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LETTERS

Magnetic monitoring of hydrothermal magnetite nucleation-and-growth: Record of magnetic reversals

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ABSTRACT

Hematite reduction in the presence of pyrite and CaO led to the formation of anhydrite and magnetite at 30 MPa and 723 K under hydrothermal conditions in a sealed gold container. For the first time, hydrothermal magnetite production was monitored magnetically at the run conditions. Sample magnetic susceptibility was found to follow an Avrami kinetic law with $k = 1.5\ 10^{-5}$/s and $n = 2.07$. Application of up to two external field reversals in the course of the magnetite production reaction shows that partial Chemical Remanent Magnetizations (CRM) are recorded by the sample. The intensity of each partial CRM acquired within a given time interval (under a given field intensity) is proportional to the amount of magnetite produced during that time interval. Alternating magnetic field demagnetization failed at separating these partial CRMs, which are believed to superpose in the (V, Hc) diagram of Néel. Additional TEM, SEM, and magnetic characterizations suggest that continuous nucleation and fast magnetite growth (to a maximum size of ca. 10 μm), compared to the field polarity duration, can account for the evolution of the sample CRM with time. This study demonstrates that one should be cautious when using natural CRM apparent polarity to infer timing of the corresponding chemical event.