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Temperature and time dependent growth of magnetite derived from siderite decomposition: in situ Raman spectroscopy and magnetic susceptibility measurements

A. Isambert (1), B. Reynard (2), A. Gloter (3), F. Guyot (4) and J-P. Valet (1)

(1) Laboratoire de Paléomagnétisme, Université Paris VII et IPGP, Paris, (2) Laboratoire de Sciences de la Terre, ENS Lyon, (3) Laboratoire de Physique des Solides, Université Paris-Sud, Orsay, (4) Département de Minéralogie IMPMC and IPGP, Paris (isambert@ipgp.jussieu.fr)

Siderite ($FeCO_3$) is an iron bearing carbonate common in a wide range of terrestrial environments. It forms a solid solution with magnesite ($MgCO_3$) and rhodocrosite ($MnCO_3$). The study of the thermal decomposition and oxidation of the mineral siderite is a topic of considerable interest because of its commercial importance and its scientific interest to geologist in different research areas. Upon heating in air, natural Mn-bearing siderite breaks down into Mn-hematite and Mn-magnetite. This Mn-magnetite can carry a stable chemical remanent magnetization with important consequences both for the magnet-industry and various types of magnetic studies. This work was focused on the characteristic timing for decomposition of siderite into magnetite using in-situ high-temperature Raman spectroscopy and magnetic susceptibility measurements. The association of these two analytical tools allowed us to observe both the process of siderite decomposition and the growth of hematite and magnetite crystals. It was found that nanometre-sized magnetites can be formed from siderite within minutes at temperatures as low as 300°C. Moreover, the kinetic study by magnetic measurements allowed to follow in situ the evolution of magnetite grains from superparamagnetic to single domain states.