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Garnet chemistry as an exploration tool for Li-pegmatites in the Oxford pegmatite field (Maine, USA)

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Highly evolved pegmatites from the Oxford County (Maine, USA) (e.g., Mount Mica, Berry-Havey, Emmons) are a potential source of metals such as Li, Nb, Ta, Sn, Cs and Be, while pegmatites with a lower degree of fractionation (e.g., Perham, STOP-35), lack most of these elements. The purpose of this study is to evaluate the correlation between the chemical composition of garnets and the fractionation degree of their hosting pegmatites to help exploration for highly fractionated pegmatites in this region.

All the studied garnets belong to the almandine-spessartine series. Those from the most fractionated pegmatites show the highest Mn, Nb, Ta, Zr and Hf values, followed by those from the intermediate grade pegmatites and, finally, garnets from the barren pegmatites show the lowest values. Iron, Ca and Mg contents follow an inverse order, with the highest contents in the barren pegmatites. Major element zoning in garnet crystals shows increasing Mn values from core to rim, while most trace elements show a core to rim depletion. Chondrite normalized HREE spectra show positive slopes for garnets from the barren pegmatites, both positive and negative slopes for those associated with the intermediate-fractionated pegmatites, and negative or flat slopes for garnets from the highly fractionated pegmatites. Garnet chemistry reflects, on the one hand, the composition of the pegmatitic magma (barren pegmatites originate from a more ferromagnesian-rich magma than fractionated pegmatites); and, on the other hand, of the coexisting mineral phases competing with garnets to host certain chemical elements, such as biotite, schorl, plagioclase, apatite, Fe-Mn phosphates, zircon, xenotime and monazite. Compositional variations observed in the studied garnets seem to be mainly controlled by the following exchange mechanisms: Fe-1Mn1, (Fe, Mn)-1Si-1Li1P1; (Y, Ho3+)2(vac)1(Fe, Mn2+)-3.

Chemical characterization of garnet is, therefore, proposed as a potential indicator of the degree of fractionation of pegmatites, with those potentially enriched in Li and other rare elements hosting the garnets richest in Mn, Nb, Ta, Zr and Hf. It would be necessary to include garnet samples from other pegmatitic belts in order to corroborate the usefulness of these garnet geochemical indicators in other regions.