The potential of flood basalts for hosting magmatic sulphide deposits: an application of exploration criteria to the Sverdrup basin, Nunavut, Canadian Arctic

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It is now widely accepted that flood basalt provinces are important targets in the search for Ni– Cu sulphide ores. These ores may also contain concentrations of the platinum-group elements (PGE) that are of economic interest. As a result, mining companies now conduct extensive mineral exploration programs in large igneous provinces associated with continental rifting. We describe a GSC project under development that will examine the potential of the Sverdrup Basin magmatic province (SBMP) for hosting Ni–Cu sulphide deposits, by integrating three types of geoscience information: field observations and mapping; petrological and geochemical data; and the results of aeromagnetic surveys. The SBMP is located in the Canadian Arctic islands, and consists of hypabyssal intrusive sheets and dykes, flood basalts, and central volcanoes that were emplaced during a period of approximately 60 Ma, starting in the Early Cretaceous. The volume of magma erupted in the east-central part of the Sverdrup Basin has been estimated at 10-20,000 km^3, making the province comparable in scale to the Columbia River basaltic province of the western U.S. The volume of magma intruded as sills and dykes is at least an order of magnitude larger, a characteristic of many flood basalt provinces associated with continental breakup. In this talk, we present a summary of the tectonic and magmatic history of the SBMP; compare the attributes of the SBMP with those of other flood basalt provinces hosting Ni–Cu–PGE deposits; and outline the rationale, objectives, and methods of the new project.

The Sverdrup Basin is a northeast-trending, intracratonic basin that extends along the Arctic polar margin from the northern tip of Ellesmere Island to Prince Patrick and Melville Islands. It is 1300 km long and 400 km wide (after compressive deformation), and contains up to 13 km of Carboniferous to Tertiary strata. The basin originated during a Carboniferous-Early Permian rifting event accompanied by minor, episodic volcanic activity of alkaline character. Renewed rifting during the Cretaceous led to widespread magmatism in areas close to the Mesozoic depocentre. As a result, the sedimentary succession is intruded by a large number of mafic sills and dykes, most of which have not been mapped in detail. Volcanic successions, however, are included on recent 1:250,000 geological maps compiled by the Geological Survey of Canada, and their Cretaceous ages have in many cases been confirmed by $^{40}Ar/^{39}Ar$ radiometric dating. The peak of volcanic activity was marked by the emplacement of flood basalts during the Albian and is contemporaneous with the age of the breakup unconformity in the Canadian Arctic Islands. The volcanic nature of the Alpha Ridge also suggests a tectonic link with the opening of the Arctic ocean. During the Late Cretaceous and earliest Tertiary, bimodal volcanic rocks were emplaced along the northern margin of the Sverdrup Basin. Following the waning of igneous activity, the basin was segmented and deformed during the Eurekan Orogeny, producing a foreland-style fold and thrust belt cut by major arches and high-angle reverse faults.

Volcanic and intrusive rocks of the Sverdrup Basin magmatic province remain virtually unexplored for their economic potential. A comparison of the attributes of the SBMP with the Noril'sk, Voisey's Bay and Midcontinent Rift regions, however, suggests many similarities. The following observations will be illustrated in the talk:

- The presence and eruptive style of the flood basalt province, and the evidence for widespread intrusion of basaltic magma during continental rifting.
- The possibility that major sills that could have acted as

magma reservoirs or conduits.

- The geochemical evidence for a mantle plume origin and the selective crustal contamination of basaltic magmas.
- The presence of black shales and evaporites in the stratigraphic succession.
- The identification of major faults and their intersection with volcanic systems.
- The presence of magnetic anomalies that could represent large, deep mafic bodies.
- The possibility that lithospheric-scale faults acted as magma conduits.

The striking similarities to regions such as Noril'sk promote the Sverdrup Basin as a natural laboratory to test the exploration guidelines proposed by Naldrett (1992), for areas of flood basalt volcanism. We discuss the application of this exploration model to the SBMP, in light of the existing geochemical database, economic indicators, and remaining gaps in geoscience knowledge.