SHOCK-THERMAL HISTORY OF THE ENSTATITE CHONDRITES ON DATA OF THERMOLUMINESCENCE, TRACK AND NAA ANALYSES

Ivliev A.I., Kashkarov L.L., Kalinina G.V., Kuyunko N.S., Lavrentyeva Z.A., Lyul A.Yu., Skripnik A.Ya.

(Vernadsky Institute of Geochemistry and Analytical Chemistry RAS - GEOKHI RAS)

cosmo@geokhi.ru; phone: (095) 137-86-14

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Introduction

The results of complex research of the bulk samples of the enstatite chondrites Adhi Kot EH4 (sample № 15059), Atlanta EL6 (№ 2611) and Pillistfer EL6 (№ 1864), carried out by the thermoluminescence (TL), track and neutron-activation of methods are presented. The purpose of work consist in revealing the quantitative characteristics of a degree thermal and - or of shock-thermal influence on meteorite matter during formation and subsequent evolution of their parent bodies.

Thermoluminescence analysis

The intensity of the natural TL, saved by meteorites in cosmic space, in samples from Atlanta and Pillistfer was close to background radiation of apparatus. In a meteorite Adhi Kot the clear peak of a natural TL is observed at temperature in the region of 220-250 ^{o}C. The glow curve of TL, artificially induced by X-ray radiation, are shown in a Fig. 1. It is seen, that for meteorites Atlanta and Pillistfer the wide peak of a TL (50-350 ^{o}C) with temperature of the maximal intensity TL is observed in the region of 100 ^{o}C (curves 1 and 2). However, for Adhi Kot the high-temperature peak is characteristic in the region of 270 ^{o}C (curve 3). The peak of low intensity TL at same temperature is observed also in a meteorite Atlanta. The accounts of the areas under glow curves of TL in the regions (S1) 50- 200 ^{o}C and (S2) 200-350 ^{o}C are carried out. Is shown, that values S1/S2 in samples Atlanta and Pillistfer is equal: 1.13 ± 0.02 and 1.22 ± 0.08, accordingly, essentially differ from value received for Adhi Kot: 0.34 ± 0.02.

Research of tracks

The distribution of the enstatite micro-crystals (size fraction of 100 - 200 μm), extracted from three researched meteorites, on track density (ρ), observable in each of these crystals after chemical etching, is given in Fig. 2. It is seen the values of ρ for researched meteorites vary in the same interval of about (10^4 ÷ 10^6) cm^{-2}. However, character of the crystals distribution on ρ values indicate on the appreciable distinction in the specific statistical track parameters: a fraction of Adhi Kot crystals with $\rho \geq 2\cdot10^5$ cm^{-2} appears by considerably lower in comparison with Atlanta and Pillistfer.

The Cu and Ir contents in the metal particles

The results of NAA measurements in Adhi Kot and Pillistfer are given in Table. Observed distinctions in the Cu and Ir contents in metal particles caused by processes existent on the pre-accretion stage of evolution of EH- and EL- group chondrite matter. Whereas the features of the variation trends in the contents of these elements respectively to the size of metal grains (see Fig. 3) reflect higher intensity of post-accretion metamorphic processes in the parent body for Adhi Kot in comparison with Pillistfer. Probably, these processes are caused both thermal and shock-thermal influences.

On the petrology-chemical data [5] in a meteorite Adhi Kot the signs of strong (up to melting of separate phases) shock-thermal processing of matter are observed. It is possible, the metal of this meteorite also could be changed and, in particular, in it could be an additional redistribution of elements. It is obvious, that the size of secondary shock-thermal effects resulting in enrichment of metal by sierophile elements, firstly depends on the size of metal particles.

Conclusions

Complex analysis of the received data in comparison with results of our TL researches in olivine, quartz and calcite [1-3], results in the following basic conclusions.

Chondrite Adhi Kot has undergoes the strongest shock loadings, that has resulted in practically complete melting and subsequent recristallization of his matter. This assumption is coordinated well to conclusions of petrography researches [4], and as by reference of this meteorite in group of the enstatite chondrites with features of shock-melting breccias [5].

