Tectonics and Metallogeny of the northern Cordillera

Maurice Colpron[1] and JoAnne Nelson[2]

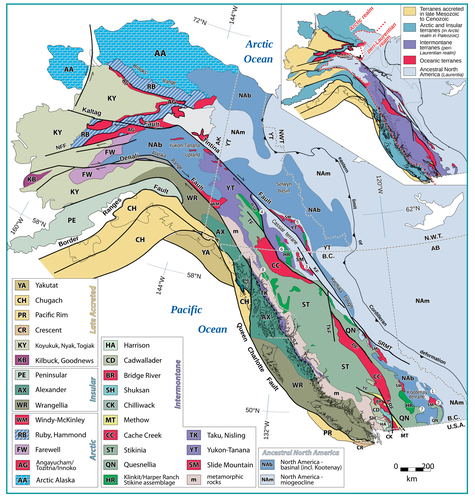
[1]Yukon Geological Survey
[2]B.C. Geological Survey

Introduction

The northern Cordilleran orogen of western Canada and Alaska comprises rocks that attest to over 1.8 billion years of tectonic history, from cratonization of the Laurentian continental core to current subduction and transform motion off the west coast today. Evolving tectonic styles, ranging from Proterozoic intracratonic basin formation through Paleozoic rifting through the construction of Mesozoic and younger intra-oceanic and continent margin arcs, has led to the wide variety of metallogenetic styles that define the mineral wealth of the northern Cordillera.

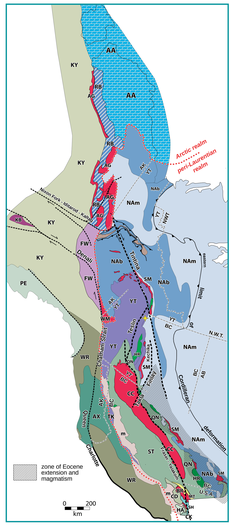
The northern Cordillera is made up of five large-scale tectonic provinces: the Laurentian craton and its deformed margins; allochthonous terranes of the peri-Laurentian realm, that represent offshore rifted continental fragments, arcs and ocean basins formed in a setting similar to the modern western Pacific province; the Arctic and Insular terranes, a group of crustal fragments that originated in the Arctic realm between Laurentia and Siberia and were transported separately southwards to impinge on the outer peri-Laurentian margin in Mesozoic time; and the late-accreted Pacific terranes, Mesozoic to Cenozoic accretionary prisms that developed along an active Pacific plate margin with a configuration much like the present one. Each tectonic province carries its own metallogenetic signature. Superimposed post-accretionary magmatic arcs and compressional and extensional tectonic regimes have also given rise to important mineral deposit suites. Seafloor hotspring deposits forming presently along the Juan de Fuca Ridge off the southwest coast of B.C. show the continuation of Cordilleran metallogeny into the foreseeable future.

Cordilleran Terranes and Realms



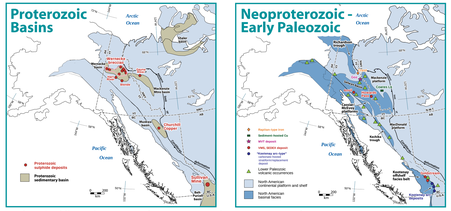
Terranes of the Canadian-Alaskan Cordillera. Inset shows terrane groupings and tectonic realms. Fault abbreviations: BSF – Big Salmon fault; CSF – Chatham Strait fault; CSZ – Coast shear zone; FRF – Fraser River fault; KF – Kechika fault; NFF – Nixon Fork-Iditarod fault; PF – Pinchi fault; SMRT – southern Rocky Mountain trench; TkF – Takla-Finlay-Ingenika fault system; YK – Yalakom fault. Other abbreviations: AB – Alberta; AK – Alaska; B.C. – British Columbia; NWT – Northwest territories; YT – Yukon.

Cretaceous Restoration



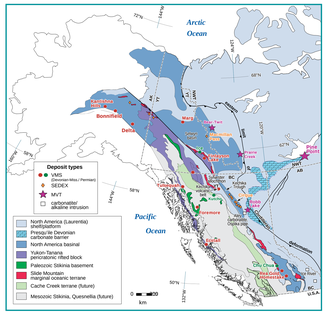
An approximate pre-Late Cretaceous restoration of the northern Cordillera.

