

Biotite chemistry as a monitor of magma fertility and mineralisation potential: Results from the Devonian granitoids of New Brunswick

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There are over 150 granitoid intrusions in the New Brunswick; however, all the mineralised intrusions formed in relation to Acadian and Neoacadian orogenic phases of Appalachian accretion. These granitoid intrusions range in age from ca. 423 to 360 Ma, and include examples of pre-, syn-, late-, and post-tectonic emplacement with affinities ranging from primitive to highly evolved A-, S-, and I-type granitoid rocks along with their hybrid varieties. Many of these plutons are spatially and temporally related to specific styles of mineralization, producing deposits of Sn, Ta, Li, Sb, W, Mo, Cu, and Au, as well as other base metals and U.

Igneous biotite crystallises over a wide range of conditions and reacts very sensitively to physio-chemical conditions like halogen and oxygen fugacities, pressure, temperature and chemical composition of the magmas. This sensitivity makes biotite a suitable mineral for identifying the petrogenetic processes, mineralization, and alteration of the host granitic rocks. The following features make biotite a valuable probe of magma composition: (1) it is the most important reservoir of any excess aluminium in granites that do not contain modal garnet, cordierite, or the Al_2SiO_5 polymorphs; therefore, it directly reflects the peraluminosity of the host magma in such rocks; (2) it is the most readily available indicator of oxidation state; and (3) it can provide information about the F and Cl composition of the magma.

Previous studies have shown that biotite, and to lesser extent hornblende and magnetite, continuously equilibrate with host liquids. Consequently, a core-to-rim study of these minerals and their compositional zoning can provide a record of magma evolution so that the origin and evolution of granitoids can be documented.

The aim of this study is to calculate fluoride and chloride activity of aqueous fluids based on measuring F and Cl contents in the minerals containing hydroxyl and halogens, using a combination of electron microprobe and Laser Ablation ICP-MS. These data will be combined and compared with whole-rock trace element geochemistry. The results are expected to help constrain crystallisation conditions, volatile exsolution, and fluorine-chlorine activity of fluids associated with these intrusions, and also to examine the degree of subsolidus re-equilibration using various geothermobarometry techniques. By linking these results to the various styles/types of granitoids and their associated mineralisation it is hoped to establish biotite composition as a robust indicator of the ore potential of an intrusion.