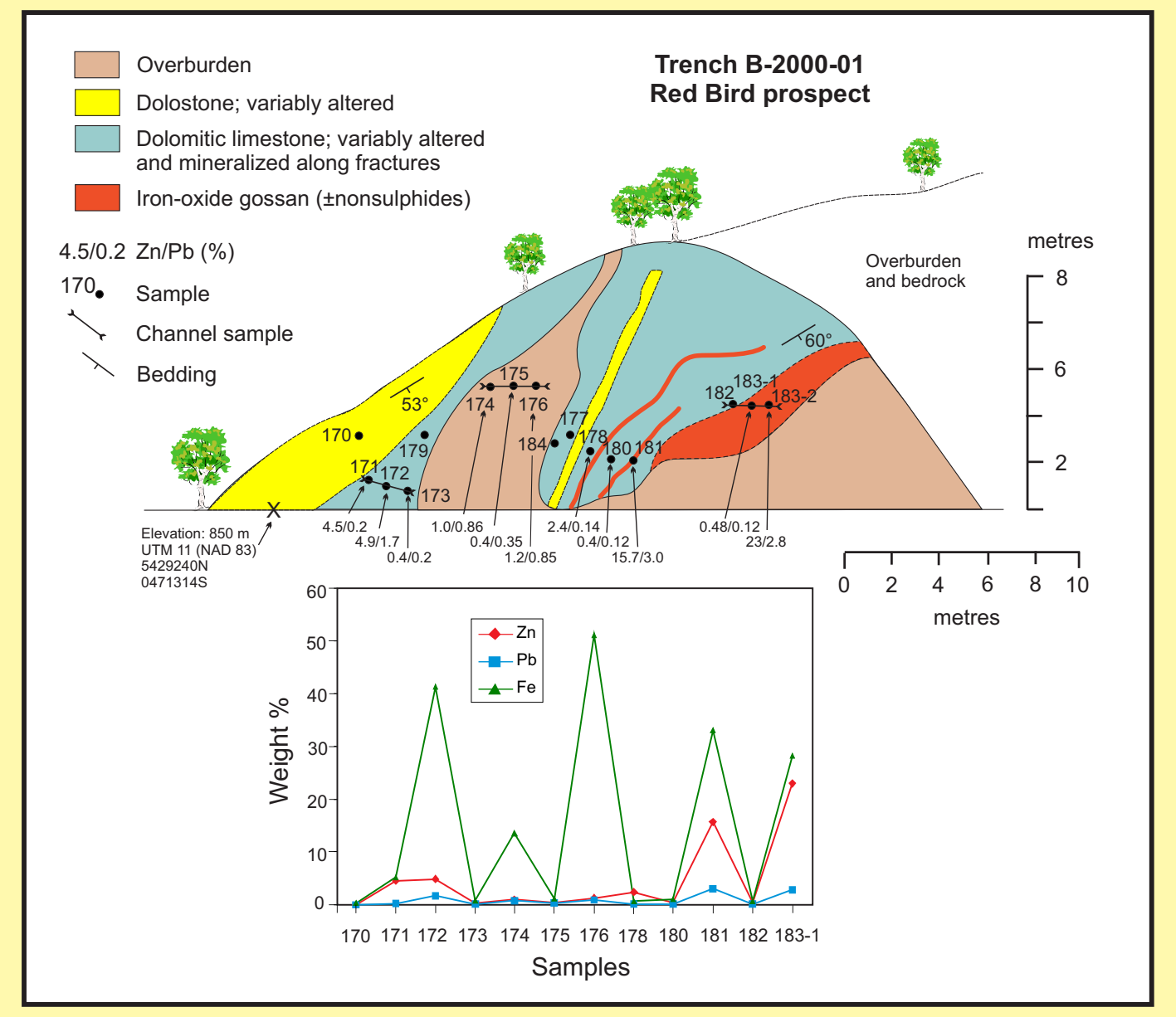
Simplified geological map of southeastern BC showing the Kootenay Arc and location of carbonate-hosted Zn-Pb deposits (modified from Wheeler and McFeely, 1991; Logan and Colpron, 2006). The Cambrian-Devonian carbonates host the Zn-Pb sulphide and nonsulphide deposits.



