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Laser-induced breakdown spectroscopy (LIBS) as a tool for in situ mapping and textural interpretation of lithium in pegmatite minerals

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Abstract

Laser-induced breakdown spectroscopy (LIBS) offers an efficient method for qualitative and semi-quantitative analysis of light elements ($Z < 10$), including lithium. This relatively inexpensive analytical tool provides very rapid analysis with little sample damage, requiring minimal sample preparation. In principle, LIBS is a form of atomic emission spectroscopy, relying on characteristic spectra emitted from plasma generated by a high-energy laser pulse striking a sample (solid, liquid, or gas).

In this study, LIBS mapping was applied to petrographically characterized samples of hydrothermally altered spodumene from the Neoarchaean Mt. Cattlin lithium pegmatite deposit. Spodumene ($LiAlSi_2O_6$) is the ore mineral in this deposit, but lithium is distributed in variety of minerals including primary micas and tourmaline, as well as in the alteration mineralogy of spodumene. Mapping was carried out using a grid of analysis spots of 125 µm diameter, spaced at 200 µm intervals, on a sample surface cut by a diamond saw blade without further preparation. Results from mapping of lithium in these samples effectively discriminated between spodumene, its alteration mineralogy, and matrix silicate minerals of the matrix. However, quantification of LIBS results using lithium-doped borosilicate glasses as standards was limited due to issues with the sensitivity of matrix matching of standards and self-absorption effects at Li_2O values greater than ~2 wt%, especially at values greater than ~6 wt%. The results of this study testify to the effectiveness of LIBS as a mapping tool for light elements, which may be used as a complement to other mapping techniques. Mapping of lithium in pegmatite minerals has important applications in exploration, evaluation, and beneficiation of lithium pegmatite ore bodies.

Keywords: Lithium, pegmatite, LIBS, mineral mapping, laser-induced breakdown spectroscopy