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# Ferritchromite and chromian-chlorite formation in mélange-hosted Kalkan chromitite (Southern Urals, Russia)

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## Abstract

Spinel is often used as a magmatic indicator of crystallization processes, without considering the effects of metamorphic alteration on spinel geochemical features. Serpentinized mélanges in the southern Urals host different kinds of disseminated to massive chromitite mineralization. In mélange environments, intense metamorphic alteration above 300 °C leads to major changes in chromite chemistry and to the growth of secondary phases such as ferritchromite and chromian-chlorite. Based on textural and chemical analyses, mélange-hosted Kalkan chromitites exhibit a hydration and oxidation reaction that can explain the formation of ferritchromite and chromian-chlorite from chromite and serpentine:

$$\underset{\text{Chr}}{2(Mg_{0.60}Fe_{0.40})(Cr_{1.30}Al_{0.70})O_4} + \underset{\text{Atg}}{3/2(Mg_{2.57}Al_{0.32}Fe_{0.11})Si_2O_5(OH)_4} + H_2O + 1/12O_2 \rightarrow$$
$$\underset{\text{Fe-Chr}}{7/6(Mg_{0.40}Fe_{0.60})(Cr_{1.85}Fe_{0.08}Al_{0.07})O_4} + \underset{\text{Cr-Chl}}{1/2(Mg_{9.18}Fe_{0.34}Al_{1.60}Cr_{0.88})(Al_2Si_6)O_{20}(OH)_{16}}.$$

Textural analyses fit well with the proposed reaction and show that it usually proceeds very close to completion. The degree of alteration of chromite into ferritchromite is controlled by the initial chromite to serpentine ratio. In chromitites, high ratios prevent complete transformation of chromite into ferritchromite. The most likely environment for such reaction is a prograde metamorphic event post-dating serpentinization of the Kalkan ophiolite, possibly related to emplacement within an accretionary wedge.

**Keywords:** Chromitite, chromite, ferritchromite, chromian-chlorite, alteration, ophiolite