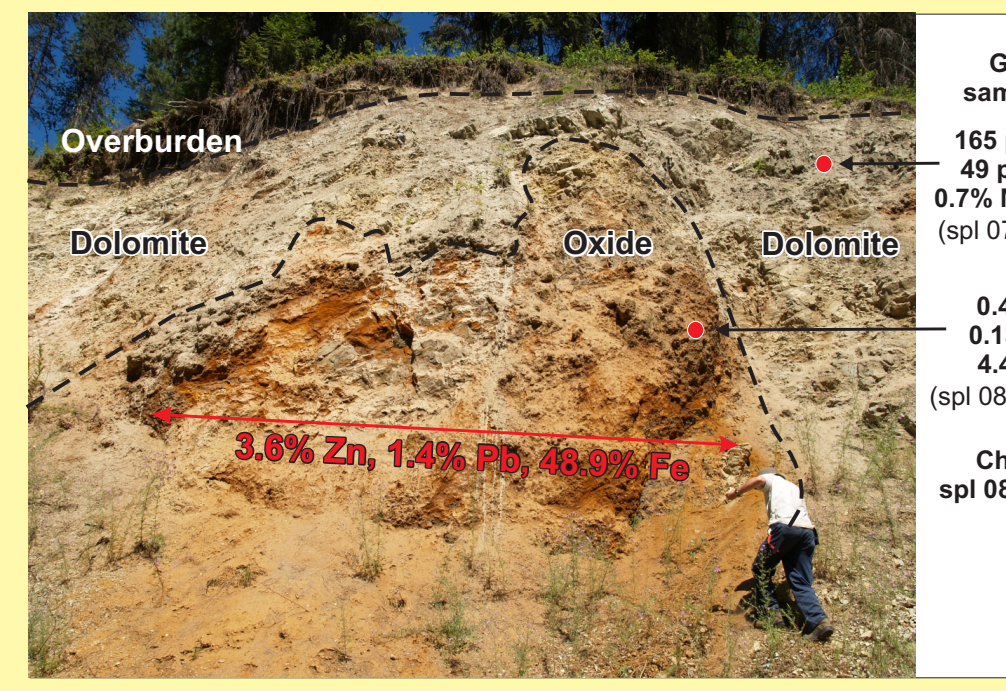
Schematic surface plan of zones B and C, Red Bird prospect, Salmo district, southeastern BC (after Gorzynski, 2001).

Vertical section oriented 316° looking NE of Trench B-2000-01, Red Bird prospect.

Iron-rich gossan, Jersey-Emerald property with location of grab sample 08-SP-105.



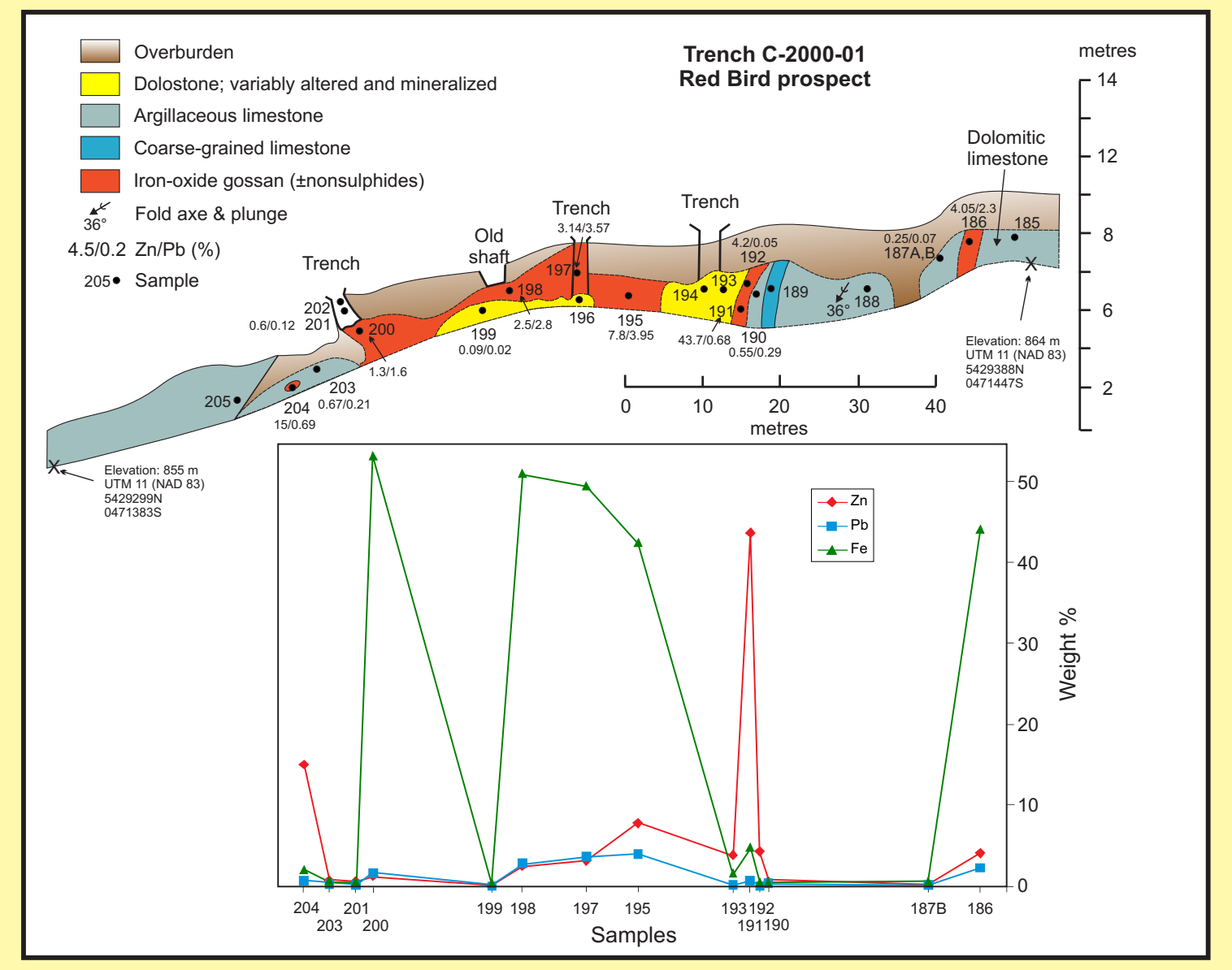
Vertical section oriented 030°, looking NW, and whole rock geochemical profiles of trench C-2000-01, Red Bird prospect.



