Stratigraphy of the Tower Cu-Zn-Ag-Au deposit, sub-Phanerozoic Thompson nickel belt, central Manitoba

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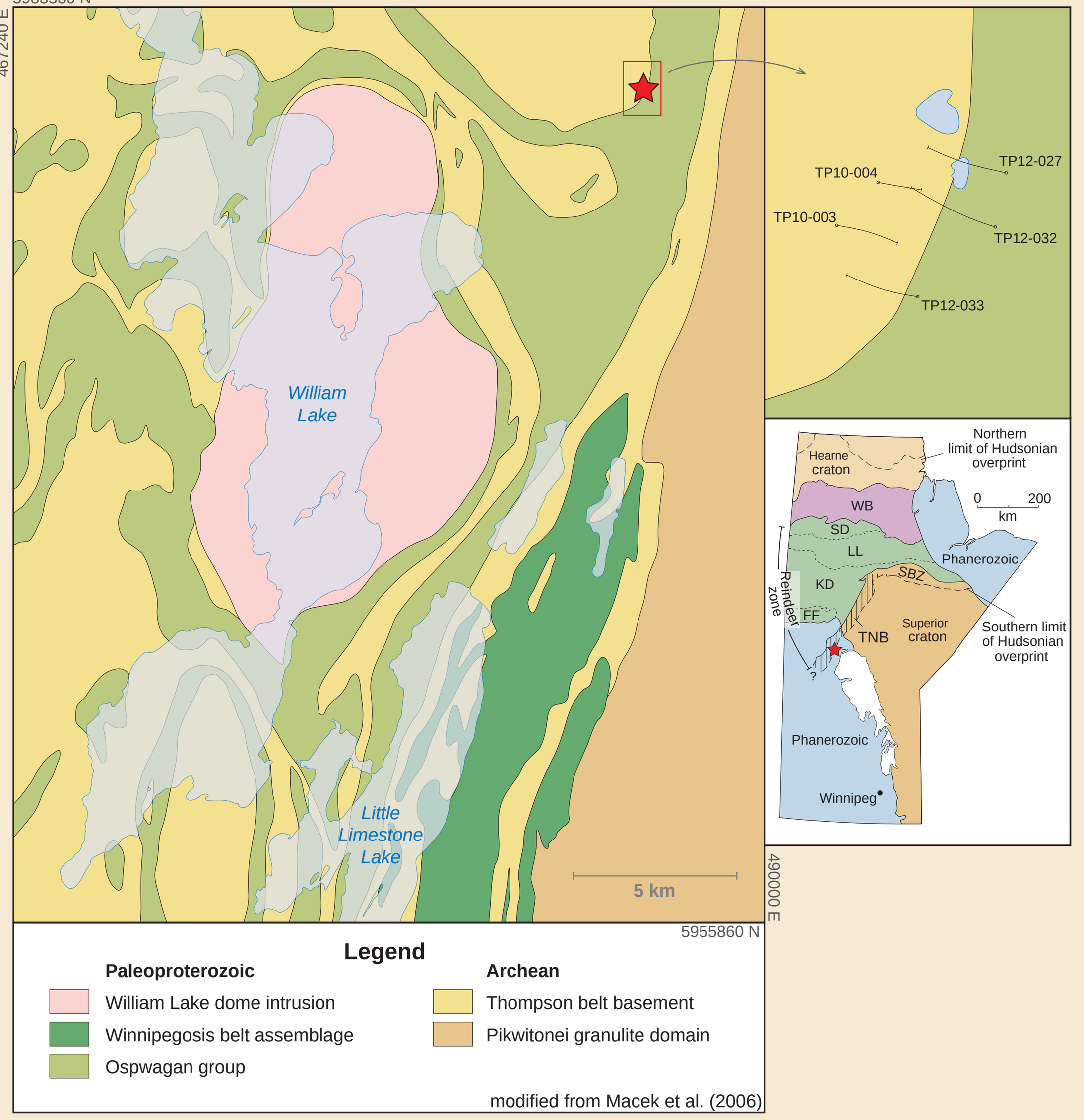

