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Spinels Renaissance: The past, present, and future of those ubiquitous minerals and materials

Geothermometric study of Cr-spinels of peridotite mantle xenoliths from northern Victoria Land (Antarctica)†

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Abstract

The crystal chemistry of Cr-spinels included in spinel peridotite mantle xenoliths from Baker Rocks and Greene Point (northern Victoria Land, Antarctica) has been studied by single-crystal structure refinement and electron microprobe analysis. All crystals are characterized by a dominance of Al ↔ Cr substitution with minor evidences of Mg ↔ Fe^{2+} substitution and pertain to the Mg-rich portion of the spinel sensu stricto-chromite join. The two groups of samples, Baker Rocks (BR) and Greene Point (GP), show distinct degree of cation order with the inversion parameter ranging from 0.17 to 0.20 for BR spinels and from 0.06 to 0.13 for GP crystals. Closure temperatures, computed by a geothermometer based on the $^{M}Al+^{T}Mg \leftrightarrow {}^{T}Al+{}^{M}Mg$ intracrystalline exchange, range from 883 to 911 °C for BR spinels and from 592 to 675 °C for GP spinels. We show that this difference is due to the higher concentration in Fe^{3+} in GP spinels that enabled a faster kinetics of the intracrystalline cation ordering reaction, allowing the GP spinels to reach a higher degree of cation ordering and then lower closure temperatures.

Keywords: Cr-spinel, crystal structure, crystal chemistry, geothermometer, order-disorder kinetics, mantle xenoliths, Antarctica