Some Peculiarities of Quartz, Biotite and Garnet Transformation in Conditions of Step-like Shock Compression of Crystal Slate.

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A character investigated of changes of the crystal slate, which consists of a garnet (40-45 %), biotite (20-25 %), quartz (5-10 %) and plagioclase (25-30 %), has been studied using of recovery assemblies of planar geometry. The assemblies were loaded by impact of Al plates up to pressures 19, 23.5, 26, 36 and 52 GPa. In the sample, the peak pressure was achieved after several reverberations of the waves between the walls of the steel sample container.

Quartz. Planar elements develop in quartz at shock loading **19 - 36 GPa**, at the same time this mineral already at **19 GPa** begins to transform to amorphous phase. By the X-ray data at shock pressure **52 GPa** about 96 % of quartz grains transform to amorphous phase. The quartz transformations from crystal slates are the same on the whole as in experiments with monomineral samples [1].

Biotite. In the whole range of loadings the mechanical deformations in biotite (fractures and kink bands of various crystallographic orientation) are present. The melt of biotite begins from **23.5 GPa** along fractures and on contacts with other minerals. Plenty of bubbles are a sign of biotite melting under SEM (fig. 1). Presence of very thin veins of biotite glass in other minerals is one more sign of biotite melting already at shock pressure **23.5 GPa**. The decrease of diffraction peak integral intensities on X-ray diffraction patterns shows presence of biotite glass. This effect is observed from the shock pressure **23,5 GPa** and increases with the growth of shock pressure. By the X-ray data at shock pressure **52 GPa** about 70 % of biotite grains transform to glass. Earlier the shock-induced melting of biotite in experimental works has been observed only once, when biotite-muscovite gneiss samples were shock loaded. In these experiments beginning of biotite grains melting was observed at 327 kb and intensive melting at 353 kb [2,3]. In our experiments biotite melting begins at lower shock pressure - **23.5 GPa**. Congruent melting of biotite is also observed in a number of astroblemes [2,3]. On heating of biotite in static conditions it melts incongruently, breaking down to an assemblage of newly formed minerals and glass. [2]. From biotite melt, formed at **52 GPa**, after pressure and temperature drop, crystallization of new phases begins. One of them corresponds to alumina ringwoodite (Al_2O_3 content up to 16 %) with grain size 1-2 micron. The grain are either slightly-elongate or close to hexahedron form (fig. 2). The grains of the second phase are of isometric form and few microns sizes. The composition of this phase is essentially close to that of grossular garnet (60 - 68 % of grossular minal, 28 - 34 % of almandine minal and only 4 - 7 % of pyrope minal). Such minal combination is not found in nature conditions, but in general should correspond to low (regarding shock metamorphism) parameter values: pressure less than 0.5 GPa and temperature not higher 1000-1300^{0}C. It was not possible to register newly formed phases with the help of X-ray diffraction, probably, because of their small content in the material.

Garnet. Up to **36 GPa** only mechanical deformations (fractures, planar elements, crushing with a turn of separate fragments of grains) detected in the garnet. Any transformations in a crystal lattice (by the data X-ray diffraction) have not been observed. The garnet melting along fractures begins at **36 GPa**. At shock pressure **52 GPa** intensive garnet melting has been observed under SEM with frequent developing to the main part of grains. But it is evident that at this pressure the melting starts from grain fractures and from grains edges (fig. 3). By the X-ray data at shock pressure **52 GPa** about 35 % of garnet grains transform to glass. In earlier experiments with shock-wave loading melting of garnet was observed just at pressure 90 GPa [4].

