Nanoanalysis of Metamorphic Magnetite using Field Ion Microscopy and Atom Probe Tomography

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Abstract

Atom probe tomography (APT) is a highly attractive technique for the nanoanalysis of geological materials despite the difficulties inherent in analyzing semiconducting and insulating materials. Field ion specimens have been successfully fabricated from samples of metamorphic magnetite crystals (Fe_3O_4) extracted from a polymetamorphosed, granulite-facies marble with the use of a focused ion beam (FIB). These magnetite crystals contain nanometer-scale, disk-shaped lamellae which qualitative energy-dispersive X-ray spectroscopy (EDS) has shown contain elevated concentrations of manganese and aluminum. These lamellae make this magnetite particularly attractive for investigating the capabilities of APT for the nanoanalysis of geological materials.

Field ion microscope (FIM) images of these magnetite crystals were obtained in which the observed size and morphology of the precipitates agree with previous results. Although a limited number (>3000) of ions were collected in an energy compensated optical position-sensitive atom probe (ECOPoSAP), peaks for singly ionized ^{16}O, ^{56}Fe, and ^{56}FeO and doubly ionized $^{16}O_2$ ^{54}Fe, ^{56}Fe and ^{57}Fe peaks were fully resolved. Manganese and aluminum were observed in a limited analysis of a single lamella in the ECOPoSAP.

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