RESEARCH OF A THERMOLUMINESCENCE IN THE EXPERIMENTALLY SHOCK LOADED MINERALS

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Introduction. In a history of formation of terrestrial planets the collision of solid bodies were central at an accretion and at early stage of their geologic evolution. The same events have rendered considerable influencing on development of a crust of terrestrial planets. On a surface of planets similar Earth at collision with a body driving with a cosmic velocity a crater will be formed. Therefore, it is possible to recognize the shock structures, in most cases, only on changes of geologic rock has occurred. At researches of shock structures above ground significant role play feldspar, quartz and calcite as ones of the most abundant minerals.

The model experiments play the important role at analysis of shock processes in natural minerals. The method of an individual impulsive load of each investigated sample is most abundant. In this method the shock flat waves generated with the help of mud caps of explosive, or by shock an aluminum plate accelerated by production of detonation are applied [1, 2]. The model experiments on loading sphere filled polycrystalline natural matter by spherical concurrent shock waves [3] opens out new capabilities of analysis of matter loaded different stages of a shock metamorphism within the limits of one investigated sample. The study of shock loaded matter in such experiments, can appear useful at interpretation of measurement results of physicochemical transformations of different minerals conditioned by affecting of high pressures and temperatures.

Experiment. The induced thermoluminescence (TL) in samples of oligoclase, quartz and calcite shock loading in different model experiments was measured. Following samples were used: 1. Crystals of oligoclase containing 18 mol % of anorthite. 2. Crystals of optically pure natural quartz. 3. Samples of the yellow - white marble (calcite). In samples of oligoclase and quartz the flat shock waves were generated with the help of mud caps of explosive, or by shock an aluminum plate accelerated by production of detonation were applied [1, 2]. The sample of calcite as a sphere of ∅ 48 mm was packaged in steel pressurized jacket, which one then was shock loaded by spherical concurrent waves. TL was measured on the improved instrument, which the detailed was described in [4]. The glow curve were measured in samples with shock: oligoclase - 9, 13, 22.5, 25.5 and 27 GPa; quartz - 8.4, 9, 12.2, 20, 24, 27, 31.5, 34 and 49 GPa. Samples of calcite isolated of different parts of a sphere was shock loaded - 27.6-29.6, 29.6-31.7, 31.7-35.0, 35.0-39.1, 39.1-47.5, 47.5-53.1, 53.1-83.1 GPa. The obtained results of the TL measurements in these samples were compared to similar ones in the initial samples not subjected of experimental shock loading.

Results and discussion. The recording of induced TL has shown a sharp sensibility of intensity of glow depending on magnitude of a shock, which was undergone investigated samples. Glow curves of oligoclase and quartz were calculated with the help of the special mathematical program [5]. This program allow to show the glow curves as a set from 11 of Gaussian peaks each of which had a constancy value of full width of a peak on half of magnitude (FWHM) and to calculate TL intensity of each peak (I_P) [6, 7]. The calculations have allowed to find a linear relation of magnitude of the relation of intensity TL of different Gaussian peaks from value of shock. As an example, in a fig. 1 is shown the dependence of magnitude of the relation I_{P9}/I_{P3} versus of a shock load in samples of oligoclase. In this figure I_{P9} is intensity of the 9-th peak located in a temperature interval 350-380 ^oC and I_{P3} is the 3-rd peak, located in an interval 165-195 ^oC. The detected linear dependence in region of shock pressure 0-25.5 GPa shown in a fig. 1 as a straight line corresponds to an equation $I_{P9}/I_{P3} = 0.205 + 0.036$ P, where P – pressure in GPa, with a correlation factor (r) equal to 0.99.

In samples of quartz the linear dependence of $I_{P(3+4)}/I_{P8}$ relation from shock pressure is detected in all range of shock-recovery experiments - 0-49 GPa (see fig. 2). In this case $I_{P(3+4)}$ – the total intensity of the 3-rd and 4-th peaks located in a temperature interval 175-235 °C and I_8 - intensity the 8-th peak located in an interval 335-365 °C. This linear relation shown in a fig. 2 as a straight line corresponds to an equation $I_{P(3+4)}/I_{P8} = 6.05 - 0.10\ P$ (r = 0.96).

In calcite samples the linear relation of an integral TL intensity (I_{TL}) versus of shock pressure is detected in the region of 80-340 °C (see fig. 3). From results reduced in a fig. 3 it is visible that the I_{TL} magnitude decrease with magnification of shock pressure up to ~ 35 GPa in comparison with a source sample. But in the region of shock pressure from ~ 35 up to ~ 83 GPa the increase of I_{TL} magnitude is observed. The performed calculations have shown, that the variations of I_{TL} magnitude in the indicated regions of a shock pressure have linear nature and are described by equations:

$$I_{TL} = -0{,}020\ P + 1.00 \qquad (1)$$

$$I_{TL} = 0{,}022\ P - 0.44 \qquad (1a),$$

where the equation (1) corresponds to 0-35 GPa, and equation (1a) to 35-83 GPa. I_{TL} magnitude is calculated of a about source sample, the value of which is accepted for 1. The values of r are equal 0.998 and 0.976 accordingly. In a fig. 3 straight line shown according to an equation (1) is a continuous line, and equation (1a) - dotted line.

Thus, for the first time at study of some silicate minerals shock loaded in the model experiments, the TL method established linear barometric scales in two regions of shock pressure.

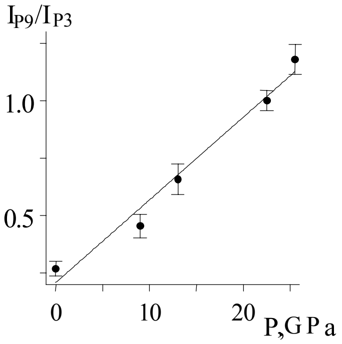

Fig. 1. Plot of the TL intensities relation (I_{P9}/I_{P3}) *vs*. of shock pressure (P) in samples of oligoclase.

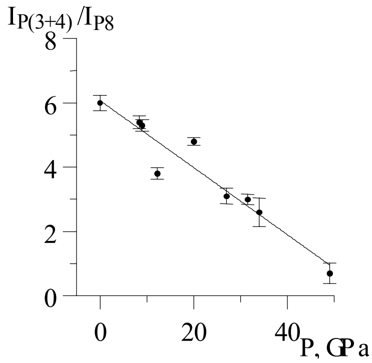

Fig. 2. Plot of the TL intensities relation ($I_{P(3+4)}/I_{P8}$) *vs*. of shock pressure (P) in samples of quartz.

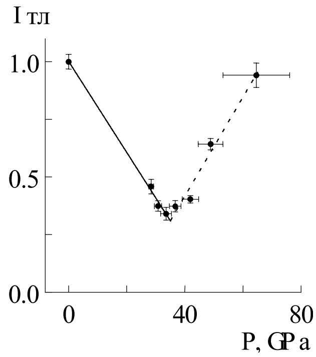

Fig. 3. Plot of the TL intensities (I_{TL}) *vs*. of shock pressure (P) in samples of calcite.

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