Summary

The Tower Cu-Zn-Ag-Au deposit is a pelitic-mafic or Besshi-type volcanogenic massive-sulphide (VMS) system located in the sub-Phanerozoic Thompson nickel belt (TNB). Preliminary findings suggest that the deposit is hosted in Pipe formation rocks of the Ospwagan group. A simplified stratigraphy for the deposit consists of impure chert and siliceous rock of the Pipe formation P1 member, overlain by pelite and local sulphide-facies iron formation of the P2 member. This is overlain by laminated calcareous rock and a thick sequence of impure chert with intercalations of calcsilicate, iron formation, siliceous rock and minor carbonate, constituting the P3 member. The upper portion of the P3 member hosts a heterogeneous chlorite schist unit that has not been identified in the Pipe formation from other parts of the TNB and appears to result from hydrothermal alteration, likely during sulphide deposition.

The T1 zone mineralization is discordant to stratigraphy and is hosted within the P2 member in the north and P3 member in the south. The T1 zone varies from a sulphidic schist to a sulphide breccia, the latter consisting of fragments of wall-rock, interpreted to result from mobilization along a late (D_3-D_4) structure. The T2 zone mineralization and associated chlorite schist may represent a stratiform zone of sub-seafloor hydrothermal replacement that is mostly in situ.

It is suggested that mafic to ultramafic magmatism, associated with either the Bah Lake assemblage or ca. 1883 Ma Molson-age intrusions, could have provided the heat source to drive the hydrothermal circulation system required to generate the Tower VMS deposit. Both of these magmatic events are of regional extent, suggesting there could be potential for VMS mineralization throughout the TNB. Volcanogenic massive-sulphide systems typically occur in clusters, suggesting that additional deposits could be found along strike from the Tower deposit.

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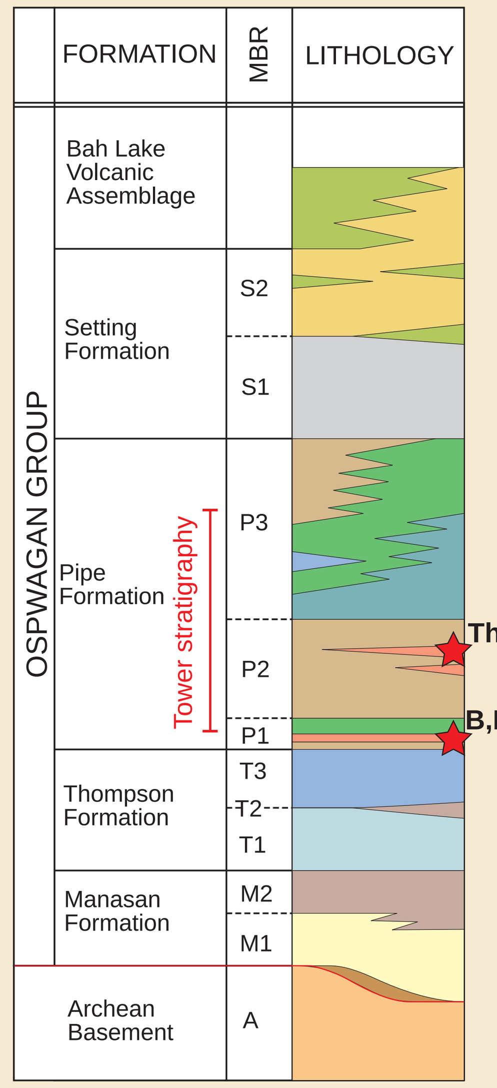
The Ospwagan group

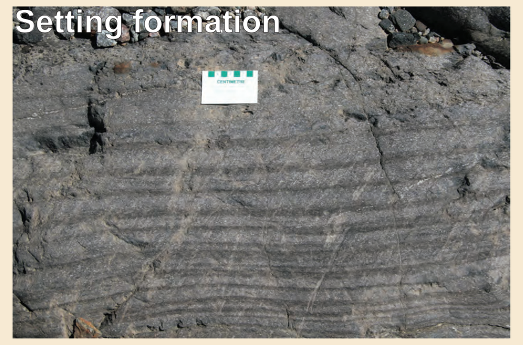


Schematic section of the Ospwagan group stratigraphy (modified after Bleeker, 1990). Red stars indicate the stratigraphic position of the Thompson (Th), Birchtree (B), and Pipe (P) mines.

