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Closure temperatures of intracrystalline ordering in anatectic and metamorphic hercynite, $Fe^{2+}Al_2O_4$

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Abstract

The closure temperature, T_C, of the intracrystalline ordering of Mg-hercynite is estimated with a comparative crystal-chemical approach. The single crystals were selected from two distinct geological environments that represent extremely different cooling rates. The fast cooled setting refers to anatectic metapelitic enclaves that occur in the high-K calc-alkaline lavas of the Neogene Volcanic Province of SE Spain. The slow cooled setting refers to metabauxite from the Anga metamorphic complex, Lake Baikal. Parameters sensitive to T_C include the oxygen fractional coordinate (u) and the inversion parameter (i). Experimental equilibration data on the spinel and hercynite end-members and on their solid solution are fitted to equations where T_C is given as a function of the hercynite content (Hc) of the solid solution and of u or i. The unavoidable simplifications made in this empirical approach are discussed. A reasonable value for T_C, ~400 °C, was obtained for the slow cooled metamorphic hercynite from the oxygen fractional coordinates. In contrast, an unreasonably high value of T_C, ~600 °C, was obtained from the inversion parameters. In the case of the fast cooled anatectic samples, T_C calculated from the two structural parameters are comparable; the five crystals show a range in the calculated values for T_C over ~250 °C, from ~700 to ~950 °C, which is reasonable considering the known diversity of cooling rates exhibited by their volcanic host-rocks.

Keywords: Hercynite, spinel, closure temperature