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B and Li in Proterozoic metapelites from the Black Hills, U.S.A.: Implications for the origin of leucogranitic magmas

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ABSTRACT

The abundance and distribution of B and Li in metasedimentary rocks and in the Harney Peak Granite (HPG) in the Black Hills, South Dakota, U.S.A., elucidate the behavior of these two elements during (1) regional metamorphism that began at ~1760 Ma; (2) subsequent contact metamorphism associated with emplacement of the HPG and associated pegmatites at ~1715 Ma; and (3) anatexis leading to production of the granite. There is no clear evidence for changes in B and Li concentrations with progressive regional metamorphism of the metapelites from chlorite-biotite grade up to staurolite grade. Rocks outside the pegmatite aureole that surround the HPG have average B contents of ~80 ppm. There is no correlation of B with other elements in the pelitic schists, which indicates that none of the major phases is the dominant host for B. Boron content is mainly controlled by small amounts of randomly distributed tourmaline that was identified in alpha-track maps of thin sections. In the aureole of the granite, B concentrations are depleted in many samples. The depletion is attributed to consumption of tourmaline during interaction of the rocks with alkalic fluids. The average Li contents in metapelites far away from the HPG are also ~80 ppm. Near the HPG, Li concentrations reach roughly 190 ppm, indicating significant metasomatism by fluids that emanated from the granite and pegmatites.

The concentrations of B and Li in the low-grade metapelites are sufficient to explain their abundances in the HPG, if the granite formed by partial melting of the metapelites and if there was total breakdown of tourmaline. Stabilization of tourmaline in leucogranites is not necessarily related to sources enriched in B, but may be related to its competition for Fe and Mg with biotite.