SOME PECULIARITIAS OF IMPACT MELTS (NATURAL AND EXPERIMENTAL DATA).

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All impact melts are very specific formations distinctly differing from any other endogenous magmatic formations by sum of features. This publication presents our results obtained by studying the impact melts in the nature and experiments

Impact melts appear naturally in cosmic bodies collisions. At the Earth surface they are found in many astroblemes. One can distinguish two kinds of impact melts differing by the time and conditions of formation. They are penetration phase melts (I) and bottom melts (II). The former appear first on the phase of striking pin penetration into target rocks of the Earth crust. These melts are monorocks (their chemical composition corresponds to concrete target rock composition) and as a rule they do not mix with each other. The latter are formed later and represent well mixed and averaged melt (polyrock melt) with composition that differs from concrete target rocks composition.

Very inhomogeneous rocks, structures and textures are generated on impact cooling due to fast temperature drop of overheated melt containing relatively cold target fragments. Lechatelierite (quartz glass, melted quartz crystals), shock metamorphosed, partly or completely melted rutile, zircon (fig.1,2) and baddeleite (product of high temperature decomposition of zircon) are often found in these rocks.

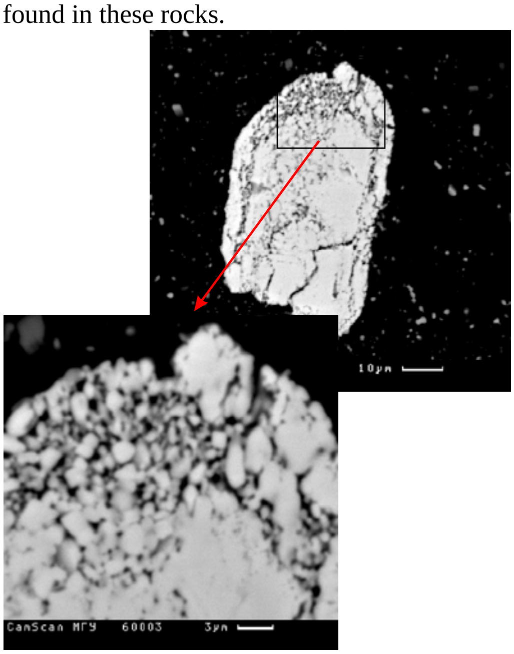

Fig1. SEM photograph of a granular shock metamorphosed zircon grain from melt rock of astrobleme Janisjarvi (Russia, Karelia)

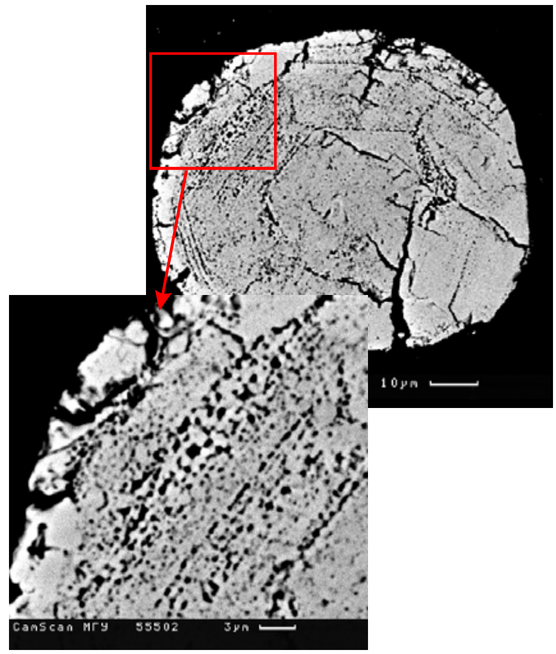

Fig.2. SEM photograph of a zircon crystal from melt rock of astrobleme Janisjarvi (Russia, Karelia). The fine degassing holes in grain are the result of incipient melting at extremely high temperatures (the melting point of zircon is 1676^0C).

During impact melts formation shock loads exceed 50-70 GPa (depending on rock mineral composition) and melt temperature reaches 3000^oC. A very typical feature of these rocks is a high degree of oxidation. In nature hematite was found as liquidus phase (Elgygytghyn astrobleme) and in experiment anortite with Fe^{3+} in tetrahedron was detected.

