Petrology of the Mechanic Settlement Pluton, southern New Brunswick, and potential for platinum group element mineralization

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The Mechanic Settlement Pluton, located on the northern margin of the Caledonian Highlands of southern New Brunswick, is a relatively undeformed late Neoproterozoic layered mafic intrusion. It contains at least seven lithologies: plagioclase-bearing lherzolite, olivine gabbronorite, gabbronorite, troctolite, anorthosite, websterite, and diorite. In a small portion of the pluton, previous studies have recognized six variably incomplete cyclic units that consist of plagioclase-bearing lherzolite at the base, olivine gabbronorite and gabbronorite in the middle, and anorthosite at the top. The intrusion has been variably altered, with hematite replacing mafic minerals and serpentine replacing olivine in ultramafic rocks; mafic rocks are relatively unaltered. Epidote and serpentine occur along shear zones in all rock types. The Mechanic Settlement Pluton contains stratabound, but not necessarily stratiform, horizons of anomalously high platinum- group element concentrations (Pt + Pd up to 2.4 ppm over 1 m in drill core, and 5.7 ppm in grab samples), typical of reef-type mineralization such as in the Merensky Reef of the Bushveld Intrusive Complex, South Africa, and the J-M Reef of the Stillwater Complex, Montana. These mineralized horizons have caused the pluton to be the focus of various exploration efforts from 1968 to present. Exploration in the earlier years focussed on copper and nickel, but now is directed to the platinum group elements.

The goals of this project are (i) to document layering and mineralized horizons in drill core for correlation between drill holes in order to assess the number, pattern and continuity of layers in the pluton, and (ii) to better understand the petrogenesis of the pluton, including controls on the distribution of potentially economic elements, especially platinum group elements. Logging, sampling, and magnetic susceptibility measurements of 5420 m of core from 20 archived holes drilled by Noranda, BHP, and Wildhorse Resources were completed in the summer of 2003, and detailed petrographic descriptions of the core samples, as well as an extensive surface sample collection archived at Acadia University, are in progress. Surface sample rock types correlate well with those in the subsurface. Magnetic susceptibility measurements coupled with archived downhole platinum group element assays, allow confident correlation of units between drill holes. Preliminary correlations suggest that at least two igneous contacts dip 68 degrees south.

Historical lithogeochemical data, supplemented by new data from representative drill core samples, are being evaluated using Pearce element ratio analysis to provide insight into compositional controls in the pluton. Preliminary results suggest that compositional change in the pluton can be explained by fractionation of olivine and plagioclase, with subordinate clinopyroxene control. In peridotite samples compositional variation can be best explained by 80% olivine and 20% plagioclase fractionation, whereas in gabbroic samples compositional variation can be explained by about 43% olivine and 57% plagioclase fractionation. Trace element compositions show patterns consistent with these observations; for example, Ni concentrations correlate well with olivine fractionation measures. Future work will include investigations of silicate and sulphide mineral compositions using electron microprobe analysis, and identification of platinum group element-bearing minerals.

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