Iron-rich gossan at the Lomond deposit with location of grab samples and channel sample.

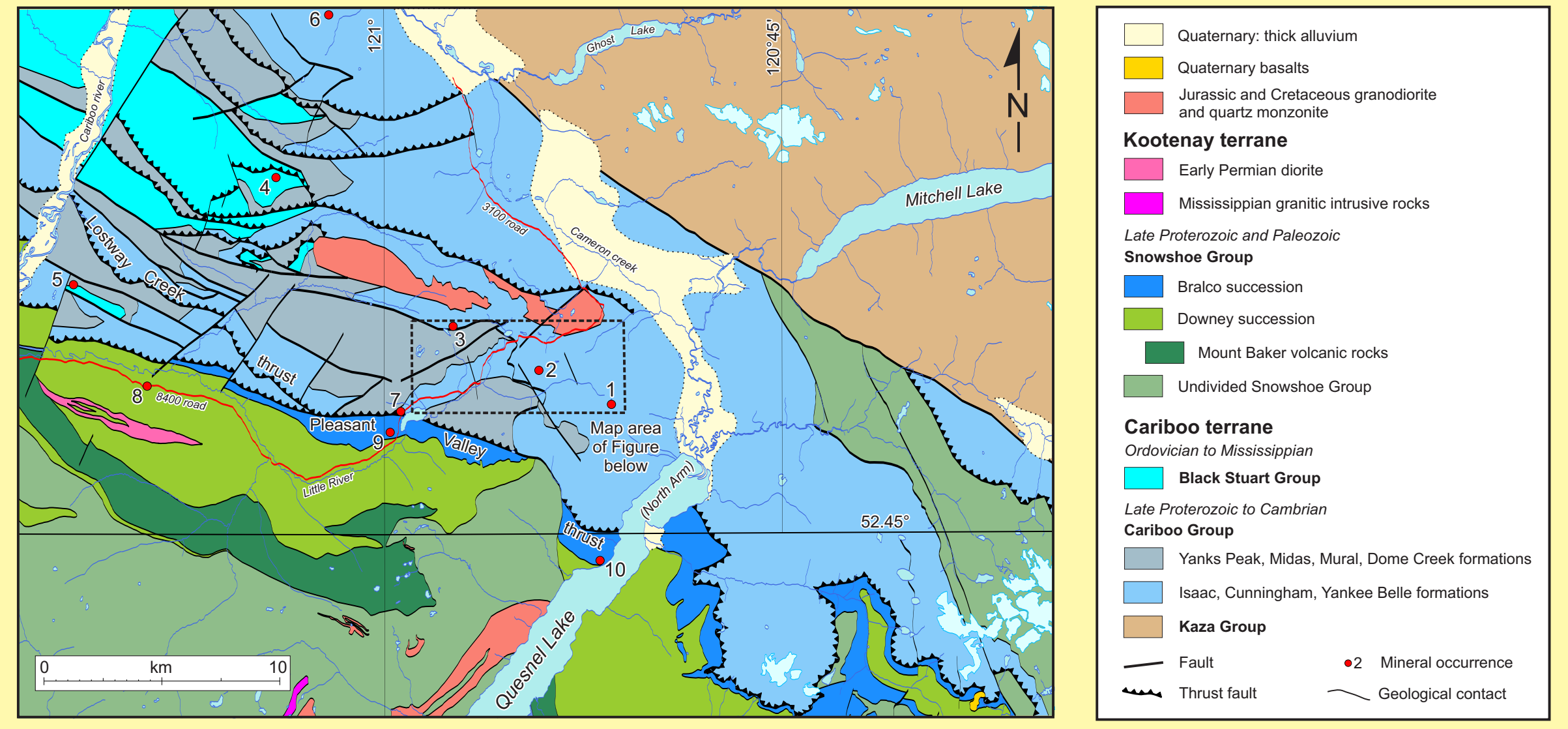
Hemimorphite-rich material at the Oxide deposit.

Hemimorphite-rich sample (08-SP-88B) from the Oxide deposit.

