3-D colloidal crystals of magnetite in the Tagish Lake carbonaceous chondrite

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Tagish Lake carbonaceous chondrite (fallen on 2000) is known as a primitive meteorite in chemical composition but the meteorite heavily suffered aqueous alteration. In the matrix, magnetite (Fe_3O_4) particles were reported to be present in between tiny forsterite crystals [1]. However no detailed observation of morphology from these particles has been done, though the morphology of crystals possess the growth conditions precisely in which these crystals have been growing [2].

The chondrite with a few mm, in diameter, were cleaved, so that fine crystalline particles would expose on the fractured surface. These crystal surfaces were investigated employing field emission scanning electron microscopy (FE-SEM) and transmission electron microscopy (TEM).

Magnetite crystals (*Fd*3*m*, cubic) usually exhibit an octahedron shape surrounded by the {111} faces. In this meteorite, however, magnetite fine particles, which are result of reaction of other silicate minerals with water or ice in the early stage of solar system, exhibit varieties of shapes, e.g. octahedron, rhombic dodecahedron with {110} face (Fig. 1), trisoctahedron with {211} face, 100-1000 nm in diameter (peak size, 200 nm). It is surprising to find that these fine magnetite particles form 3D colloidal crystals with varieties of structures, f.c.c. (Fig. 1), b.c.c, and h.c.p. In this colloidal system, not only the size but also the morphology of these particles determined the lattice structure of the colloidal crystal. It is very interesting to note that only the rhombic dodecahedron particles exhibit multiple twinning.

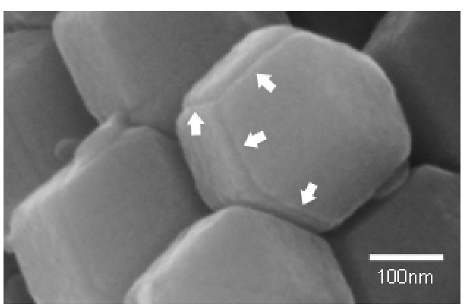

Figure 1: FE-SEM image, magnetite colloidal crystals formed by multiple-twin particles. Twin-boundaries are indicated by white arrows.

References

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The nature of the Arabian lithospheric mantle beneath Aritain Volcano, NE Jordan

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The mantle xenolith-bearing Jabel Aritain volcano in NE Jordan belongs to the As Shamah Cenozoic lava field, which is the largest in the W part of the Arabian plate extending from S Syria through Jordan into NW Saudi Arabia.

Most Jabel Aritain mantle xenoliths are spinel lherzolites but herzburgites, dunites, websterites and wehrlites are also present. Calculated equilibrium P,T conditions range from 900 to 1000 °C and 12-17 kbar, respectively, and are consistent with estimations made for peridotites from other localities in this area of the Arabian platform, indicating that xenoliths were extracted from shallow depths of 40 to 60 km (Medaris and Syada, 1998).

Glasses from melt pockets present in a number of xenoliths have an unusually high mg# of 75 and secondary olivines with $Fo_{94.5}$, which suggests that the metasomatic melt was probably picritic.

LA-ICP-MS analyses of cpx show that xenoliths experienced cryptic metasomatism. Three groups of xenoliths have been recognized according to REE and other incompatible trace element patterrns in cpx: group 1 has depleted LREE abundances, group 2 is highly enriched in LREE (80 x chondritic) and group 3 has moderate LREE enrichments. The REE patterns in group 3 indicate that for some reason equilibrium conditions for trace elements has non been achieved as some cpx have higher LREE abundances than others within the same sample. In this group, the common Zr depletion relative to Nd and Sm implies that it is not associated to partial melting processes but rather to metasomatic processes and that the cpx was originally not depleted in Zr. Evidently, the metasomatic agent was a H_2O-rich fluid (high LREE and Sr) with carbonatitic components (depletion of Zr and Ti).

The Jabel Aritain mantle xenoliths are in terms of PT equilibrium conditions similar to xenoliths from Jabel El Arab (ca. 100 km N of Aritain) and other Arabian plate peridotites suggesting a common thermal regime.

The metasomatic fluids/melts affected variably the trace element but not the major element abundances. Apparently, the metasomatic processes were interrupted before equlibration could be achieved indicating a pre-eruption metasomatic front rising from lower levels of the local upper mantle.

Reference

Medaris L.G and Syada G. (1998), *Int. Geol. Review* **40**, 305-324