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Microscopic observation of titanomagnetite grains during paleointensity experiments of volcanic rocks

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Titanomagnetite (Tmt) grains, some partially maghemitized, of various oxidation levels were microscopically observed under reflected light as a function of temperature step in a Kǒnigsberger Thellier Thellier experiment in air. The reflected light microscopy indicated that the brownish colour of homogeneous Tmt turned blue at ∼300 ℃. This false blue colour was caused by submicron scale rugged stripes on the surface, according to scanning electron microscope observations, which was made after the final heating step. The typical grey-to-bluish colour of maghemitized parts of Tmt grains turned to a brownish colour at ∼300 ℃, indicating inversion of titanomaghemite to a mixture of magnetite and ilmenite (Ilm) or haematite (Hem). Although these observations were from Tmt grains on the sample surface, oxidation must have proceeded similarly within samples because the surface changes in the Tmt grains were highly correlated with behaviour of data points on Arai plots. Alterations in Tmt after heating at 610 ℃ in air for increasing times from 10 to 500 min were evaluated by reflected light microscopy and scanning electron microscopy at the end of the experiment. Mottled patches gradually emerged in the Tmt grains during subsequent heatings. However, the formation of new Ilm lamellae was not observed, even after the final 500 min heating. In conclusion, the alteration of Tmt during laboratory heating in air at ∼600 ℃ is likely not due to the typical high-temperature oxidation that forms trellis-type Ilm lamellae. Below ∼400 ℃, the process should be closer to low-temperature oxidation. On the other hand, maghemitized parts of Tmt grains invert instantaneously at 300 ℃, and a trellis-type structure with Hem lamellae soon emerges when heated at 610 ℃.