EBSD analyses of crystallographic orientation memory in magnetite-haematite transformation

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The samples studied in this paper contain magnetite transformed to haematite. They are from iron formation (IF) rocks of the Quadrilátero Ferrífero, southeastern Brazil. The magnetite and haematite transformation of the IFs can be considered as a Fe-O system. Samples were carefully selected of these rocks where magnetite crystals occur as isolated large crystals immersed in a matrix of haematite grains. An electron microscope equipped with an EBSD system were used to investigate the microstructural and crystallographic relationship involved in the phase transformation magnetite-haematite. Magnetite crystals analyzed in IF samples are partially transformed to haematite. The transformation occurs along the crystallographic planes {111} producing a characteristic triangular pattern of interlocking stripes of transformed haematite crystals oriented along {111}. EBSD analyses of the magnetite host and the transformed haematite show that the magnetite and the new haematite crystals share crystallographic planes of highest atomic density, e.g. {111} and (0001), respectively, possibly due to the CCP and HCP atomic arrangement of the two crystals. Therefore when the poles of these two planes are plotted in the stereogram their maxima coincide. However crystallographic orientation of haematite crystals in the matrix shows maxima of (0001) poles not coincident with those of {111} planes of magnetite. Consequently, it is concluded that the direct transformation to haematite crystals carry the crystallographic orientation memory of the old magnetite crystals, possibly due to the similar manner whereby atoms are packed together in the crystal structures. On the hand no such relationships are observed between magnetite and haematite crystal in matrix. This suggests that haematite grains in the matrix may have been formed by other processes rather than those involved in the iron oxide transformation observed within the magnetite grains.

Keywords: Magnetite, Haematite, iron oxides, EBSD, crystallography