TERRESTRIAL ANALOGS OF LUNAR GRANULITES. V.L.Masaitis, M.S. Mashchak. Karpinsky Geological Institute, St.-Petersburg

So called lunar granulites are recrystallized polimict or monomict impact breccias and are similar in texture and metamorphic history to some types of rocks from terrestrial impact craters. Ferroan anorthosites, norites and troctolites from highlands are the pristine rocks of lunar granulites usually having granoblastic texture. Notwithstanding the numerous works concerning these rocks their true geological setting and mode of origin are disputable (1,2,3,4,5,6).

In terrestrial impact craters there exist metamorphosed crystalline rocks with textural features (including totally recrystallized maskelinite) and inherited from initial target rocks chemical composition which remind the lunar granulites. These extensively recrystallized impact breccias from Puchezh-Katunki structure, Central Russia, (7,8), was named coptoblastolithes (from Greek words copto- to destroy by shock and blastos - the sprout) (9,10). They are located in authigenic crystalline breccias of the central uplift of this impact crater and form subvertical zone of some tens meters thick. The Vorotilovskaya deep drillhole (5374m) and parallel to it Pilot drillhole (10,11) penetrated this zone and traced it down to the depth about 3,0 km where the zone splits into several ones. The ajacent rocks mostly consist of diaplectic minerals and diaplectic glasses, the estimated shock compression at the surface of uplift is about 40-45 GPa and about 20-25 GPa at the mentioned depth.

Coptoblastolithes occur as irregular lenses and macroscopically look like fine-grained cataclastic breccias with some larger clasts plastically deformed and sometimes accompanied by small injections of impact melt. They have blastoporphyric, heteroblastic and granoblastic textures with the average grain size about 0.1 mm. Plagioclase (An 35-40) and pyroxene (salite with high Ca content) are the main minerals, some quartz, tridymite, magnetite are present. The recrystallized breccias are distinct form melt injections characterized by homogeneous igneous texture and different composition of rock-forming minerals (An 42-47, pigeonite). Chemical composition of the first ones correspond to the ajacent brecciated and annealed gneisses just as melt injections reflect the average composition of their mixture with more femic varieties. All of them underwent strong hydrothermal alteration.

The petrographic study of coptoblastolithes and their surroundings where the femic minerals (biotite, hornblende) are totally decomposed and diaplectic guartz and maskelinite recrystallized showed that these transformations occured at the temperatures (~950-1100°) significally exceeding post-shock ones at certain depths. The volume of injected melt is too small to provide this thermal effect.

Extensive heating produced recystallization of brecciated crystalline rocks of central uplifts in Boltysh and Terny impact structures, Ukraine (8,12) as well. In the last one the elliptical zone of these breccias with insignificant melt injections was traced to the depth about 1.5 km where it thinned out. They originate here after ferrugineous quartzites and shists and were subjected to hydrothermal alteration. Similar recrystallization and local melting were observed in authigenic granite breccias in Boltysh structure (8). The shocked and recrystallized granite of the core of Vredefort structure, South Africa, reminds coptoblastolithes described above. The annealing occurred at temperature 900-1100° and caused partial fusion (13,14,15). Footwall breccia rocks in Sudbury structure, Canada (16) resemble in some aspects coptoblastolithes as well. Strong annealing followed by incipient melting at 1000° or more was imposed here on cataclased and shocked rocks (16,17).

If the source of strong heating and recrystallization of clasts included into thick sheets of impact melt known in some craters (Popigai, Manicouagan, West Clearwater etc.) as well as metamorphism at the base of Sudbury melt sheet are obvious, the source of heat in other cases mentioned above is enigmatic. The reason of this heating may be the shear strain underneath the crater during its growth. The strong differential displacements and plastic deformations especially along fissures oblique to the front of shock wave may lead to extensive heating behind it. The identity of metamorphic history of coptoblastolithes from terrestrial craters to this one of lunar granulitic breccias implies that their mode of origin may be the same (6). The differencies between two types of recrystallized breccias mainly depend on distinct composition of pristine target rocks, their water content and single (Earth) or multiple (Moon) impacts.The previous geological settings of lunar granulites may be also similar to terrestrial analogs.

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