# Feldman V.I.[1], Sazonova L.V.[1], Kozlov E.A.[2], Zhugin Yu.N.[2] Crystallochemical control of material migration in spherical convergent waves

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*key words: [shock metamorphism, diaplectic minerals, migration of components, chrystallochemical control]*

Loading of number of rocks (pegmatite, granite, enstatitite, wollastonitite, skarn, amphibolite, mica-quartz schist, biotite-amphibole plagiogneiss) with shock waves was carried out by the method of RFNC-VNIITF [1-3]. Experimental samples were prepared as spheres of about 50 mm in diameter. This sphere was sealed into the steel hermetic case. A layer of explosive was put on the case surface. The detonation of the explosive created a spherical convergent shock wave. An amplitude of strains was 20 GPa on the case surface and 250 GPa at 1 mm from the center of the sample. Duration of an impulse was $1\text{-}2\times10^{-6}$ sec. Data obtained in the experiment are in a good agreement with observations on impactites. A multi-level crystalochemical control (CC) of the material migration during the shock-wave loading up to its melting was recognized.

The first level of CC is reflected in subdivision of crystalline compounds into two groups: 1) ring and framework silicates and alumosilicates are amorphized (transformation into diaplect glasses), 2) other rock-forming minerals are affected by shock-thermal decomposition (STD) (replacement by aggregates of newly formed minerals with complete preservation of a shape of an initial crystal). Both in the nature and in the experiment, diaplect glasses were found after quartz, plagioclase, K-feldspar, cordierite [4]. The amorphization of scapolite and epidote was also identified in the experiment. Both in the nature and in the experiment, the shock-thermal decomposition is known for diverse minerals: biotite, amphibole, pyroxenes, garnet, staurolite, etc. [4, 5].

The second level of CC determines a value of shock strains, at which STD starts. It increases from the mineral with distinct inhomogeneity of crystalline lattice (for instance, schist alumosilicate biotite) to more homogeneous compounds (for instance, sub-frame-work silicate garnet).

The third level of CC establishes a sequence of migration of cations from a crystalline lattice, where the cations occupy different sites. In general, this sequence is determined by coordination number (CN) of a cation in some mineral. The following sequence of cation migration can be induced: potassium from biotite (CN=12), potassium and sodium from feldspars (CN=10), calcium from feldspars (CN=8), manganese and iron from garnet (CN=8), aluminum from staurolite, magnesium from biotite, iron from biotite and staurolite (CN=6). In the separate mineral, the migration starts from the less bounded cations (for example, $Fe^{2+}$ and $Ca^{2+}$ in the M1 site of pyroxenes), while the migration of cations in symmetrical sites ($Mg^{2+}$ in the M2 site of pyroxenes) is not statistically significant. Silicon and aluminum in tetrahedral sites (CN=4) retain their position up to melting, despite the removal of more than 50 % of cations (that, apparently, explains the preservation of crystal shape).

The forth level of CC composes a dependence of an intensity of cation migration on their sizes. At other conditions being equal, if cations occupy the same site, the smallest cation migrates more readily. So, iron from clinopyroxene ($r_i$ = 0.80 Å) migrates faster than calcium ($r_i$ = 1.04 Å); iron from garnet migrates faster than manganese ($r_i$ = 0.91 Å); aluminum ($r_i$ = 0.57 Å) leaves staurolite more readily than iron ($r_i$ = 0.67 Å); sodium ($r_i$ = 0.98 Å) leaves feldspars faster than potassium ($r_i$ = 1.33 Å).

The study is partially supported by the Russian Foundation for Basic Research (project N 00-05-64102).

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