Bah Lake assemblage

The Bah Lake assemblage consists of mafic to ultramafic volcanic rocks.

Setting formation

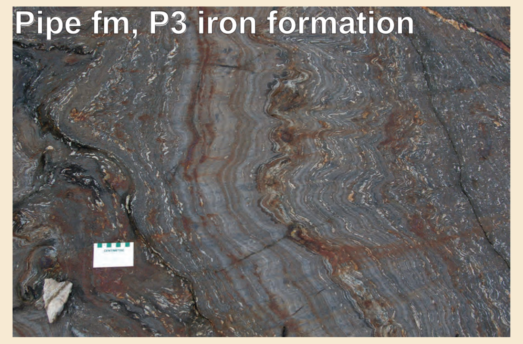


Setting formation rocks consist of interbedded quartzite, wacke, and mudstone with local pebbley beds.

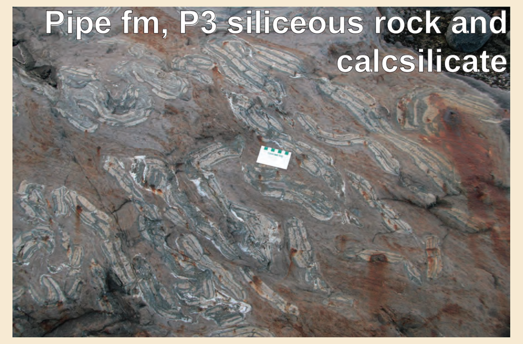
Pipe fm, P3 dolomitic marble

(Photo by J. Macek)

Pipe fm, P3 iron formation



Pipe fm, P3 siliceous rock and calcsilicate



The Pipe formation, P3 member consists of a variety of chemical and fine-grained siliclastic rocks including silicate-, carbonate-, and oxide-facies iron formation; impure chert; calcsilicate; dolomitic marble; pelite; and greywacke.

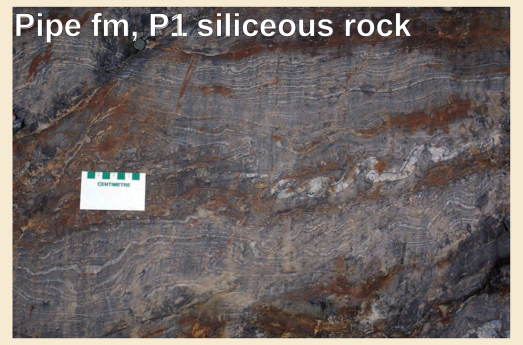
Pipe fm, P2 sulphide-facies iron formation (left)

(Photo by J. Macek)

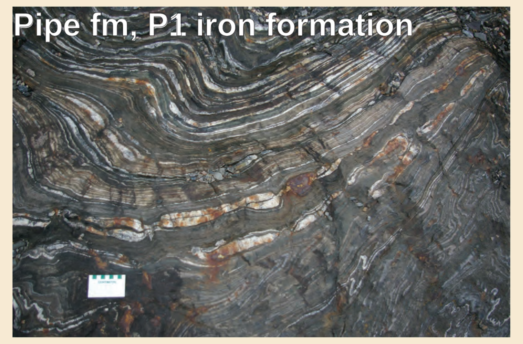
Pipe fm, P2 pelitic schist

The Pipe formation, P2 member consists of pelitic schist overlain by sulphide-facies iron formation (locus of the Thompson mine ore-body).