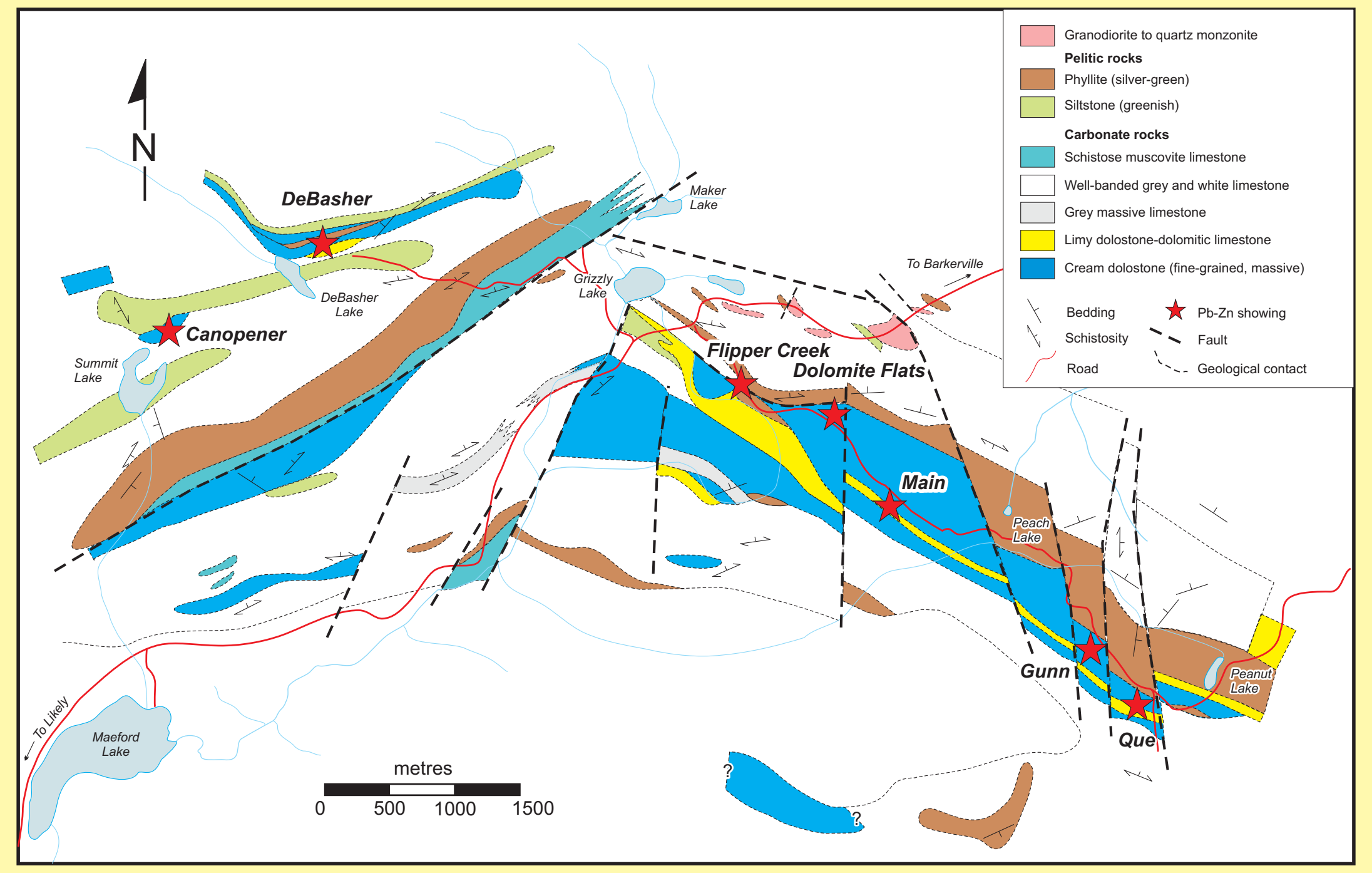


Vertical section oriented 316°, looking NE, and whole rock geochemical profiles of trench B-2000-01, Red Bird prospect.

Quesnel Lake district



General bedrock geology between Cariboo River and Mitchell Lake (after Campbell, 1978; Struik, 1983a, b, 1988; Ferri and O'Brien, 2003), east-central BC. The dotted rectangle (occurrences 1, 2, and 3) is the area covered by the Cariboo Zinc property (Figure 3). Mineral occurrences, according to BC MINFILE (BCGS, 2010): 1 - Sil (corresponds to the Gunn and Que showings in this study), 2 - Grizzly Lake (corresponds to the Flipper Creek, Dolomite Flats, and Main showings in this study), 3 - Lam (corresponds to the DeBasher showing in this study), 4 - Comin Throu Bear, 5 - Maybe, 6 - Mt Kimball, 7 - Maeford Lake, 8 - Ace, 9 - Mae, 10 - Cariboo Scheelite.

