Comparative Study of Olivine in Pallasites and Chondrites Using Mössbauer Spectroscopy with a High Velocity Resolution

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There are two crystallographically non-equivalent six-fold octahedral sites in olivines $(Fe,Mg)_2SiO_4$ which are occupied by Fe^{2+} or Mg^{2+}. Small differences of the ^{57}Fe hyperfine parameters were revealed for the M1 and M2 sites in olivine for a number of ordinary chondrite samples using Mössbauer spectroscopy with a high velocity resolution (spectra were presented in 1024 channels) at room temperature (Grokhovsky et al. 2009; Oshtrakh et al. 2008). In this study we present a comparison of the study of olivines extracted from pallasites and olivines in the bulk ordinary chondrites using Mössbauer spectroscopy with a high velocity resolution (spectra presentation was in 4096 channels) at 295 and 90 K. Olivine crystals extracted from pallasites Omolon and Seymchan and samples of Tzarev L5 and Farmington L5 chondrites were powdered and used for Mössbauer measurements. Spectra were measured using automated precision Mössbauer spectrometric system with absorber moving in cryostat (Semionkin et al. 2010).
Mössbauer spectra of olivines from Omolon and Seymchan demonstrated inverse asymmetry at 295 and 90 K (Fig. 1) which is related to the second order Doppler shift and different Debye temperature for the M1 and M2 sites of olivines. The minor component 3 was observed in addition to doublets 1 and 2 which were related to the M1 and M2 sites. It was shown small variations of quadrupole splitting for the ^{57}Fe in both the M1 and M2 sites of two olivines (Fig. 2).

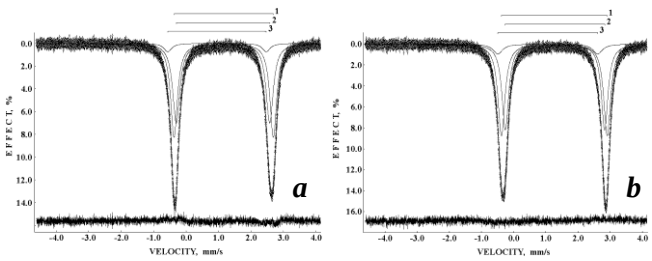

Fig. 1. Mössbauer spectra of olivine from Seymchan measured in 4096 channels at 295 K (***a***) and 90 K (***b***).

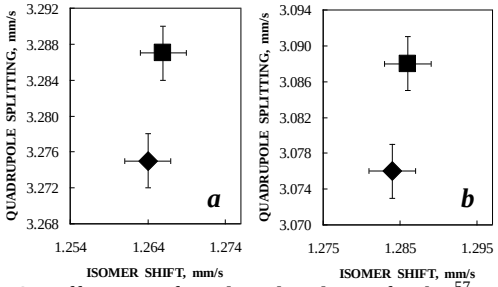

Fig. 2. Differences of quadrupole splitting for the ^{57}Fe in the M1 (***a***) and M2 (***b***) sites of olivine from Omolon (◆) and Seymchan (■) at 90 K.

Similar differences were obtained for olivines in ordinary chondrites while the minor third component was not observed in complex chondrite spectra. On the basis of Mössbauer results evaluation of the temperature of equilibrium cation distribution was done. The results obtained demonstrated small variations of Mössbauer hyperfine parameters for different olivines that may be related to some structural peculiarities of Fe^{2+} environment in olivines formed in different meteorites.
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