Pipe fm, P1 siliceous rock



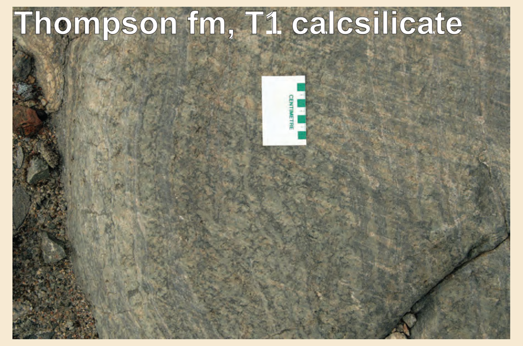
Pipe fm, P1 iron-formation



The Pipe formation, P1 member consists of sulphide-facies iron formation (locus of Birchtree and Pipe mines ore-bodies), overlain by silicate-facies iron formation, and a siliceous and micaceous rock that grades into the P2 member.

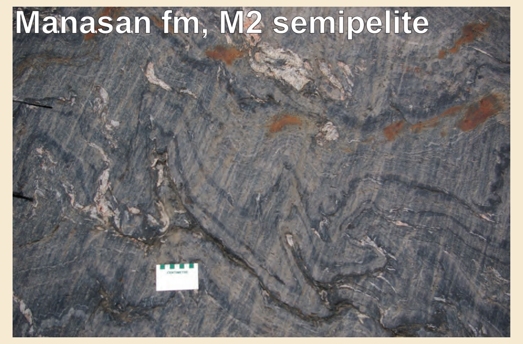
Thompson fm, T3 megacrystic marble

Thompson fm, T1 calcsilicate

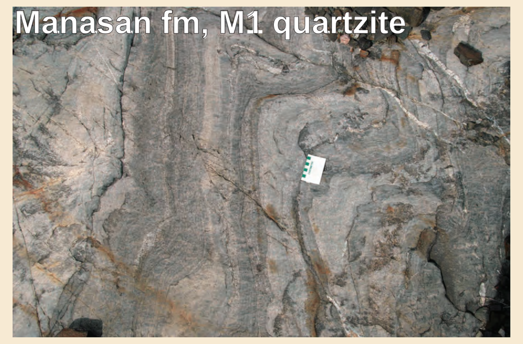


The Thompson formation consists of calcareous sedimentary rocks including calcsilicate and impure marble.

Manasan fm, M2 semipelite



Manasan fm, M1 quartzite



The Manasan formation consists of the M1 quartzite, which fines-upward into the M2 semipelite.

