

EXPERIMENTAL RESEARCH OF SHOCK - THERMAL HISTORY OF CARBONACEOUS CHONDRITES BY THERMOLUMINESCENCE AND TRACK METHODS

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Introduction

The results of thermoluminescence (TL) and tracks research of carbonaceous chondrites Allende CV3 (sample N 15035), Axtell CV3 (N 15846), Coolidge CV3 (N 2566), Efremovka CV3 (N 2349), Leoville CV3 (15759), and Ningqiang CV3 (N 15855) are presented. The CV chondrites are similar to type 3 ordinary chondrites in several respects. They are both chondritic in bulk composition, with non-volatile elemental abundances generally within about 30% of the CI values. Thus the two groups are mineralogically very similar, consisting of olivine, pyroxene, plagioclase, metal and sulfide /1, 2/. These examinations have shown that the value of metamorphism of carbonaceous chondrites is agreed with intensity low-temperature TL peak at (105-120) °C. On this basis, the procedure of classification permitting to show up 10 subtypes of metamorphism 3 type CV chondrites was proposed. The TL peaks at (> 140 °C) did not reflect a degree of metamorphism carbonaceous chondrites. The purpose of the present article was determination of the possible reasons of change of the shape of glow curves with simultaneous attracting of track parameters investigation in the same carbonaceous chondrites.

Measurements of TL

The measured of TL induced by X-rays in whole samples, mentioned above carbonaceous chondrites, were carried out. The executed analysis of glow curves allows to the single out two groups of meteorites. To the first group it is possible may be attributed of the following meteorites: Allende, Axtell and Coolidge. The glow curves of these meteorites are shown in a Fig. 1. It is seen, that they have one brightly expressed peak with maximal temperature near of 110 °C and with width of TL peak (full width at half maximum, FWHM), equal ~ 50 °C (Allende) and ~ 75 °C (Axtell and Coolidge). The great difference in intensity of TL glow curves (~ 100-multiple) reflects a degree of thermal metamorphism of these meteorites in a parent body. The observed data of height of peaks of glows curves executed by us and are in agreement with /1, 2 /, have yielded following values of petrographic types: Allende CV3.4, Axtell CV3.0 and Coolidge CV3.7.

The second group of meteorite samples (Fig. 2) intensive glow of TL in the temperature region of glow curves (> 140 °C) - Efremovka, Leoville and Ningqiang are showing. For these meteorites it is typical increase of FWHM (~ 170 °C) and occurrence of peaks with temperature above 120 °C are characteristic. Our early investigations of experimentally shock-loaded samples in the model experiments: oligoclase, quartz and calcite /3-5/, have shown that increase of FWHM value with growth of a shock pressure are occur. It allows us to suppose, that the apparent changes of TL characteristics for samples of the second group are reflecting a shock - temperature history of carbonaceous chondrites.

The minor part of TL glow in region > 200 °C in samples of meteorites rated by us to the first group of meteorites (Fig. 1), allows suspecting, that they have undergone the least shock load at collisions in cosmic space.

This assumption is consistent with dates of /6 / in which Allende was referred to a shock S1, and Coolidge - to S2. The value of FWHM for Axtell, close to FWHM of Coolidge, that allows to attribute it to a shock S2. The meteorite Efremovka is referred to a shock class S4, and Leoville - to S3 /6/. Our results of recording TL in meteorites attributable to the second group (fig. 2) are in the good consent agree with these results and indicate that Ningqiang has undergone with shock - S4.

Measuring of tracks

The results of track-density (ρ , cm⁻²) measuring in separate olivine crystal, isolated of the referred to above meteorites, are given in a Fig. 3. Greatest number (1210) of crystals by the ~50 up to ~200 μ m size fraction was investigated for chondrite Allende. As it obvious from a histogram of allocation of these crystals on quantity of track-density, it is above 90 % of them compound a basic group with very low $\rho \leq 10^4$ cm⁻². The second group consists of crystals with ρ , lying in an interval of two orders

