SUEVITE-TAGAMITE MEGAMIXTURES: AN IMPACT FORMATION ON THE FLOOR OF THE POPIGAI SUEVITE STRATA. S. A. Vishnevsky, Institute of Mineralogy and Petrology, Novosibirsk-90, 630090, Russia <nadezhda@uiggm.nsc.ru>.

The Popigai suevites and the underlying impact formations: The Popigai explosion cloud deposits (the suevite strata) are well preserved in inner basin and annular trough of the crater and include several types of suevite formations. The Parchanai suevite formation, or PSF (the volume and nomenclature of Popigai impact formations is based upon our classification [1]), occupies the lower part of the strata and contains a number (up to 50-70 % of the rock volume) of glass particles, mainly of lapilli-size. The rest of the rock is a matrix made up of mainly psammitic fragments of target lithologies, among which the clasts of the soft Mesozoic rocks dominate. Parchanai suevites came from the lower part of the explosion cloud and were the first to be deposited in a relatively hot state; they are well lithified and strongly altered. In the field, the PSF rocks are well distinguishable from any other suevites due to pumice strongly altered light-greenish-yellow glass fragments. Syngenetic (i.e., originated during cratering) relations of the PSF with underlying bottom impact formations are the next: 1) in some places of the inner ring of the Archean gneisses the suevites either were emplaced directly on them, or served as a cementing matrix of the gneiss fragments; 2) in some other places of the ring and the crater margin the suevites are emplaced on the impact melt rocks – tagamites, or are included as small irregular bodies in the uppermost part of the tagamite sheet and megabreccia. Epigenetic (i.e., originated during post-impact modification of the crater) relations of the PSF with the bottom impact formations are the next: 1) the suevites are the wall rocks for numerous intrusions of the buried tagamite melt; 2) sheet-like and cover tagamite bodies in and on the suevites are known on the slopes of the inner ring and in some places of the crater; they originated as a result of gravity slumping and melt flow from the highlands.

Megamixtures of the Parchanai suevites and tagamites: Specific syngenetic relations between the PSF rocks and tagamites are known in some places of the west and south-east sectors of the inner ring and adjacent areas, especially in the riverheads of Balagannakh-R., Namsik-Daldyn-R. and Balagan-Yurege-R. There is a kind of transition zone between the suevites and underlying tagamites represented by a chaotic mixture of irregular and swirled tagamite and suevite bodies up to several tens of meters in size. The type of the contacts (a complex interfingering and stream-vortical relations) indicates the turbulent interaction between the contacting masses at still mobile and plastic state.

Small, up to 2 meters in size, tagamite bodies are rarely known in the PSF at various places of the crater. However, the impactites described above and defined here as the suevite-tagamite megamixtires occupy extensive enough (of many square kilometers) areas and can be distinguished as a special allogenic impact formation. In a mode of transportation and deposition of the material this formation is intermediate between the suevites themselves and the bottom centrifugal flows of the tagamite melt.

As we suppose, the partial disintegration of the tagamite melt into large lumps at the stage of its centrifugal displacement is a result of any regular process, but not a result of any random fluctuations in moving near-bottom flow. The explosive disintegration of the impact melt at the excavation was already analyzed [2], and these authors come to the conclusion on the important role of the volatiles in this process. In particular, they found an importance of free porous water derived from the target lithologies; shock vaporization and explosive expansion of this water led to the origin of suevites. Below we consider the role of the water in mega disintegration of the Popigai impact melt during cratering.

Water in the Popigai impactites: Our previous studies show that water from target lithologies played an important role at various stages of origin and evolution of the Popigai impact melts: “dry” and “wet” tagamites [1,3]; “dry” and “wet” glass fragments in suevites [3,4]; syngenetic dense water inclusions in lechatelierites [5]; injections of fluid-enriched tagamite melt into the target rocks [6]. A main conclusion resulted from all the studies is that heterogeneous distribution of water inherited by the impact melt from the target lithologies was not homogenized at all the stages of evolution of this melt, including its recrystallization and solidification. The dimension range of these heterogeneities is very broad: from irregular distribution of fluid inclusions and fine alternating of “dry” and “wet” glass bands observed in thin section scale up to alternating of giant, of many hundreds of meters in size, “wet” and “dry” tagamite bodies. We are using this feature in order to explain the nature of mega lump explosive disintegration of the Popigai impact melts.