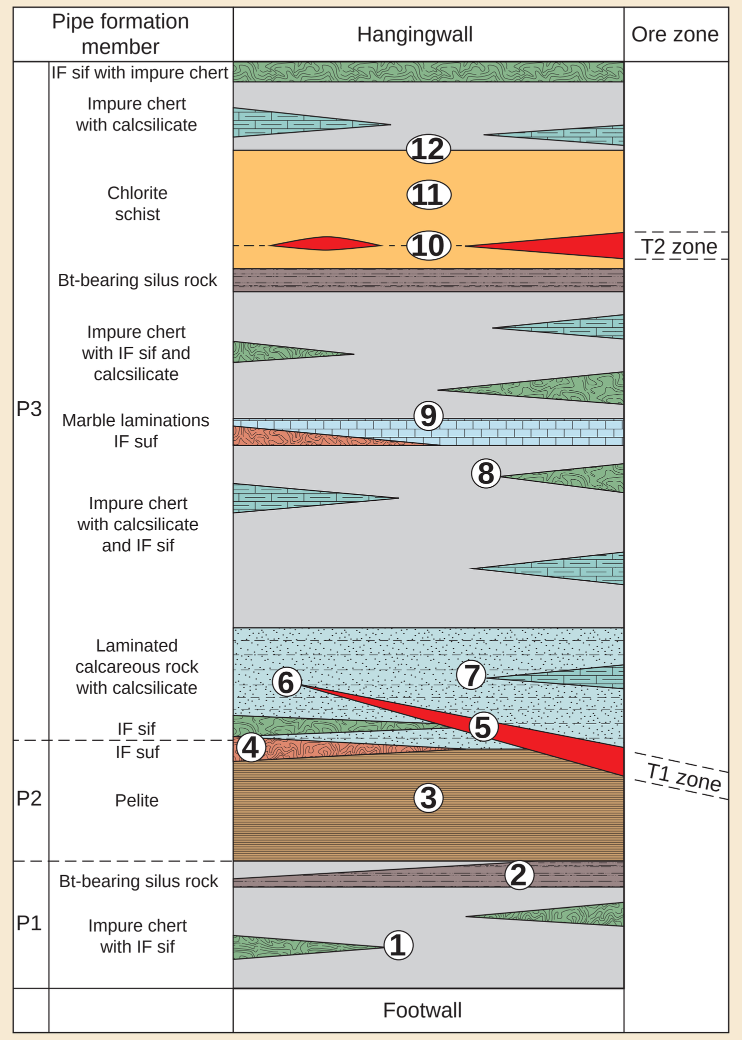
Acknowledgements

The author thanks N. Clark, M. Stocking and S. Walker for providing enthusiastic field assistance; and N. Brandson and E. Anderson for logistical support. This project was made possible by Akuna Minerals Inc. and Rockcliff Copper Corporation, who provided access to the Tower property core. Thanks go to M. Lapierre for looking after our needs at the Rockcliff core-storage facility and for cutting samples. Special thanks to J. Macek for discussions regarding the geology of the Ospwagan group and the sub-Phanerozoic TNB.

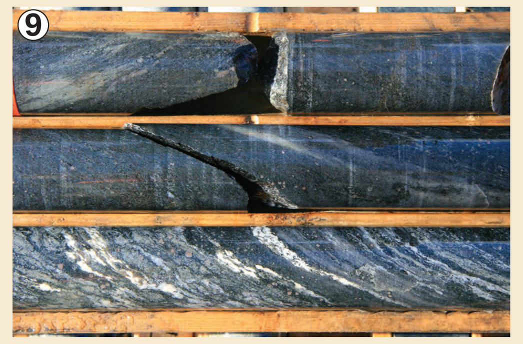
Tower deposit stratigraphy

P3 member impure chert with diffuse and discontinuous bands of chlorite (top row), grading into chlorite schist.

Staurolite-rich and garnet-rich chlorite schist, likely represents a strataform zone of sub-seafloor hydrothermal replacement within the P3 member.

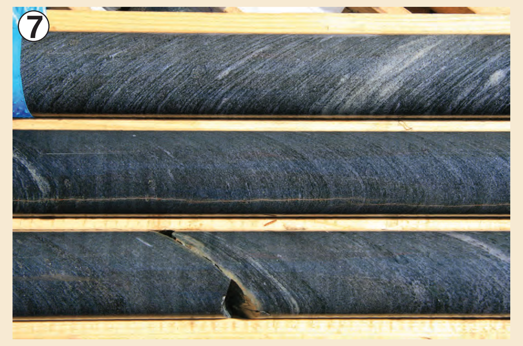


Semi-solid sulphide hosted near the base of the chlorite schist. The sulphide is likely correlative with mineralization of the T2 zone.

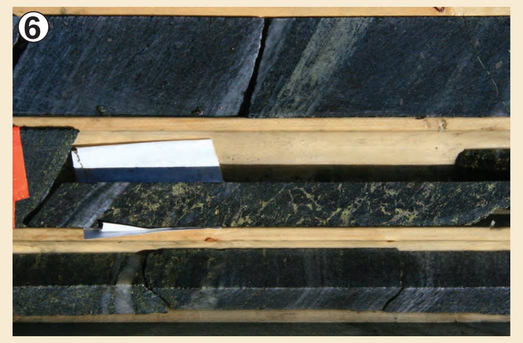


P3 member impure chert with diffuse calcsilicate (top left), and layers of carbonate (bottom row).

P3 member impure chert grading into silicate-facies iron formation (bottom row).

