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57Fe Hyperfine Interactions in M1 and M2 Sites of Olivine from Omolon Meteorite: Study Using Mössbauer Spectroscopy

Olivine (Fe, Mg)2SiO4 is a mineral with two crystallographically non-equivalent six-fold octahedral sites for Fe2+ and Mg2+ denoted as M1 and M2. These sites in olivine are occupied by Fe2+ and Mg2+ ions in different ways. The Fe–Mg distribution between two sites is of interest for mineral cooling history determination. Recently we demonstrated new possibilities in the study of ordinary chondrites and other meteorites using Mössbauer spectroscopy with a high velocity resolution [1–3]. In particular, in these works differences of hyperfine parameters for the M1 and M2 sites of olivine in bulk ordinary chondrites were revealed for the first time. In the present study olivine extracted from pallasite Omolon was investigated using Mössbauer spectroscopy with a high velocity resolution. Mössbauer spectra of olivine were measured using a spectrometric complex described in details elsewhere [4, 5] in 4096 channels at 295 and 90 K. Mössbauer spectrum of olivine at 295 K is shown in Fig. 1. This spectrum was fitted using superposition of two main doublets (1 and 2) and one minor doublet 3. Mössbauer hyperfine parameters for the minor doublet characterized ferric compound while those for the main doublets were correspondent to ferrous compounds with different values of isomer shift and quadrupole splitting. The 1st and the 2nd doublets were related to the 57Fe nuclei in the M1 and M2 sites, respectively. Mössbauer spectrum of olivine measured at 90 K was fitted using two main doublets related to the 57Fe nuclei in the M1 and M2 sites. It was found that quadrupole splitting values for the M1 and M2 sites simultaneously increased with temperature decrease while isomer shift values increased with temperature decrease in different way (Fig. 2). This fact may indicate differences in the second order Doppler shift and Debye temperature for the 57Fe nuclei in the M1 and M2 sites of olivine.

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