# $Fe^{2+}$ OCCUPANCIES IN THE M1 AND M2 SITES IN SILICATE CRYSTALS IN CHELYABINSK LL5 FRAGMENTS WITH DIFFERENT LITHOLOGIES ANALYZED USING X-RAY DIFFRACTION AND MÖSSBAUER SPECTROSCOPY.

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**Introduction:** The distribution of $Fe^{2+}$ and $Mg^{2+}$ cations between crystallographically nonequivalent M1 and M2 sites in silicates crystals is related to the thermal history of silicates and meteorites containing these phases. Recently, we demonstrated that the data obtained from the study of Annama H5 and Northwest Africa 6286 and 7857 LL6 ordinary chondrites by means of two independent techniques, X-ray diffraction (XRD) and Mössbauer spectroscopy, can be used for calculation of the $Fe^{2+}$ occupancies of the M1 and M2 sites in olivine, orthopyroxene and clinopyroxene which results were in a good consistency [1, 2]. Therefore, we applied this approach for the study of Chelyabinsk LL5 fragments with different lithologies.

**Materials and Methods:** The samples of the powdered internal matter from five fragments of Chelyabinsk LL5 meteorite with different lithologies such as light lithology (two fragments marked No 1 and No 1a), mixed light and dark lithologies (two fragments marked No 2 and No 2a) and black lithology (one fragment marked No 3) were prepared for XRD and Mössbauer studies. The XRD–7000 powder diffractometer (Shimadzu) was used for XRD measurements while the SM-2201 spectrometer with a high velocity resolution was used for the $^{57}Fe$ Mössbauer spectra measurements at 295 K. Detailed description can be found elsewhere [3].

**Results and Discussion:** Using the Rietveld full profile analysis of the XRD patterns the values of the $Fe^{2+}$ occupancies in the M1 and M2 sites ($X_{Fe}^{M1}$ and $X_{Fe}^{M2}$) in silicate crystals were determined (see Table 1). The best fits of the Mössbauer spectra of the studied fragments revealed spectral components assigned to the $^{57}Fe$ in the M1 and M2 sites in silicates ($A^{M1}$ and $A^{M2}$). The ratio $A_{Fe}^{M1}/A_{Fe}^{M2}$ corresponds roughly to the ratio of the $Fe^{2+}$ occupancies of the M1 and M2 sites. The results are presented in Table 1 for selected fragments. These results demonstrate a good consistency for two techniques and some variations in the $Fe^{2+}$ occupancies for the same silicate crystals in different fragments.

**Table 1.** The ratios of $Fe^{2+}$ occupancies in the M1 and M2 sites in olivine, orthopyroxene and clinopyroxene in selected Chelyabinsk LL5 fragments calculated using XRD and Mössbauer spectroscopy data.

| Silicates in different fragments | XRD | | | Mössbauer spectroscopy |
|---|---|---|---|---|
| | $X_{Fe}^{M1}$ | $X_{Fe}^{M2}$ | $X_{Fe}^{M1}/X_{Fe}^{M2}$ | $A^{M1}/A^{M2}$ |
| **Olivine** | | | | |
| No 1a (light lithology) | 0.29 | 0.24 | 1.21 | 1.21 |
| No 2 (mixed light and dark lithologies) | 0.27 | 0.23 | 1.17 | 1.18 |
| No 2a (mixed light and dark lithologies) | 0.33 | 0.25 | 1.32 | 1.37 |
| No 3 (black lithology) | 0.30 | 0.25 | 1.20 | 1.17 |
| **Orthopyroxene** | | | | |
| No 1a (light lithology) | 0.09 | 0.41 | 0.18 | 0.33 |
| No 2 (mixed light and dark lithologies) | 0.08 | 0.40 | 0.20 | 0.25 |
| No 2a (mixed light and dark lithologies) | 0.10 | 0.38 | 0.26 | 0.40 |
| No 3 (black lithology) | 0.11 | 0.38 | 0.29 | 0.30 |
| **Clinopyroxene** | | | | |
| No 1a (light lithology) | 0.34 | 0.09 | 3.78 | 4.78 |
| No 2 (mixed light and dark lithologies) | 0.32 | 0.18 | 1.78 | 1.90 |
| No 2a (mixed light and dark lithologies) | 0.33 | 0.13 | 2.54 | 2.31 |
| No 3 (black lithology) | 0.34 | 0.14 | 2.43 | 2.33 |

**Acknowledgements:** This work was supported by the Ministry of Science and Higher Education of the Russian Federation, the Project № 3.1959.2017/4.6 and by Act 211 of the Government of the Russian Federation, agreement № 02.A03.21.0006.

**References:**

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