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Plastic deformation and post-deformation annealing in chromite: Mechanisms and implications

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Abstract

Plastic deformation in chromite is not frequently reported in literature. We present a detailed microstructural analysis of this mineral from the massive chromitite of the Neoarchaean Sittampundi Complex, southern India. The study reveals intracrystalline plasticity is dominantly active in this mineral, and it produces distinctive features corresponding to at least two different microstructural regimes. The Regime 1 is deformation-related and it commenced with recovery of strained grains and formation of new grains, corresponding to subgrain rotation recrystallization. This was followed by nucleation of strain-free new grains in regions of high strain. The Regime 2 appears to be post-deformational and dominantly temperature-controlled, producing distinctive features of static annealing of already deformed grains. This regime corresponds to grain boundary migration recrystallization resulting coarsening of strain-free facetted, new grains at the expense of high-dislocation density subgrains. The resultant micro-features resemble closely what is known as "abnormal grain growth," not yet documented for chromites. These coarse grains, in places, also feature accommodation of deformation by displaying very low-angle subgrain boundaries. The movement of high-angle grain boundaries in Regime 2 through precursor strained grains provided high diffusivity paths for the rapid exchange of components, producing compositional heterogeneity between grains dominated by deformation features and facetted new grains. These microstructural observations coupled with chemical heterogeneity provide new directions in interpreting the deformation mechanism of chromite and its annealing history at the post-deformation stage.

Keywords: Chromite, plastic deformation and recrystallization, strain-free new grain, annealing, abnormal grain growth