Oral presentation

Synchrotron X-ray characterization of icosahedrite, the first natural icosahedral AlCuFe quasicrystal

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In 2009, the first natural icosahedral quasicrystal (icosahedrite: $Al_{63}Cu_{24}Fe_{13}$) was found in nature [1], thus showing that these materials could form also in a natural environment beside those produced in laboratory experiments. To shed light on the formation process and stability of this natural quasicrystals, we measured a full diffraction pattern containing both Bragg and diffuse scattering, using synchrotron radiation at the ID28 ESRF beam line. The investigated icosahedrite single grain sample exhibits the characteristic diffraction pattern of the icosahedral quasicrystal, but each icosahedral Bragg peak is flanked by 12 satellite reflections lying along directions parallel to a 5-fold axis. The distance between the main Bragg peaks and the satellites reflection is very small and equal to $1/1$ where 1 is found to be about 19 nm. This diffraction pattern is completely analogous to the one of the modulated icosahedral AlCuFe phase, observed with laboratory-grown single AlCuFe grains after a specific heat treatment. The modulation, was shown to result from a cosine modulation wave, with a wavelength equal to 19 nm, propagating along 5-fold directions and having a polarization in the complementary 'phason' space [2]. This results in a specific intensity distribution of the satellite that is also observed in the natural icosahedrite single grain diffraction pattern demonstrating that the modulation can also be interpreted as having a phason modulation origin in this sample.

These x-ray diffraction results have been compared to previously obtained electron diffraction pattern of a single crystal from the same batch originating from Khatyrka. Differences observed between the two diffraction patterns can be interpreted by strong shock-induced heterogeneity in the temperature and pression profile during the formation process. This is supported by the observation of both olivine and ringwoodite in similar samples [3]. Consequences on the formation process and thermal history of the icosahedrite will be discussed.

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