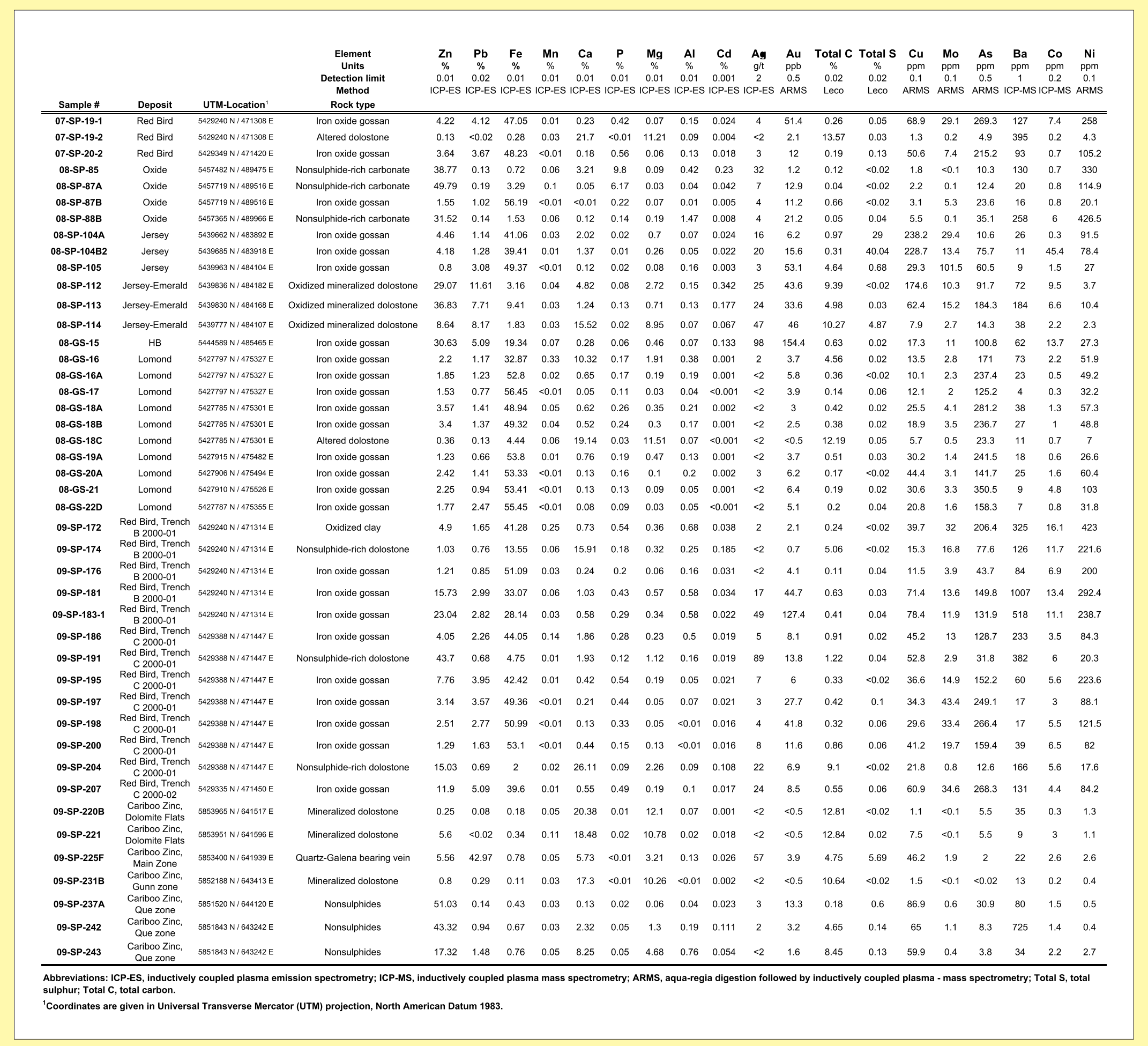


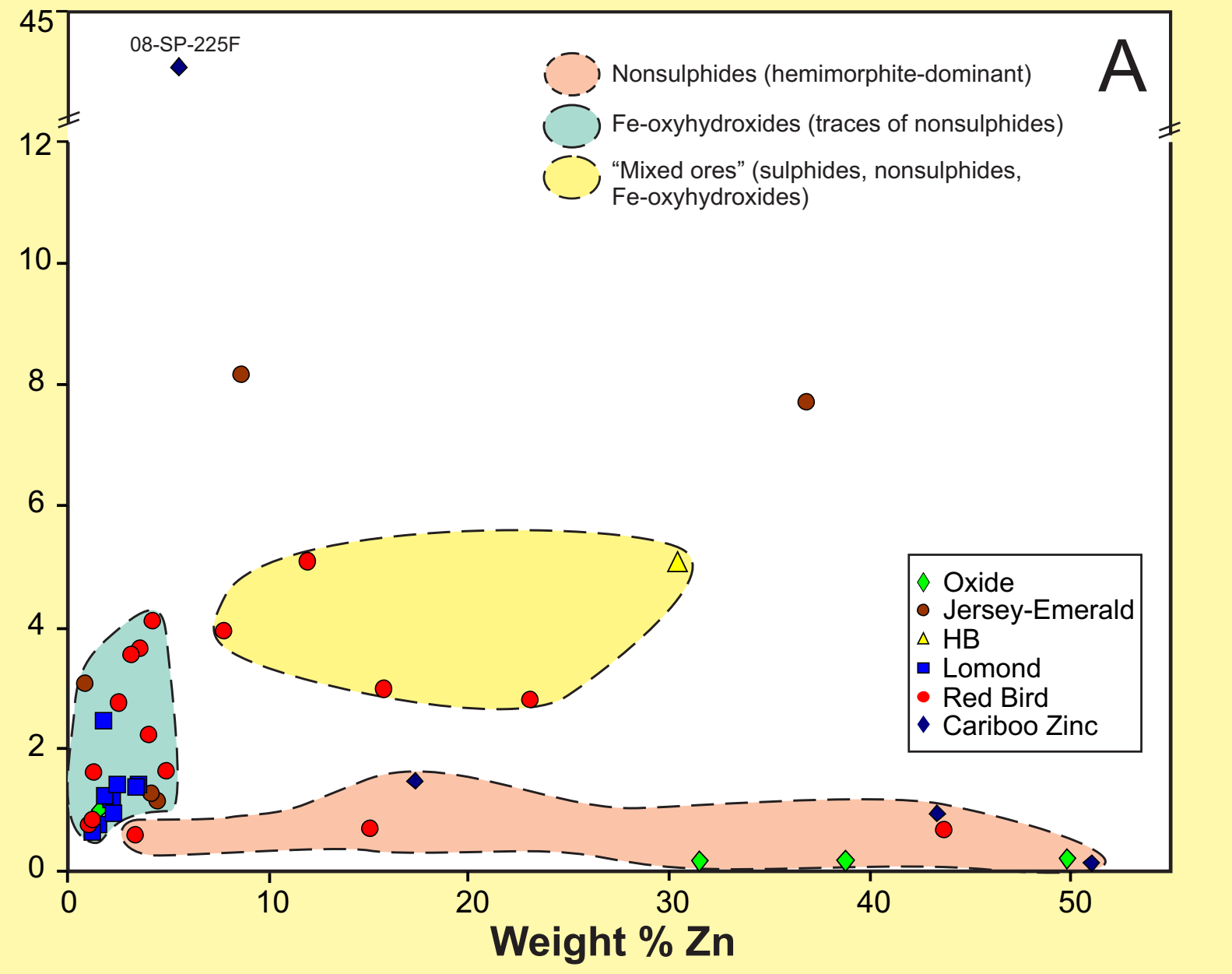
Regional geology of the Cariboo Zinc property area, Quesnel Lake area, showing the location of the Canopener, DeBasher, Flipper Creek, Dolomite Flats, Main, Gunn, and Que showings (from Lormand and Alford, 1990).

