POPIGAI ASTROBLEME (RUSSIA): WATER & DIAMOND POTENTIAL OF IMPACTITES-TAGAMITES. S. A. Vishnevsky1 Institute of Geology & Mineralogy, Novosibirsk-90, 630090, <svish@uiggm.nsc.ru>

Introduction: Water plays an important role in many aspects of origin and evolution of impact melt rocks in terrestrial astroblemes, including their petrology, mineralogy and geochemistry [1, 2]. Below some data are presented showing that the diamond potential of the famous Popigai deposit of this unique essential component can be controlled by the action of water derived from the target gneisses.

Diamond potential of the Popigai impactites-tagamites: First finding of the Popigai impact diamonds was made in 1972 [3]. Since after this time, a number of investigations on the diamonds were made by various geologic organizations, both scientific and prospecting [4, 5]. The results of these efforts (including our contribution in 1971-1978) show that the diamonds are broadly widespread in various kinds of the Popigai impactites and their ejecta.

It was also found that the diamond potential of the tagamites can strongly vary, and both the diamond-rich and diamond-poor species are common for this type of rocks [6].

Two types of the Popigai tagamites: All the Popigai tagamites are characterized by the similar bulk geochemistry, and it’s no matter what is their location within a large, ~100 km in diameter, Popigai crater. On the other hand, being derived from the Archean crystalline basement target rocks, all the tagamites are also very similar to the parental gneisses in terms of their bulk geochemistry also [7, 8]. However, following to their general macro- and micro-features, the tagamites are clearly divided into two types: 1) dark-gray very hard cryptocrystalline rock with conchoidal fractures and without residual glass detected by optical means (type I tagamites in our terminology [6, 8]); 2) dark-gray, fragile, microcrystalline rock with irregular fracturing and with a number of residual glass detected by optical means (type II tagamites in our terminology [6, 8]). It was also found that both the petrologic types of the tagamites are also different in terms of their diamond potential (Fig. 3). Bimodal distribution of impact diamonds was also found for both the tagamite types. Following to our data (138 quantitative determinations of the diamond amounts in type I tagamites, and 32 determinations for type II tagamites), some tagamites exhibit a small, down to zero, diamond content (type I – 47,5 %; type II – ~80 %; with average equal to 1,42 for type I, and 1,05 for type II; all the amounts are in conventional units). As for the samples with higher diamond amounts the data are the next: type I – 42,5 %; type II – 15,5 %; with average equal to 9,43±2,30 for type I, and 6,88±1,52 for type II; all the amounts are in conventional units. These data show that both the petrologic tagamite types indicated above, are controlling their diamond potential [6].

The petrologic nature of types I and II of the Popigai tagamites: The petrologic interpretation of both I and II types of the Popigai tagamites is still a matter of debates. Following to [4, 9] type I tagamites are equal to low-temperature impact melt rocks, whereas type II tagamites are high-temperature ones. Following to [8, 10] the specificity of
both the tagamite types (which determine their different post-impact evolution within the Popigai impact complex), was related to the initial water content of the corresponding impact melts (“dry” ones for type I and “wet” ones for type II tagamites). At this, the “dry” melts were solidified into cryptocrystalline rocks, whereas the “wet” ones — into microcrystalline varieties. A broad origin of residual glasses, dissolving and impact anatexis processes in the melt-incorporated gneiss fragments, origin of corona structures around the fragments, etc., is a very common feature for the “wet” type II tagamites. The petrologic features of both the tagamite types meet a definition by means of our “dry vs. wet” impact melts hypothesis. Also, this hypothesis is confirmed by the preliminary study of the water amount in both the tagamite types and their quenched varieties. Following to this study [8], the “dry” type I tagamites are characterized by 0.74±0.18 mass % amount of H₂O, whereas “wet” type II varieties have 2.23±0.48 mass % amount of H₂O. Comparative ion probe studies on the amounts of H₂O, REE, minor and trace elements show that the diapithermites along the Khapchan gneisses of the Anabar shield can serve as the target source for the “wet” type II tagamites [11-14]. As for the “cold vs. hot” impact melts hypothesis by [4, 9], it meets some open or problematic questions, such as: 1) simultaneous association of both the strongly-shocked (lechatelierite and fused feldspar glasses) and low-shocked (quartz and feldspar) residual gneiss fragments in so-called “high-temperature” type II tagamites; 2) fine banding of types I and II tagamites within the thick long-time cooling impact melt sheets; 3) totally-observed saturation of both the types I (“cold”) and type II (“hot”) tagamites by a number of parental gneiss fragments; these fragments are residual but not strange admixtures.

Origin of impact diamonds and some general reasons for various diamond potential of the Popigai tagamites: Graphite-derived impact diamond paramorphs in the Popigai astrobleme were resulted from the shock compression of the graphite-bearing target gneisses. Following to experimental data and comparative sample investigations [5 and refs. therein], shock pressures of at least from 35 to 50 GPa range are required for the graphite → diamond transformation in case of the Popigai. In general, shock pressures attenuate uniformly in all directions from the point of impact. So, one can conclude, the initial distribution of the shock-generated diamonds in the impact melts was depended on the graphite content in the target gneisses. Following to this conclusion, bi-modal distribution of the impact diamonds in both the types of the Popigai tagamites can be related to the presence of graphite-rich and graphite poor target rock gneisses. Then, the initial diamond potential of the melts was affected to diminishing at the stage of post-impact evolution of these melts depending on their thermal evolution (quenching or long-time cooling). All-round traces of etching and dissolving of the impact diamonds are very common for the Popigai tagamites and show that thermal history of the melts was determinative fact for the final diamond potential of these rocks. Following to data by [15, 16], the main factor of the diamond corrosion in the silicate melts is the high-temperature action of K and Na at the presence of water. The combined action of these agents is one of the most powerful processes of diamond corrosion, and the time scale of such kind of the dissolving is another very important aspect for the final diamond potential of the rocks under discussion. However, in a whole at all the equal initial conditions, the preservation of diamonds in the “dry” melts was always higher than in the “wet” ones. We suppose the fact of the increased diamond potential for the “dry” type I Popigai tagamites meets an explanation within this hypothesis.

Conclusion: There are a number of evidences that water plays an important role at various stages of impact cratering including problems of impact petrology and mineralogy. The possible role of water in definition the final impact diamond potential for the Popigai tagamites is one of the examples of so kind. The studies on this interesting problem are in progress, and we hope, the results planned to have been got will be of both the scientific and practical interest.

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