The comparison of results of garnet and biotite transformations in the given experiments with transformations of these minerals in natural impactites and with changes of these minerals in the experiments with loading of rocks by converging spherical shock waves (fig. 4) has been made. It was found out, that 1) in all the three cases mechanical deformations of crystals occur at essentially the same shock pressures; 2) transformations of minerals at a level of a crystal lattice (migration of chemical elements and formation of shock-thermal assembly of minerals) have not been observed at planar geometry loading (in contrast to natural processes and experiments in spherical geometry); 3) partial melting of minerals (along fractures) begins in all the cases approximately at the same parameter values; intensive melting of a garnet occurs in the all cases at essentially the same pressures, and that of biotite - at lower shock pressure in experiments with planar geometry (step-like shock compression), than in nature and in spherical shock waves experiments [5,6]. Earlier beginning of biotite melting compared that of garnet is due to their crystal structure.

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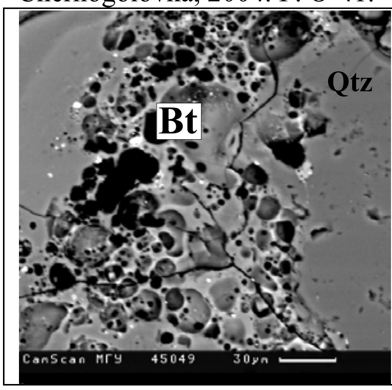

Fig.1. Completely melted the biotite grain. P_{shock} = 52GPa

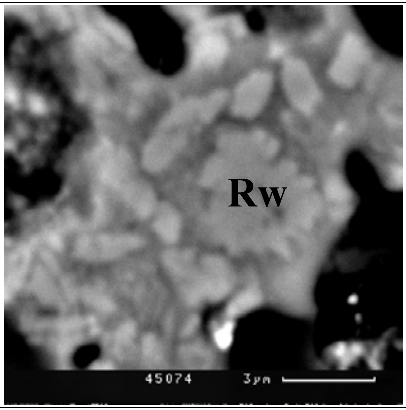

Fig.2. Newly formed phase in biotite glass. P_{shock}=52GPa.

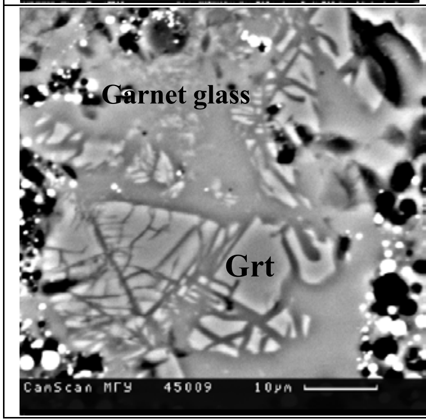

Fig.3. Intensive melted garnet grain. P_{shock}=52GPa.

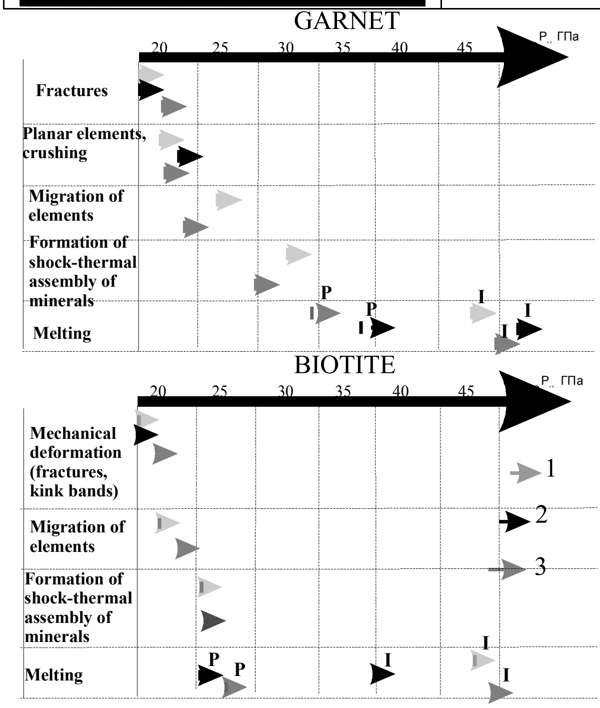

Fig.4. Comparisonof results of garnet and biotite transformations in natural impactites (1), in the experiments with shock waves of planar (2) and spherical geometry (3). P-partial melting; I-intensive melting