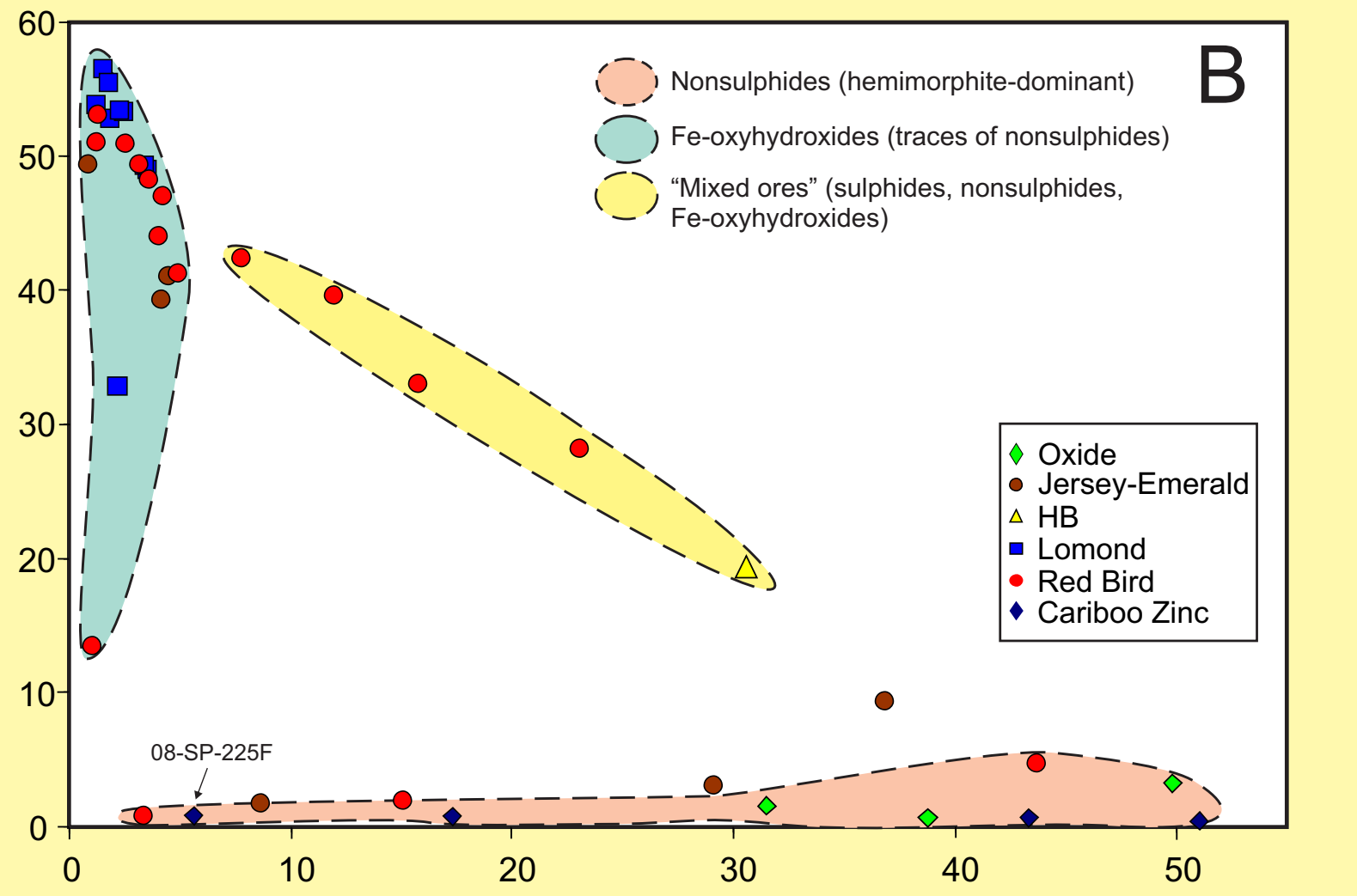
Large angular nonsulphide-bearing blocks (samples 09-SP-242 and 09-SP-243), Que showing, Cariboo Zinc property.

