MÖSSBAUER SPECTROSCOPY WITH A HIGH VELOCITY RESOLUTION: ADVANCES IN THE STUDY OF METEORITIC IRON-BEARING MINERALS. M. I. Oshtrakh[1,2], A. A. Maksimova[1], M. V. Goryunov[1,2], G. A. Yakovlev[1], E. V. Petrova[1], M. Yu. Larionov[1], V. I. Grokhovsky[1] and V. A. Semionkin[1,2]. [1]Department of Physical Techniques and Devices for Quality Control, Institute of Physics and Technology, Ural Federal University, Ekaterinburg, 620002, Russian Federation. [2]Department of Experimental Physics, Institute of Physics and Technology, Ural Federal University, Ekaterinburg, 620002, Russian Federation. E-Mail: oshtrakh@gmail.com.

Introduction: ^{57}Fe Mössbauer spectroscopy is a powerful analytical tool in the study of various iron-bearing phases in meteorites. Further development of this technique to increase its quality and accuracy led to creation of new high precision Mössbauer spectrometric system with a high velocity resolution which demonstrates accuracy in the determination of Mössbauer hyperfine parameters at least 8 times higher than in any other conventional spectrometers [1]. This more powerful technique has been successfully applied in the study of various iron-bearing phases in iron meteorites (such as Sikhote-Alin, Chinga, etc.), ordinary chondrites LL, L and H groups (such as Chelyabinsk LL5, Tsarev L5, Farmington L5, etc.), pallasites (Omolon and Seimchan) and some extracted phases such as troilite, schreibersite, rhabdite. These studies showed complicated Mössbauer spectra of the majority of minerals which were fitted much better than similar spectra measured with a low velocity resolution by other researches. Application of Mössbauer spectroscopy with a high velocity resolution permitted us to measure spectra of studied meteorite samples with a high quality and reveal information about composition of iron-bearing phases as well as differences in local microenvironment of iron in the same phases from different meteorites [2–4].

Selected Results: Some examples of various meteorites study using Mössbauer spectroscopy with a high velocity resolution demonstrated the following results. In the Mössbauer spectra of ordinary chondrites Farmington L5, Tzarev L5, Chelyabinsk LL5 and 9 other L and H chondrites spectral components related to crystallographycally nonequivalent M1 and M2 sites occupied by Fe^{2+} and Mg^{2+} in both olivine and pyroxene were revealed in the bulk samples (Fig. 1a) and difference in the phase composition were observed. Further study of olivine extracted from Omolon and Seymchan pallasites (Fig. 1b) showed small variations of the ^{57}Fe hyperfine parameters in the corresponded nonequivalent M1 and M2 sites in both olivines. Mössbauer spectra of schreibersite and rhabdite samples extracted from Sikhote-Alin iron meteorite with three crystallographically nonequivalent M1, M2 and M3 sites occupied by Fe and Ni were analyzed using various numbers of components (Fig. 2a). These components were related to the ^{57}Fe in the M1, M2 and M3 sites with further evaluation of Fe and Ni occupations in the samples. Study of Sikhote-Alin, Chinga and some other iron meteorite samples revealed complicated Mössbauer spectra with various components related to α-Fe(Ni, Co) and γ-Fe(Ni, Co) phases (Fig. 2b). Moreover, in the samples of Chinga fragment obtained from visually different zones on fragment saw cut demonstrated complicated Mössbauer spectra with some differences of Mössbauer parameters.