Proterozoic - Early Paleozoic



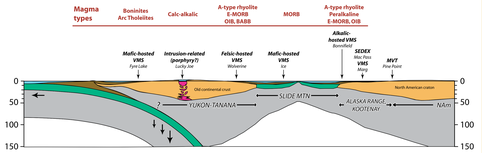
Earliest Cordilleran deposits are of various types and occur in a series of separate Meso- to Neoproterozoic sedimentary basins. Late Neoproterozoic - Early Paleozoic deposits are generally associated with rifting and breakup of Rodinia and the early development of the Laurentian continental margin.

Mid- to Late Paleozoic — *The Age of Syngenetic Sulphides*



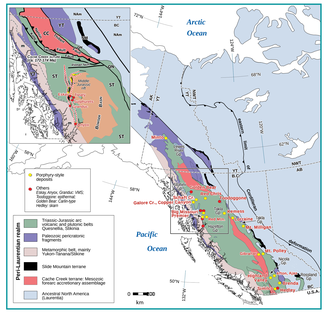
Portal to Wolverine deposit

Wolverine ore

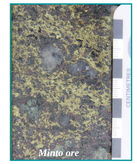


Devonian to Mississippian time is an important metallogenetic episode in the northern Cordillera. Dominated by syngenetic sulphide deposits of VMS, SEDEX and MVT types, the various deposits are related to the establishment, rifting and separation of a continent-margin arc system behind the opening Slide Mountain marginal sea.

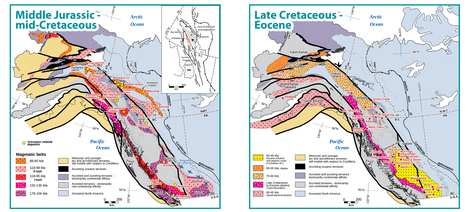
Early Mesozoic — *The Age of Porphyries*



Late Triassic to Early Jurassic Cu-Au and Cu-Mo porphyry deposits of Stikine and Quesnel terranes are collectively the most important group of deposits in British Columbia; this belt extends into central Yukon, where it is represented by the Minto and Carmacks Copper deposits. Development of the Eskay rift in mid-Jurassic favoured the formation of polymetallic VMS deposits in NW B.C.

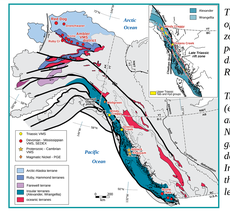


Late Mesozoic - Cenozoic



Middle Jurassic to early Cenozoic deposits are generally intrusion-related or orogenic styles of deposits and spatially associated with major magmatic suites.

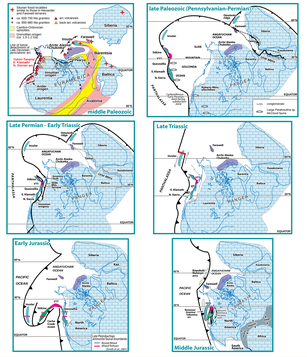
Arctic and Insular Terranes



The Arctic terranes of Alaska host Paleozoic syngenetic deposits in the Ambler district (VMS) and at Red Dog (SEDEX).

Triassic VMS (eg. Windy Craggy) and magmatic Ni-PGE (eg. Wellgreen) are the main deposit types in the Insular terranes of the northern Cordillera.

Paleogeography



Summary

- **The northern Cordillera can be subdivided in its simplest expression into a peri-Laurentian realm and an Arctic realm.**
- **The metallogeny of the peri-Laurentian realm evolved from:**
  - *Paleozoic syngenetic sulphide deposits (VMS, SEDEX, MVT) along a divergent margin;*
  - *to early Mesozoic Cu-Au porphyries in an island arc setting;*
  - *to late Mesozoic-Cenozoic orogenic Au deposits.*
- **Tectonics and metallogeny of the peri-Laurentian realm are linked to the evolution of subduction zones along the western edge of Laurentia since at least Devonian time.**

"To understand metallogeny, one must know the geologic sources of the constituents in ore minerals, appreciate the structural preparation of rock masses for ore deposition, and understand the mechanisms for ore transport and precipitation. Tectonics lies at the roots of all these issues."

W.R. Dickinson (2006 - *Geosphere*, v. 2, p. 353)

Reference

The diagrams on this poster are from:

Nelson, J. L. and Colpron, M., 2007, Tectonics and metallogeny of the Canadian and Alaskan Cordillera, 1.8 Ga to present, *in* Goodfellow, W. D., ed., Mineral Deposits of Canada: A Synthesis of Major Deposit Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods: *Geological Association of Canada, Mineral Deposit Division, Special Publication No. 5.*

For more information, contact:

Maurice Colpron
(867) 667-8235
Maurice.Colpron@gov.yk.ca

JoAnne Nelson
(250) 952-0438
JoAnne.Nelson@gov.bc.ca

www.geology.gov.yk.ca