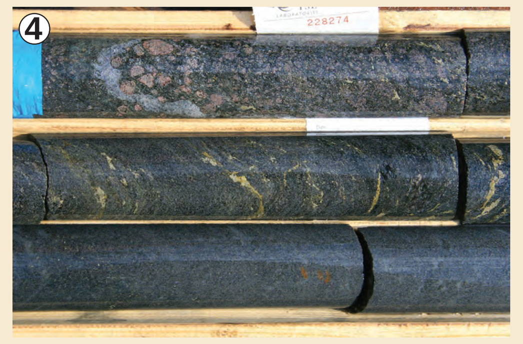


Laminated calcareous rock with diffuse calcsilicate (top right) near the base of the P3 member.



T1 zone sulphidic schist with net-textured sulphide (middle row).

Solid-sulphide breccia of the T1 zone with fragments of ultramafic amphibolite and white quartz (middle row).



Sulphide-bearing P2 pelite (top row) grading into sulphidic schist (middle row) and overlain by P3 magnetite-bearing iron formation (bottom row).

Staurolite- and garnet-bearing pelitic schist of the P2 member.

Garnet- and biotite-bearing siliceous rock of the P1 member.

P1 member impure chert grading into silicate-facies iron formation (bottom row).

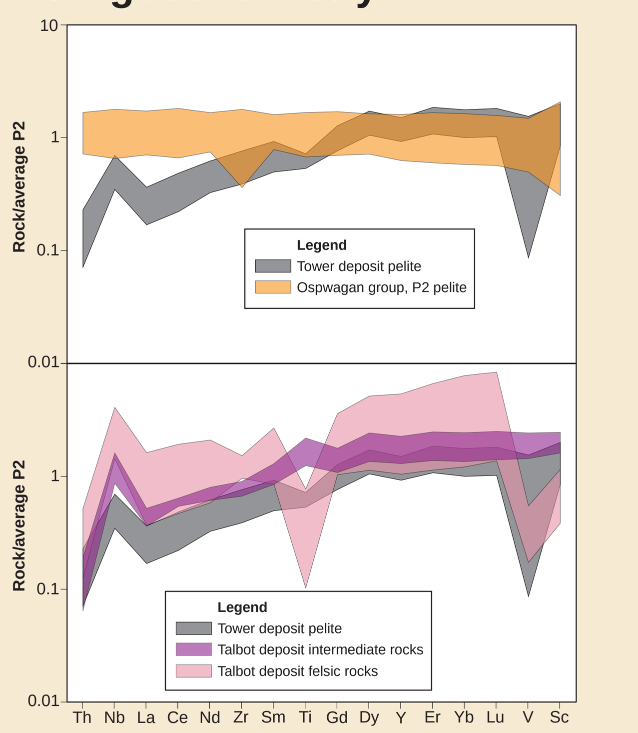
Intrusive rocks at Tower

Small granitoid dikes <2 m thick occur sporadically. A >73 m intersection of granodiorite occurs below the Phanerozoic unconformity in hole TP12-032.

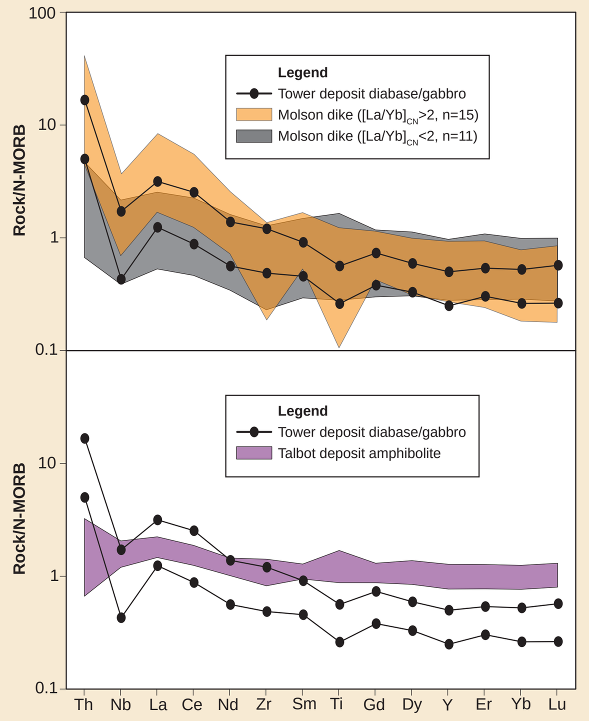
Ten to 100 m long intervals of ultramafic schist occur within the P3 member. These altered bodies of peridotite consist of varying amounts of talc, anthophyllite, chlorite, carbonate, and serpentine with minor magnetite.

