MAGNETITES FORMED FROM THERMAL DECOMPOSITION OF (CA,MG,FE)CO_3: "FOREIGN" CATION INCORPORATION INTO THE ESTRUCUTURE OF MAGNETITE

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It has been claimed that chemically pure magnetites (Fe_3O_4) can be obtained from thermal decomposition of (Fe,Mg)CO_3 [1], offering, thus, the possibility of an inorganic via of formation for magnetite crystals in Martian meteorite ALH84001. Such a chemical purity is one of the parameters used so far to recognize bacterial origin of natural magnetites samples, both terrestrial and extraterrestrial [2], since it has been demonstrated that biologically-controlled magnetites are chemically pure [3]. However, while Golden[1] obtained pure magnetite from an almost pure precursor, the ankerite cores in ALH84001 in which magnetites are embedded are far from being chemically pure, since they contain considerable amounts of Ca and Mg [4].

In this study we have performed several experiments to analyze the chemical purity of magnetites produced from thermal decomposition of four ankerites, synthesized in the laboratory, and containing different amounts of Ca, Mg and Fe, ranging from 0 to 27.4 mol % Ca and from 12.3 to 54.6 mol% Mg. Such a thermal decomposition was achieved by two procedures: (1) by heating the samples at 470ºC under 1 atm CO_2 pressure [equal to the hypothetical ancient CO_2 pressure in Mars [4]] and (2) by decomposing the ankerite "in situ" under the TEM (Transmission electron microscopy) electron beam. Magnetite produced by the first procedure was analyzed by XRD to determine whether or not the resulting solid was a mixture of oxides or rather a solid solution of (Ca, Fe and Mg)oxide. Magnetites formed by the two methods were studied by High Resolution TEM. The chemical composition of about 20 crystals of each experiment was analyzed by EDAX.

Under our experimental conditions, ankerites decomposed into magnetite crystals of about 5 nanometers in size. Magnetite crystals aggregates keep the morphology of the precursor (i.e., they form pseudomorphs). Our results confirm that none of these magnetites is chemically pure, but rather, each one of them is a solid solution of Ca and Mg. Therefore, chemically pure magnetites found in the meteorite ALH84001 cannot be obtained, as Golden [1] proposed, just by the thermal decomposition of the (Fe,Ca,Mg)CO_3 precursor in which they were embedded.

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