of magnitude from $8 \times 10^5 \text{ cm}^{-2}$ up to $6 \times 10^7 \text{ cm}^{-2}$. As the matter of a meteorite Allende examined to weak shock action the presence in Allende of dominating amount of olivine crystals with very low track-density can not be charged to annealing at shock - thermal action. On absence direct single-valued dependence of character of allocation of tracks and the quantities of a shock load also effects of track examinations of a meteorite Ningqiang. Rather small number of the crystals learnt for this meteorite (13) does not allow leading adequate comparison with Allende. However, that all these crystals are grouping in very narrow ($10^5 - 10^6 \text{ cm}^{-2}$) ρ -values interval does not eliminate an opportunity of partial annealing of tracks as a result of S4 shock loading. From the reduced data follows, that the analysis of track and TL data the performances for the study group of meteorites show that a broad interval of quantities of track-density, great difference of character of allocation of silicates on track-density, and as availability or absence of crystals with a track-density gradient, apparently, to some extent can reflect influencing of shock - thermal action on matter of these meteorites.

The carried out examinations give in a deduction that measuring of TL of matter of carbonaceous chondrites is highly sensitive method for study of a shock - thermal history of these meteorites. This conclusion confirms by results of track and petrographic examinations /6/.

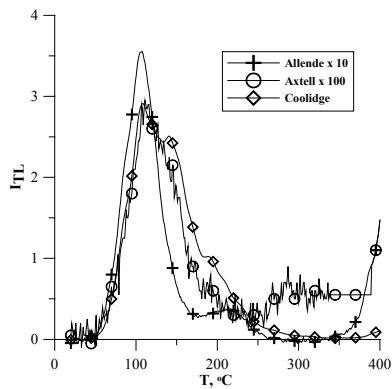


Fig. 1. The glow curves of TL, induced by X-rays, in carbonaceous chondrites Allende, Axtell and Coolidge. I_{TL} - intensity of glow TL, multiplied on 10 for Allende and on 100 for Axtell.

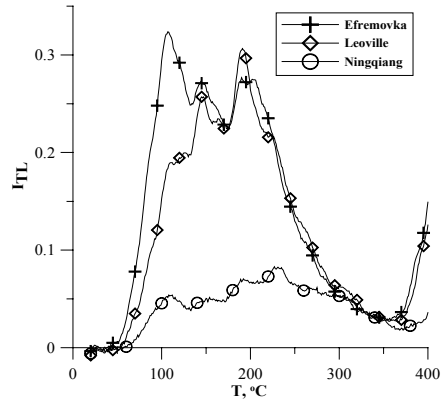


Fig. 2. The glow curves of TL, induced by X-rays, in carbonaceous chondrites Efremovka, Leoville and Ningqiang.

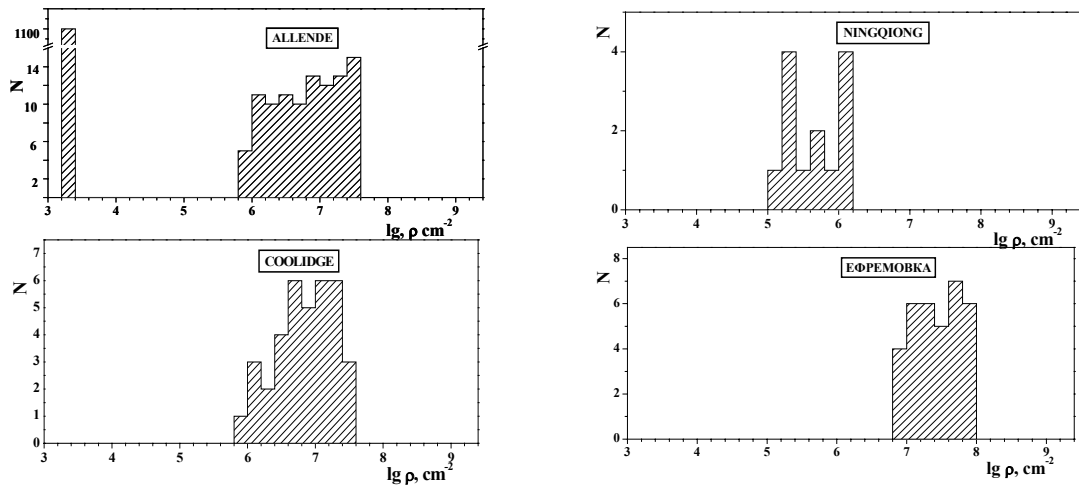


Fig. 3. Distribution of olivine crystals (N) in carbonaceous chondrites: Allende, Coolidge, Ningqiang and Efremovka, according to amount of track-density.

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