

## **Rare-Element Pegmatite Exploration**

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Granitic rare-element pegmatites host several economic commodities, such as lithium (spodumene and petalite), tantalum (Ta-oxide minerals), tin (cassiterite), rubidium (lepidolite and K-feldspar), cesium (pollucite), and ceramic grade feldspar and quartz. The current lithium rush by the exploration industry is due to the rise in the price of lithium related to the global increased interest in greener vehicles (i.e., electric and hybrid cars). While exploration techniques and deposit models for most economic deposits (i.e., gold, copper, nickel, platinum, lead and zinc) are well known to geologists, exploration techniques for lithium deposits are often unknown to geologists. This short course will consist of two parts: 1) identification of common pegmatite minerals based on physical properties and 2) pegmatite exploration techniques.

Minerals common in rare-element granitic pegmatites are often rare in other rock types. Common major pegmatite minerals include: white blocky K-feldspar, albite with aplite or cleavelandite textures and quartz. The dominant lithium minerals are often: spodumene, petalite, lepidolite and amblygonite. Accessory minerals include: garnet, tourmaline, apatite, beryl, columbite-tantalite (Nb-Ta-oxide minerals) and pollucite (Cs).

Rare-element pegmatites of the Superior Province tend to occur along subprovince boundaries, such as Uchi-English River, Winnipeg River-Wabigoon and English River-Wabigoon subprovincial boundaries. They also occur within the metasedimentary Quetico and Opatika subprovinces.

One pegmatite exploration technique is to find a fertile granite pluton and then search the surrounding area (within 10 km) for its associated pegmatite dikes. The degree of fractionation and rare-element content of the pegmatite dikes increases with increasing distance from their fertile parent granite. Fertile granites differ from regular granites in that they are enriched in rare-elements and contain minerals and textures not usually seen, such as graphic blocky potassium feldspar crystals (> 5 cm) and graphic muscovite + quartz intergrowths. Elevated Rb and Cs contents in bulk analyses of potassium feldspar and muscovite are good indicators of fertile granites. Elevated Ta contents in bulk analyses of muscovite indicate the potential for the pegmatite to contain Ta-oxide minerals. Fertile granites may also contain minerals not present in barren granites: Li-bearing muscovite, garnet, fluorapatite, tourmaline, beryl and rare ferrocolumbite (Nb-oxide).

Another pegmatite exploration technique is to search for pegmatites associated with rare-element enriched metasomatized host rocks, such as mafic metavolcanic and metasedimentary rocks. When a rare-element enriched melt intrudes a host rock, metasomatic fluids from the pegmatite will alter the composition of the host rock to produce a metasomatic aureole. Metasomatized host rocks can be identified by elevated Li, Rb, Cs and B contents in bulk analyses, or by the presence of exotic minerals. Purple needles of holmquistite (Li-amphibole) in mafic metavolcanic rocks are an excellent indicator mineral for rare-element pegmatites because its only mode of occurrence is in metasomatized host rocks next to rare-element pegmatites. Metasomatic aureoles may also contain (Rb, Cs)-rich biotite and tourmaline.