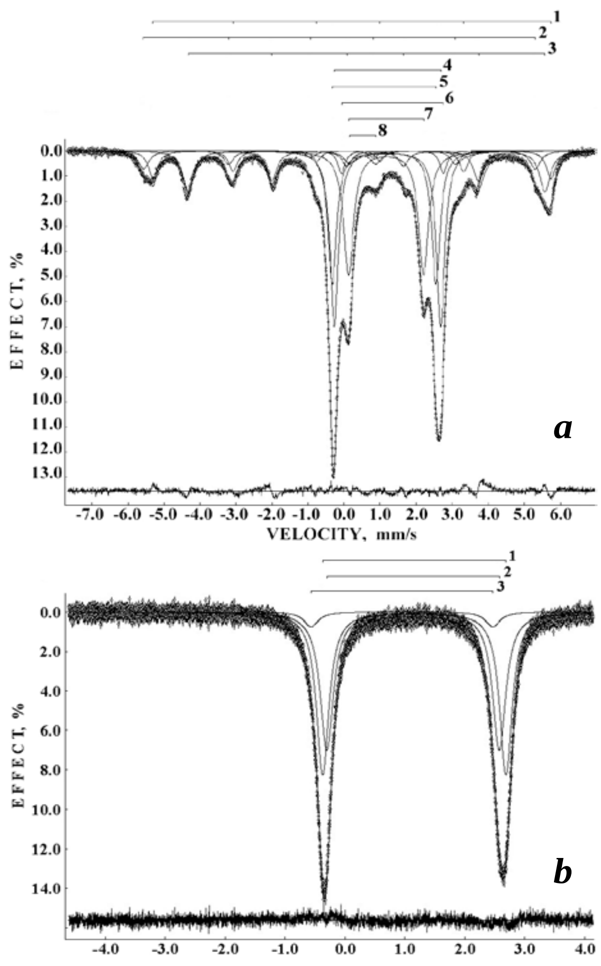

Fig. 1. Mössbauer spectra of Farmington L5 (***a***), olivine extracted from Seymchan (***b***) measured with a high velocity resolution. Indicated components are the results of the best fits. Differential spectra are shown below as indicators of the fitting quality. T=295 K.

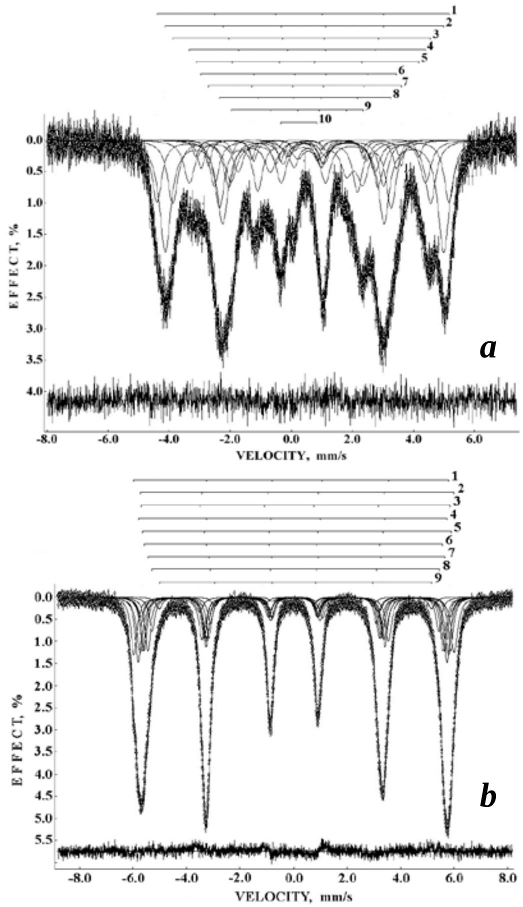

Fig. 2. Mössbauer spectra of schreibersite extracted from Sikhote-Alin iron meteorite (***a***) and Chinga metal (***b***) measured with a high velocity resolution. Indicated components are the results of the best fits. Differential spectra are shown below as indicators of the fitting quality. T=295 K.

Some new results obtained in the study of different fragments of Chelyabinsk LL5 meteorite using Mössbauer spectroscopy with a high velocity resolution as well as other obtained results will be discussed also. These results clearly demonstrated advances of this technique in the study of meteoritic iron-bearing minerals.

References:

[1] Oshtrakh M. I. and Semionkin V. A. (2013) *Spectrochim. Acta, Part A: Molec. and Biomolec. Spectroscopy, 100*, 78–87. [2] Oshtrakh M. I., Petrova E. V., Grokhovsky V. I. and Semionkin V. A. (2008) *Meteoritics & Planetary Sci*., *43*, 941–958. [3] Grokhovsky V. I., Oshtrakh M. I., Petrova E. V., Larionov M. Yu., Uymina K. A. and Semionkin V. A. (2009) *Eur. J. Mineral., 21*, 51–63. [4] Oshtrakh M. I., Grokhovsky V. I., Petrova E. V., Larionov M. Yu., Goryunov M. V. and Semionkin V. A. (2013) *J. Mol. Struct*., *1044*, 268–278.