Intervals of plagioclase amphibolite occur at all stratigraphic levels at the Tower deposit, and represent diabase and gabbro intrusions. Intervals are generally < 6m, but can be up to 113m.

Lithogeochemistry

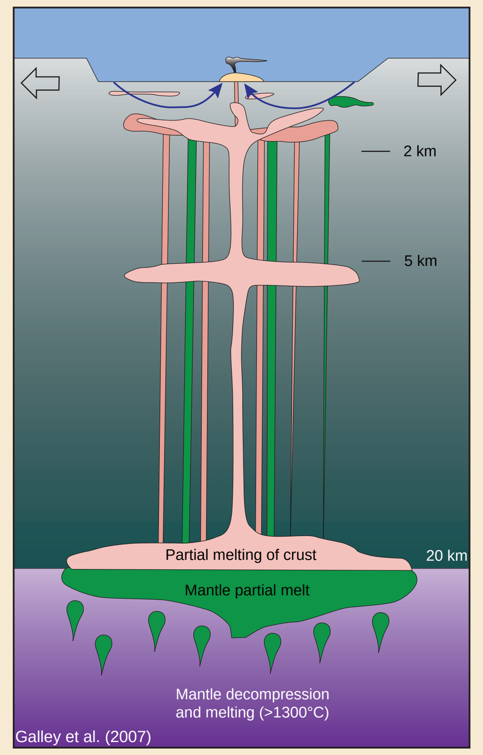


Multi-element plots for Tower deposit pelites are distinct from the Ospwagan Group P2 pelite (top), but share similarities with some Talbot deposit rocks (bottom).



Multi-element plots for Tower deposit mafic intrusions are similar to Molson dikes, but distinct from Talbot deposit amphibolite. The enriched character of the Tower and Molson rocks is the result of interaction with evolved Archean crust.

Economic considerations



Volcanogenic massive-sulphide deposits form in areas of high heat flow, typically related to upwelling mafic magmas in extensional basins (Franklin et al., 2005; Galley et al., 2007; Piercey, 2011). The thinned crust and pooled mafic magmas provide the necessary heat to drive the hydrothermal circulation required to scavenge, transport and deposit base metals (Piercey, 2011). Mafic and ultramafic intrusive rocks are common in the stratigraphy that hosts the Tower deposit and are likely related to the ca. 1883 Ma Molson dike swarm and coeval ultramafic intrusions associated with magmatic Ni deposits in the TNB. Although not intersected in the drillcore at Tower, mafic to ultramafic volcanic rocks occur in the Bah Lake assemblage at the top of the Ospwagan group. Both of these suites are characterized by MORB-like trace-element signatures, which suggests relatively shallow partial melting of the mantle, likely in an extensional environment and accompanied by high heat flow. Hydrothermal activity sufficient to form VMS deposits could be associated with either suite of rocks.

Volcanogenic massive-sulphide deposits typically occur in clusters, around calderas or along linear rifts (Galley et al., 2007). The MORB-like character of the mafic magmas in the TNB is suggestive of an extensional environment. This, combined with the apparent lack of a volcanic edifice in the Tower property area, suggests that the VMS system likely developed along an extensional fault. Hence, there may be potential for additional deposits along strike. Although not on trend, intersections of anomalous Cu and Zn have been encountered in drillholes on the adjacent William Lake property (Beaudry, 2007), suggesting that VMS mineralization may well be more widespread than is currently recognized in the sub-Phanerozoic portion of the TNB.