Evaluating Muscovite as an indicator mineral for lithium bearing pegmatites, Wekusko Lake pegmatite field, Manitoba, Canada

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Introduction

The increased focus on renewable energies and battery technologies have resulted in an increased use of lithium (Li) batteries. Consequently, there is an increased demand for high grade Li deposits. Currently, there are two primary sources for Li; pegmatites (i.e. Greenbushes, Australia) and brines (i.e. Salar de Atacama, Chile). In Canada, the primary source of Li is Li-Cs-Ta (LCT) pegmatites such as the world-class Tanco pegmatite, in Manitoba (a former Li producer) and the Wabouchi pegmatite province, in Quebec (a future producer). Lithium can be obtained from different minerals, including spodumene, petalite and Li-bearing micas. LCT pegmatites are also enriched in rare metals such as niobium, tantalum, cesium, tin, and rubidium.
This study focuses on 8 of at least 13 pegmatite dikes of the Wekusko Lake pegmatite field, in Manitoba, Canada, which is under current exploration by Far Resources (Far Resources Ltd., 2019). This pegmatite field is part of the Green Bay group (Černý et al, 1981) and offers an excellent opportunity to investigate muscovite as a potential indicator mineral for Li-bearing pegmatites. The dikes are mineralized to different extents, varying from barren to highly mineralized. The dikes were ranked based average whole rock assay Li_2O concentration and size. The dike ranking from the most to least prospective are: Dike 1, Dike 8, Dike 5, Dike 7, Dike 2, Dike 4, Dike 6. Dike 3 has not been drill tested and therefore was not ranked. The pegmatites consist of 5 zones: border, wall, intermediate, central, and core (Benn et al, 2018). The central zone contains the highest whole rock Li_2O and spodumene concentrations. Muscovite is prevalent throughout all zones in the pegmatite and in all the dikes. Muscovite forms a solid solution with polylithionite as it incorporates increasing amounts of Li into the octahedral site (Tindle and Webb, 1990). As a result, the Li contents of muscovite have the potential to reflect the whole rock Li contents.

Workflow

Muscovite samples were selected from quartered drill core and representative of all drilled dikes and zones. Most of the muscovite are primary, but some secondary were also collected and analyzed. The selected samples were cut into polished thin sections and analyzed with electron microprobe analysis (EMPA) and laser ablation induction coupled plasma mass spectroscopy (LA-ICP-MS). The corresponding thin section blocks were analysis with field portable Raman spectroscopy and portable laser induced breakdown spectroscopy (LIBS). Muscovites were measured using EMPA to obtain major and minor element concentrations and were analyzed on the LA-ICP-MS for trace elements and Li. The portable Raman spectrometer was used to identify multiple common minerals found in pegmatites such as; muscovite, albite, K-feldspars, spodumene, petalite and amblygonite. Portable Raman was also used on a series of muscovite grains ranging in Li content from 1500ppm to 6000ppm and the same grains are being analyzed with a portable LIBS unit for Li content.

Results

K/Rb vs Cs is used to determine degree of chemical evolution of muscovite. Dike 5 is the most evolved (low K/Rb and high Cs), followed by Dike 1 and 8. Dikes 4, 6, 7 and 2 all plot as primitive. The Li content of the muscovite shows a strong correlation to the ranking of the dikes with exception of Dike 5. Muscovite from the most prospective dike, Dike 1, ranges in Li content from 1500ppm to 6500ppm with an average concentration of 3400ppm. The least prospective dike, Dike 6, has Li concentration in muscovite that ranges from 2000ppm to 2750ppm, with an average of 2100ppm. Dike 5 is ranked as the third most prospective. However, it contains the lowest Li content of all dikes, ranging in muscovite Li content from 250ppm to 1200ppm, with an average of 500ppm. Studied muscovites are enriched in Nb and Ta. The Nb contents range from 250ppm to 1000ppm Nb with most of the dikes averaging between 625ppm and 875ppm Nb. Dike 5 is an expectation with Nb ranging from 150ppm to 250ppm and an average of 225ppm. The Ta values range in Dikes 1, 5 and 8 from 25ppm to 475ppm. The other dikes range from 50ppm to 125ppm. Dike 5 has the highest concentrations of Ta ranging from 200ppm to 475ppm, with an average of 425ppm.
Portable Raman spectroscopy was able to positively identify muscovite, and other mineral commonly found in pegmatites such as muscovite, albite, K-feldspars, spodumene, petalite and amblygonite. However, the portable Raman was not able to identify any significant peak changes relating to the variations in Li content. The instrument lacked the resolution in a field environment to detect the minor peak changes above background levels.

Conclusions

Muscovite is an effective indicator mineral for identifying prospective Li-bearing pegmatites. However, multiple muscovite samples are required with both field and laboratory techniques as there is an overlap of Li concentrations between prospective and non-prospective dikes. Muscovite is also useful for identifying dikes with potential for rare metals Nb and Ta. This is very useful as columbite group minerals are typically very fine-grained and difficult to identify in the field.
The field portable Raman spectrometer, while useful for mineral identification, was not able to detect a significant Li signature at the concentrations tested (1500-6000ppm). The use of portable LIBS to detect Li contents within muscovite is a promising technique. It is currently being used successfully in Australia to map the Li concentrations of spodumene in pegmatites. The use of field portable techniques and real-time results in exploration will provide geologists with a powerful tool for more effective drilling and field exploration.

References

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