Impact melts of the I type are often met in fall-back, fall-out rock and in far fall out rocks (tektites and microspheres of catastrophic layers at distances of hundreds and thousands kilometer from mother crater). Usually they harden with glass formation and contain a small quantity of crystalline phases. These glasses have specific EPR, IR and NGR spectra which testify that impact melts temperatures and cooling rates of these melts are very high. Theoretical analysis and investigation of diffusion profiles give cooling rate of these melts up to 200 ^{o}C per second. These melts are very unstable and liquid unmixibility is often observed during their cooling(fig.3,4). Sometimes this effect repeats as, for instance, in Zhamanshin astrobleme or in experiments with shock melting of almandine and granite

The rocks generated from II type melts are characterized by crystalline structure and by

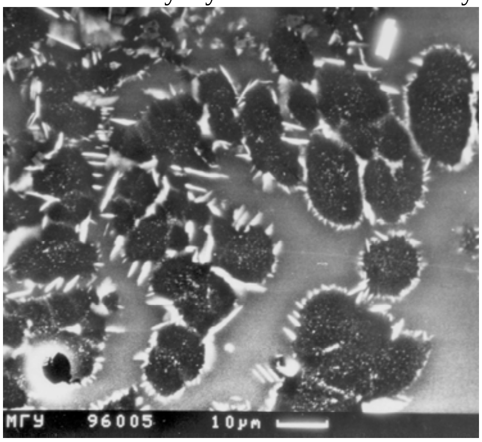

Fig3. The example of the liquid immiscibility in impact melt of astrobleme Zhamanshin, Kazakhstan.

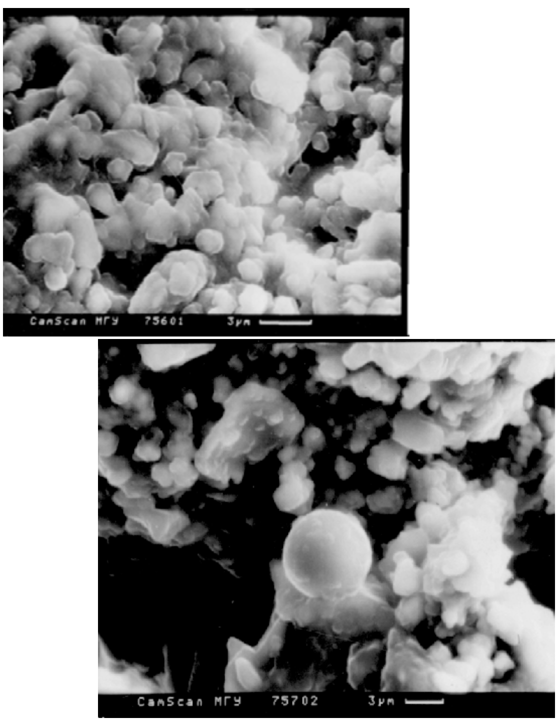

Fig. 4. Porous glass consisting of tiny beads (of composition close to forsterite) cemented by acid glass, which resulted from the liquid immiscibility of enstatite melt in experiments with spherically converging shock waves.

presence of only small quantities of glass in their bases. Their crystallization occurs at lower temperatures and starts as crystallization of minerals more refractory than minerals of the same chemical composition in igneous rocks. Abundant skeleton crystals (both edge-type and face-type) of reversed kinetic zonality are typical for these rocks.

Numerous fragments of target rock with traces of shock metamorphism ($P_{shock} > 30$ GPa) are often found in rocks formed by II type melts. These fragments differ by intensity and mechanism of interaction with surrounding melts. This interaction may include melting (with pyrogenic fringe of chemical composition other than composition of impact melt itself), covering of xenolite with impact melt crystallization products, replacement of xenolite by new mineral association accompanied by typical zonality formation.

The impact melt crystallization begins even before the completion of unloading. Therefore high pressure phases of silica (coesite and stishovite), carbon (diamond and lonsdaleit), olivine (ringwoodite) and rhombic pyroxene (majorite) are found as melts hardening products both in astroblemes and in experiments (fig.5). Formation of these minerals goes on at different temperatures and pressures (25-70 GPa), but these values are always higher than those at static loading crystallization.

Fig. 5. SEM image of phases that crystallized from the melt developing after almandine in experiments with spherically converging shock waves. Black—glass, minute gray dust—hercynite spinel, pale gray—aluminous and ferrous ringwoodite, and gray—aluminous pyroxene phase, perhaps, majorite.

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