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Topotactic transformations Between Iron Oxides and Oxyhydroxides in iron formation rocks

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Crystallographic similarities between hematite and goethite allow topotactic relationship between these two minerals [1,2,3]]. For natural occurrence of goethite and hematite little is know about such process [4,5]. The aim of this contribution is to investigate the transformation that occurs in response to a change in deformation and metamorphic conditions of iron formation rocks deformed at low temperature. We applied the EBSD techinique to investigate the transformation between iron oxides and oxyhydroxides.
Samples came from iron formation rocks in southeast of Brazil, in a region called Iron Quadrangle. Their mineralogy consists basically of iron oxides and oxihydroxides. On the optical microscope magnetite is almost completely oxidized to hematite. In several of their grains the inner core are composed of goethite rimmed by hematite grains. The inner goethite occurs in aggregates of irregularly shaped grains of varied sizes. Hematite at the rims also shows similar microstructural patterns.
The EBSD analyzes of the clasts show a close relationship in the crystallographic orientation between hematite and goethite crystal. The poles to the basal planes of hematite {001} match those of goethite crystals {001}.
Hematite and goethite, although belonging to different space group symmetries, have similar close packing structures. The structures of hematite and goethite can be described as a slightly distorted hexagonally close-packed of anions (O_2- and OH-) stacked along their [c] axes. In these conditions, atom displacements are reduced, so that clear vectorial relations can be established between crystal parameters of the two structures. It is know that the transformation to goethite does not modify significantly the layers of anions in the structure. Therefore, crystallographic orientation relationships exist between the two phases.
We proposed that the transformation described in the studied iron formation rocks was performed in two different stages. Initially, the original magnetite crystals were hydrated and transform by oxidation into the goethite. This might have been caused by a percolation of low temperature aqueous fluids in the early stages of the deformation. Subsequently, as the deformation proceeds and the temperature increase with the progressive metamorphism of the iron formations, the newly formed goethtite crystals dehydrated and transformed into hematite. This a topotactic transformation as both minerals show orientation correspondences in planes, {0001} and {001}, and directions, <a> and [010], of hematite and goethite, respectively.

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