THE STUDY OF ORDINARY CHONDRITES BY THE THERMOLUMINESCENCE METHOD. Ivliev A.I., Kuyunko N.S. Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, 119991, Kosygin str. 19, Moscow, Russia.
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Introduction. The thermoluminescence (TL) method is one of the most commonly used methods of investigation of the stone meteorites [1]. There are two types of TL: natural TL_{NAT} was accumulated by meteorite in the cosmic space, and induced TL_{IND} was induced from external source of a radioactive radiation in the laboratory. The measurements of the TL_{NAT} are mainly used for an estimation of the meteorite orbits [2], for analysis of a shocked metamorphism [3], for an estimation of the terrestrial ages of meteorites [4] and for determination of pair meteorite-finds [5]. The TL_{IND} demonstrate the changes of a crystalline structure of the feldspar produced by thermal or shocked metamorphism. The measurements of the TL_{IND} are used for analysis of a metamorphism of unequilibrated ordinary and carbonaceous chondrites [1, 6, 7] and also for a research of a shock - thermal history of meteorites [3, 8].

In the present work, the investigations of TL for recent measurements of the equilibrated ordinary chondrites: Barwell (L5), Chantonnay (L6), Dolgovoli (L6), Kilabo (LL6). Kunya-Urgench (H5), and Tugalin Bullen (H6) were made.

Experimental method. Investigated samples of meteorites weighing from 0.7 up to 1.0 g were crushed in the jasper mortar. The magnetic fraction of the powdered sample was moving off by a hand-held magnet. The nonmagnetic fraction of each meteorite was used to prepare of three samples each of which was equal 2 mg. After measurements of TL_{NAT}, samples were irradiated by X-rays or by γ-rays and then TL_{IND} was registered.

Shock loaded metamorphism. The determination of a shock load pressures of the ordinary chondrites were determined by results of measurements TL induced by X-rays. The most sensitive TL parameter for determination of shock load degree of the ordinary equilibrium chondrites is area under of a glow curve in a temperature range 40-350 °C (Sp) [3, 11]. Measurements of the TL parameters in the samples of the 14 meteorites with known shock load pressures have shown the increase of values Sp at the increase of shock pressure up to 10 GPa (stages S1-S2), and subsequent their sharp decrease up to two orders of magnitude at further increase of shock pressure from ~10 up to 90 GPa (stages S3-S6). Using the results of our measurements and values of pressures of different shock classes of meteorites [12, 13], we have received the approximate formulas for an estimation of a shock load pressure of chondrites at collisions in space. For the shock classes S1-S2, it was obtained: $P = 1.93 \times \ln(Sp) - 5.57$, and for S3-S6: $P = -12.28 \times \ln(Sp) + 91.74$, where P is a shock load pressure in GPa, and Sp is area under a glow curve in a temperature range 40-350 °C.

Sp, shock class, and P values for the studied meteorites are listed in Table 1. The obtained values of a shock class are well coincident with results of petrographic examinations [13-16].

Table 1. Results of calculations of the area under the peaks of glow curves (Sp) and the values of a shock load pressure (P).

Meteorites	Type	Shock class	This work		
			S_P	Shock class	P, GPa
Barwell	L5	S3 [14]	590±35	S3	13.4±0.8
Chantonnay	L6	f [13]	7.0±1.0	S6	68±9
Dolgovoli	L6	-	868±60	S2	7.5±0.5
Kilabo	LL6	S3 [15]	262±10	S3,4	23±1
Kunya-Urgench	H5	-	928±100	S2	7.6±0.8
Tugalin-Bulen	H6	S1 [16]	575±25	S2	6.7±0.6

Perihelion of the meteorite orbits. The value of TL_{NAT} stored by meteorites in the cosmic space can depend on an orbit of meteorites. It was assumed [17] that than less the perihelion of a meteorite orbit the above heating temperature of a meteorite and accordingly lower the value of accumulated TL_{NAT}. Hence, it is possible to suspect that the value of an irradiation dose of a meteorite in the cosmic space corresponds to value of a perihelion. For an estimation of perihelion value it was suggested to normalize intensity of a TL_{NAT} of each sample to its sensitivity by measuring the value of TL_{IND} per unit of a dose obtained from a radioactive source. This value indicated as an equivalent dose (ED) is calculated under the formula:

$ED = D\times(TL_{NAT}/TL_{IND})$, where D is radiation dose of a sample in the laboratory. However, investigations suggest that it is more reasonable to calculate ED for two temperature intervals on the glow curves; ED_{LT} at T~100-240°C and ED_{HT} at T~240-340°C. This allows us to reduce the error of ED estimate to ≤ 15% and estimate more accurately the perihelion value.

Table 2. Equivalent doses for the studied meteorites

Meteorite	Type	Fell, Year	ED_{LT}, Gy	ED_{HT}, Gy
Barwell	L5	1965	382±10	1530±180
Dolgovoli	L6	1864	112±10	2260±290
Kilabo	LL6	2002	22±3	514±50
Kunya-Urgench	H5	1998	112±10	100±8
Tugalin Bulen	H6	1967	27±2	354±31

Procedure of an ED determination is more detail described in our papers [2, 11]. The values of ED_{LT}, and ED_{HT} for the investigation meteorites are listed in Table 2. The measured value of TL_{NAT} intensity in the meteorite of Chantonnay was lower than a limit of recording of a TL. The values of ED_{LT} and ED_{HT} listed in the Table 2. The dates exhibited in the Table 2 allow to suspect that the perihelion of the studied meteorites were within the limits of 0.8 - 1 A.U. The obtained perihelion sizes are typical for the orbits of the most of ordinary chondrites.

References.

[1] Sears D.W.G. (1988) *Nucl. Tracks Radiat. Meas*., *14*. 5-17. [2] Ivliev A.I., Alexeev V.A. (2006) *LPS XXXVII,* CD-ROM #1047.pdf. [3] Ivliev A.I. et al. (2006) *Electronniy nauchno-informatsionniy zhurnal "Vestnik Otdeleniya nauk o Zemle RAN" №1 (24)*. [4] Akridge J.M.C. et al. (2000) *Meteoritics & Planet. Sci., 35.* 869-874. [5] Benoit P.H. et al. (1991) *Meteoritics, 26,* 317. [6] Sears D.W. et al. (1980) *Nature, 287,* 791-795. [7] Ivliev A.I. et al. (2005) *LPS XXXVI,* CD-ROM #1065.pdf. [8] Ivliev A.I. et al. (2004) *Electronniy nauchno-informatsionniy zhurnal "Vestnik Otdeleniya nauk o Zemle RAN", № 1 (22).* [9] Sears D.W.G.et al. (1991) *Proc. NIPR Symp. Antarct. Meteorites, 4,* 319-343. [10] Guimon R.K., et al. (1995) *Meteoritics, 30,* 704-714. [11] Alexeev V.A., et al. (2001) *Geochemistry International, 39,* 1043-1055. [12] Stöffler D. et al. (1991) *Geochim. et Cosmochim. Acta., 55,* 3845-3867. [13] Dodd R.T. and Jarosewich E. (1979) *Earth and Planet. Sci. Lett., 44,*. 335-340. [14] Rubin A.E. (1994) *Meteoritics, 29,* 83-96. [15] Russell S.S. et al. (2003) *Meteoritics & Planet. Sci. 38,* A201-A248. [16] Grady M.M. (2000) *The Catalogue of Meteorites, Cambridge University Press.* [17] Melcher C.L. (1981) *Earth Planet. Sci. Lett., 52,* 39-54.