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Distribution of trace elements in garnet from a cold subduction setting – tracing reaction history

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Due to slow diffusion, garnet efficiently preserves compositional growth zonation of major and trace elements, which in return reflect kinetics and thermodynamic conditions. We examine the distribution of trace elements in metamorphic garnet from high-pressure/low-temperature subduction zones in order to infer particular mineral reactions.

Recently, ir has been shown that breakdown of rare earth element (REE)-bearing minerals (especially lawsonite, garnet, titanite and epidote) can produce characteristic features within the garnet REE pattern [1]. According to the model, heavy REE are enriched in the garnet core and the REE decrease in a bell-shaped manner towards the rim, where two high peaks are created as a result of epidote and amphibole breakdown. The higher the atomic number (Z), the higher the peak in the core, but the lower the peak in the rim. The middle REE exhibit bowl- to W-shaped patterns, with the height of the peaks being proportional to Z.

We model such patterns for garnet from cold (lawsonite-stable) subduction zones. In addition to epidote and amphibole breakdown, our data show that lawsonite disintegration results in characteristic patterns with large rim peaks followed by a REE-depleted rim. Lawsonite is a significant water-bearing mineral (up to 11.5 wt.% H_2O), however, it usually breaks down during exhumation. Such a trend may be used to interpret the REE patterns of garnets within samples where lawsonite is no longer preserved. Titanite breakdown and onset of rutile growth can also result in similar peak signatures in the rim, however, unlike lawsonite, titanite breakdown strongly enriches garnet in the middle REE and yttrium.

References:

[1] Ditterova H *et al*. (2015) Goldschmidt Abstracts 747