Magmatic sulphide mineralization in the Pants Lake Intrusion, Labrador: implications for geological exploration models for Voisey's Bay-style deposits

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The ca. 1322 Ma Pants Lake Intrusion (PLI) comprises several mafic intrusions emplaced into sulphide-bearing metasedimentary gneisses, about 100 km south of the world-class Voisey's Bay Ni–Cu–Co deposit. The PLI provides the closest analogue to the Voisey's Bay host rocks recognized to date in Labrador, and contains widespread disseminated, and, more rarely, massive magmatic sulphide mineralization. The area presents an opportunity to test and further develop geological exploration models based upon the Voisey's Bay deposits. Many critical processes seen (and inferred) in the Voisey's Bay area apparently also operated during the emplacement of the PLI. However, there are also important differences between the two areas and their evolution may not be strictly parallel.

The PLI is dominated by several different varieties of olivine-gabbro. The component intrusions are sheet-like, and range from <50 m to over 600 m in thickness. Their presently complex geometry probably reflects the superposition of regional tilting and/or gentle folding on primary variations in their thickness and anatomy. Magmatic sulphide mineralization is ubiquitous near the basal contacts of most PLI intrusions, and is invariably associated with distinctive, contaminated, sulphide-bearing mafic rocks that include textural equivalents of the 'basal breccias' and 'leopard troctolites' described from Voisey's Bay. There is strong evidence for assimilation of local metasedimentary gneisses, which may have provided an external source for much of the sulphur. The PLI mineralized sequences record the introduction of discrete sulphide- and fragment-bearing magma pulses into evolving, dynamic, mafic magma chambers, as suggested for the Voisey's Bay deposit. However, the PLI mineralized sequences appear to be intrusion-wide 'stratigraphic' features, and discrete mineralized feeder conduits, as documented at Voisey's Bay, have not yet been located. Ni contents at 100% sulphide are mostly lower than at Voisey's Bay, but the sulphides contain higher Cu and Co at a given Ni content, and consistent Ni/Cu and Ni/Co ratios suggest a large-scale magmatic process. There is evidence for the extraction of large quantities of Ni and Cu from these magmas by sulphide liquids. The challenge for future exploration in this area is to find out where it went!