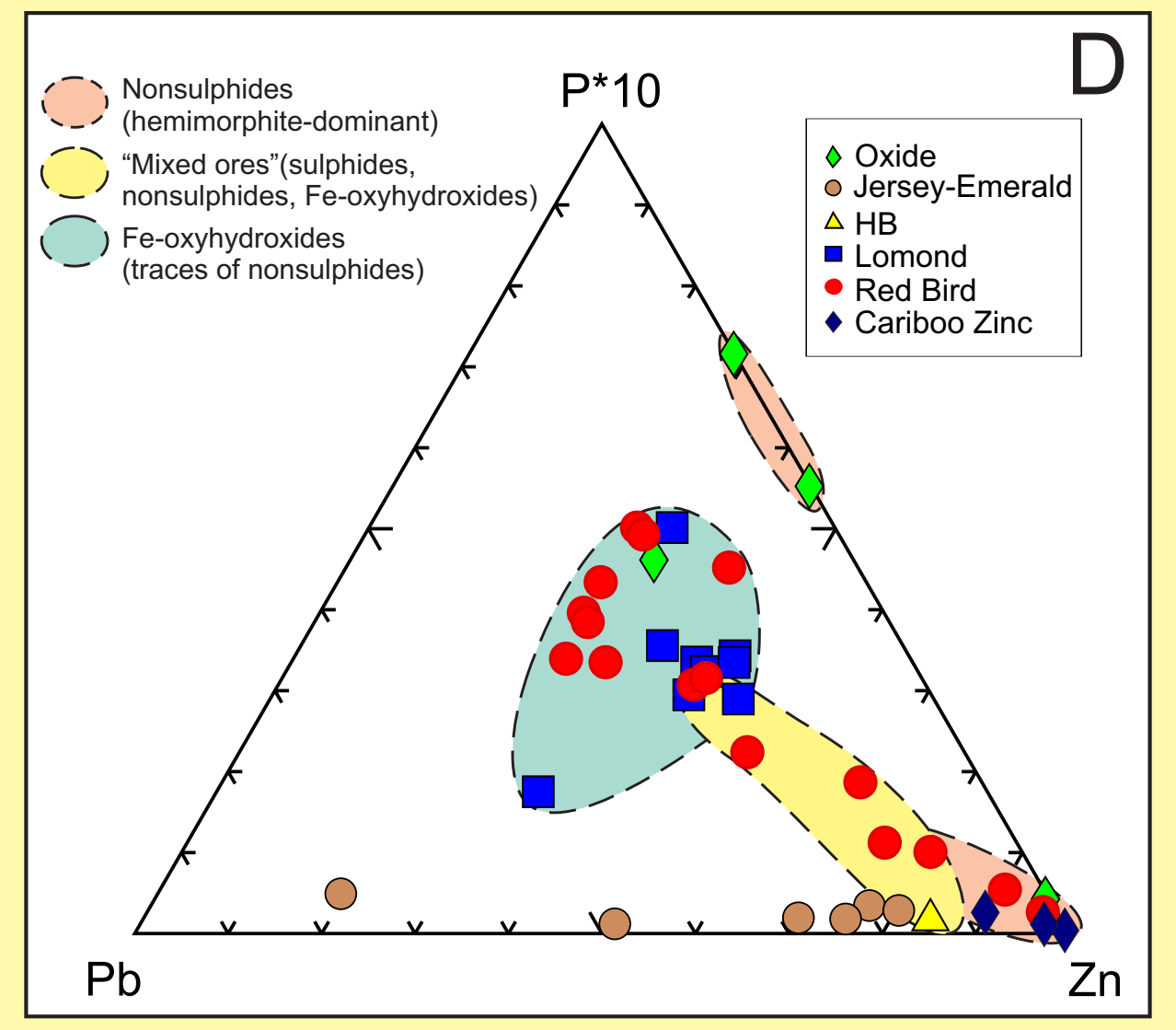
Irregular replacement zone of oxidized sulphides in dolostone, Gunn showing, Cariboo Zinc property.