It is well known that spasmodically heated water, if being closed, shows a high internal pressure. Our estimations for the water inclusions in lechatelierite schlierens from the Popigai impactites show that at the time of solidification of the glasses (temperatures >1700°C) the fluid pressure in the inclusions varied from 0.8-1.5 GPa (a case of gas+liquid inclusions with density ~0.5-0.7 g/cm^3) up to 3.2-3.3 GPa (for entirely liquid water inclusions) [5]. "Exploded" fluid inclusions in lechatelierite are the evidence of a rapid fall of the confining pressure; as a result, the droplets of compressed fluid could not reach the dynamic equilibrium with the host melt by means of a smooth expansion. Behaviors of "dry" impact melt and compressed fluid inclusions inside it are quite different in case of shock pressure release. Thus, the melt unloaded from 50 GPa to atmospheric pressure, increases in volume up to ~2-2.5 times only; at this, the pressure release occurs rapidly, by means of rarefaction waves. In case of the same unloading for the water, the droplet of compressed fluid has to increase its volume to ~2000 times, and has to do a work against viscosity of the enclosing melt. In this case, the pressure release takes place much more slowly, by means of the "piston-like" mechanism. At this, the droplet can explode, if the confining pressure fall was too fast. Anyway, when the confining pressure becomes lower that the fluid pressure inside the inclusion ("X"-moment), this inclusion begins to operate as a local buffer against the pressure fall. So, since the "X"-moment, decompression behavior of a "wet" melt, in contrast to the "dry" one, is determined by expansion of water, as it was found in shock compression experiments on "wet" targets [2].

Origin of the Popigai suevite-tagamite megamixtures: As it was stated above, a complex interfingering of "dry" and "wet" masses represented the bottom centrifugal flow of the Popigai tagamite melts. The "wet" melts kept an excess pressure of water fluid still at the final stages of shock pressure fall by rarefaction waves. That is why, the bands and streams of the "wet" melt could operate as disintegrating or explosive material. As a result of these excess local pressures, the upper part of the tagamite melt flow was disintegrated into large (up to hundreds and thousands of cubic meters in volume) lumps. Turbulent mixing of these lumps with subsiding material of the Parchanai suevite led to origin of the suevite-tagamite megamixtures. Earlier, we partially discussed this mechanism already in [5].

At what part of the melting zone did originate the tagamite melt, affected to mega scale disintegration? Following to data by [2] on the impact melting of water-saturated sedimentary target lithologies, the melt originated in the target volume limited by shock wave isobars 50-100 GPa, was dispersed to ash-like particles; suevites, composed by more large, lapilli-size particles, were derived from the 10 to 50 GPa melting zone. If compared with the scheme, the origin of the Popigai impactites has a number of special features. At first, the Popigai suevites were originated by more complex way than it is supposed by the simple cratering models. At second, the impact melt was derived from the Archean gneisses at shock pressures >50 GPa. However, the scheme proposed by [2] can be accepted in a whole. Following to it, the hottest and partially vaporized melt derived from the central part of the melting zone, was finely dispersed to ash-like particles and deposited either inside the crater (Daldyn suevite formation in the upper part of the suevite strata), or was ejected to outside the crater. Indirectly, the proximal dissemination of the impact melt can be indicated by the strewn field of impact diamonds [1] traced around the Popigai astrobleme to a distance up to 500 km. Less heated melt derived from the next part of the melting zone, was disintegrated to lapilli-size particles and took part in the origin of the PSF. As for the Popigai tagamites, it was earlier noted [1], that based upon complex of their petrographic features, these rocks were derived from the most cold marginal part of the melting zone; it can be inferred that the integrated temperature of the tagamite melts after homogenization of hot spots by thermo-diffusion was lower than the melting points of quartz (~1700°C) and feldspars (~1300-1400°C). We have no objective means to precisely estimate the temperature boundary between the melts which took place in the origin of the PSF, and the melts which formed the tagamites; obviously, the melts affected to mega disintegration, occupied any intermediate position in this sequence.

Similar water-induced (and by other volatiles also) mechanisms of large-scale explosive disintegration of impact melt could take place on the Mars and on the other Solar System planets, and may be of interest in study of large impact structures on these planets.

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