The meteorite Atlanta also, probably, has undergoes loading, which has resulted in partial melting and subsequent re-crystallization of enstatite.

The matter of a meteorite Pillistfer was exposed to the least shock loading.

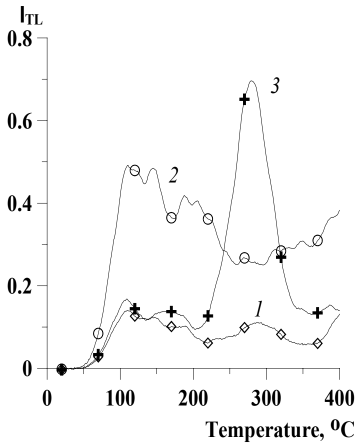

Fig. 1 Glow curves of artificially induced by X-ray irradiation TL in bulk samples from Atlanta (*1*), Pillistfer (*2*) and Adhi Kot (*3*) enstatite chondrites.

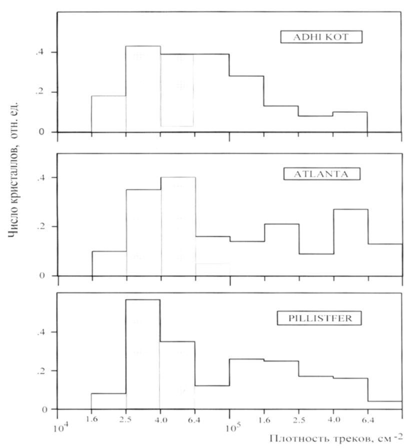

Fig. 2 Track density distributions in the enstatite crystals from Adhi Kot, Atlanta and Pillistfer chondrites. □ – Crystals in which VH-nuclei tracks were observed. ■ – Crystals, on the surface of which tracks was no observed. For these cases the high limit values of track density are indicated

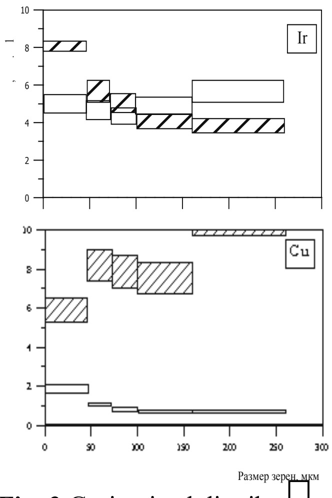

Fig. 3 Grain-sized distribution of Cu and Ir in the metal of Adhi Kot EH4 and Pillistfer EL6 chondrites.

Table. The contents Ir and Cu in metal particles of the different sizes from enstatite chondrites Adhi Kot EH4 and Pillistfer EL6.

№	Size of metal partilees, μm	Adhi Kot EH4				Pillistfer EL6			
		10^6 g/g		Relation to Cl		10^6 g/g		Relation to Cl	
		Cu	Ir	Cu	Ir	Cu	Ir	Cu	Ir
1	260 – 160	1195	1,76	9,88	3,82	85	2,6	0,71	5,65
2	160 – 100	910	1,84	7,52	4	85	2,28	0,71	4,96
3	100 – 71	960	2,32	7,93	5,05	95	2,3	0,79	5
4	71 – 45	990	2,6	8,18	5,65	125	2,1	1,03	4,6
5	< 45	710	3,5	5,87	7,6	225	2,3	1,86	5

References:

[1] *Ivliev A.I. et al.,* (1995), Geokhimiya, № 9, 1368.

[2] *Ivliev A.I. et al.,* (1996), Geokhimiya, № 10, 1011.

[3] *Ivliev A.I. et al.,* (2002), Geokhimiya, № 8, 834.

[4] *Keil K. (1968)*, J. Geophys. Res., V. 73, 6945.

[5] *Rubin A.E. and Scott E.R.D.* (1997), Geochim. Cosmochim. Acta, V. 61, 425.

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