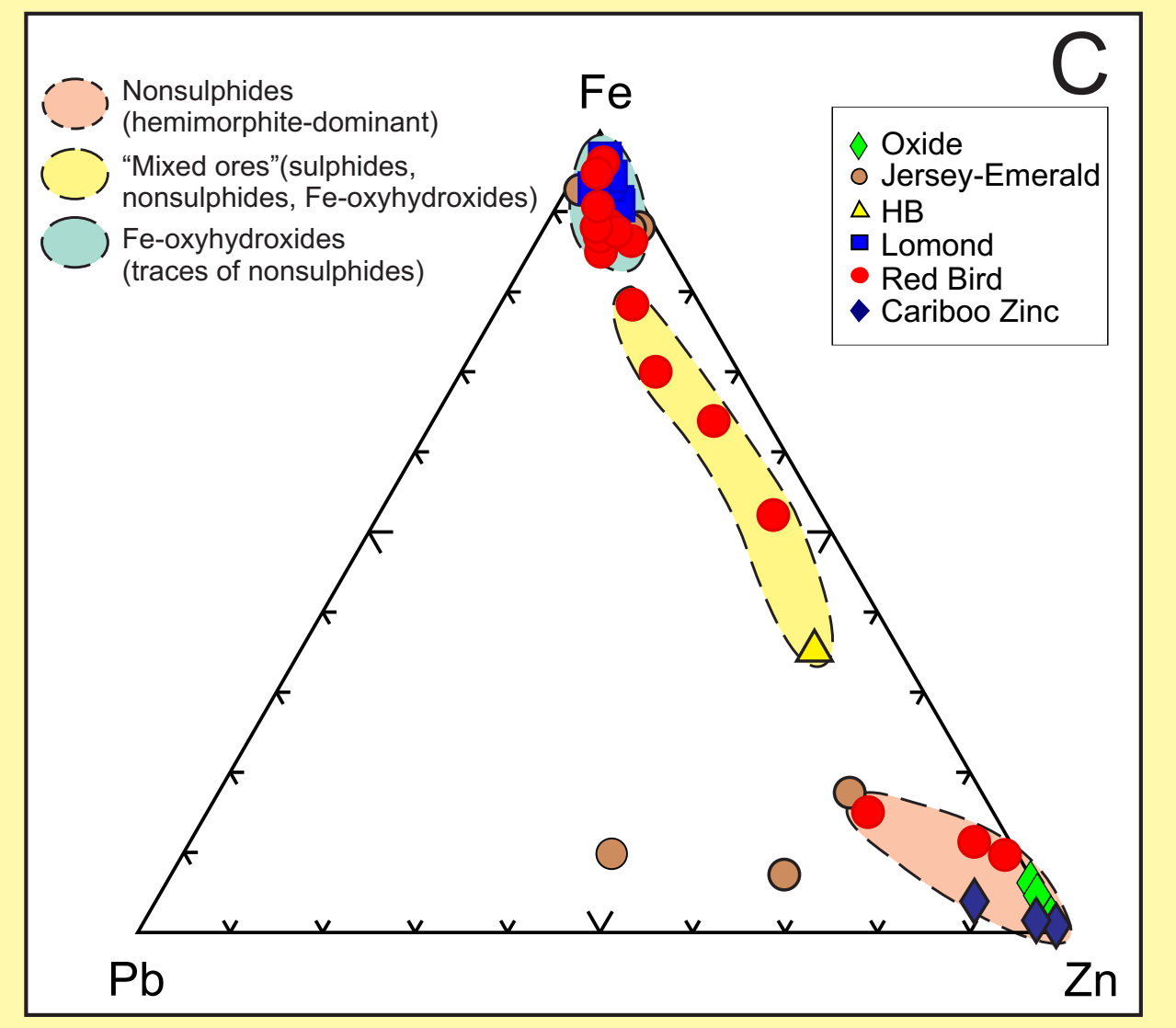
Geochemistry











Lithogeochemical considerations:
All X-Y and ternary diagrams depict major trends based on whole rock data. The units are in weight percent.
A) Plot of Zn vs. Pb. **B)** Plot of Zn vs. Fe. **C)** Pb-Fe-Zn plot. **D)** Pb-P*10-Zn plot.

Typical composition of massive sulphides in the Salmo district varies from 3 to 7 wt.% Zn, and 1 to 5 wt.% Pb. Average composition of grab samples of massive sulphide collected by the authors is 9.0 wt.% Zn and 2.33 wt.% Pb. Fe-oxyhydroxides field (blue) represents samples affected by supergene processes that have been depleted in Zn and some Pb. "Mixed ores" field (yellow) represents samples consisting of Fe-oxyhydroxides, minor nonsulphides, and remnants of sulphides; these samples have been slightly enriched in Zn relative to sulphide protore. Nonsulphides field (pink) represents samples enriched in Zn by supergene processes.

Jersey-Emerald samples are oxidized massive sulphides (no nonsulphides present); they should be considered separately because of the contact metamorphic overprint (i.e., remobilization?).

Additional information:

For background information, please consult:
Paradis, S. and Simandl, G.J. (2011): Carbonate-hosted, nonsulphide Zn-Pb (supergene) - Mineral Deposit Profile B09; in: British Columbia Ministry of Forests, Mines and Lands, Geological Fieldwork 2010, Paper 2011-1.
Complete list of references is available in:
Paradis, S., Keevil, H., Simandl, G.J., and Raudsepp, M. (2011): Geology and mineralogy of Carbonate-hosted nonsulphide Zn-Pb mineralization in southern (NTS 082F/03) and Central British Columbia (NTS 093A/14E, 15W); in: Geoscience BC Summary of Activities, Geoscience BC Report 2011-1.