**HIGH-PRESSURE WATER INCLUSIONS IN POPIGAI MONOMINERAL IMPACT GLASSES: A CRITERION OF SHOCK AND EVIDENCE OF PROLONGED SHOCK PRESSURE RELEASE FOR THE "WET" COMPRESSED LITHOLOGIES**. S. A. Vishnevsky[1] and N. A. Gibsher[1], [1]Institute of Geology & Mineralogy, 630090, Novosibirsk-90, 3 Koptug prospect, RUSSIA (svish@uiggm.nsc.ru; svish@igm.nsc.ru).

**Introduction:** $H_2O$ plays an important role at the various stages of impact cratering from the shock melting and component separation to excavation and post-impact evolution of impactites [1-5]. However, $H_2O$ behavior in impact processes is still poorly studied, and a bulk of impact studies are based upon the "dry" model. Meantime, the approach is too simplified for the terrestrial astroblemes. High-pressure specificity of $H_2O$ inclusions in fresh Popigai lechatelierites (LCHs) and fused K-Na feldspar glasses (FGs) and a buffer role of $H_2O$ in delay of shock pressure release (SPR) of "wet" compressed lithologies are presented below.

**LCHs and high-silica ($SiO_2$>93 wt. %) glasses**: They contain a number of various fluid and melt inclusions, both the kindred (derived from mineral and fluid inclusions of parental quartz) and the strange ones (melt and fluid intrusions from outside). Many of LCH schlieren from the different Popigai impactites contain fluid inclusions of various densities with a broad relation between gas and liquid phase **(Fig. 1).** Based on cryometry [5,6,7] the liquid phase of the most inclusions is made up of low-salt $H_2O$ (0.5 to 8 wt. % of salts in NaCl-equivalent). Together with them, separate groups of gas+liquid inclusions with NaCl? crystals (transparent isotropic cubic phase) are present in some shclieren; in some of the inclusions the salt phase even dominates **(Fig. 2).** These "salt" inclusions could be the relics of "brine" bubbles known after [8] in quartz of the target Archean migmatites. The most impressive among the kindred molten inclusions are the "ruthiles" **(Fig. 3)**, serving as a melt thermometer of ~1860°C.

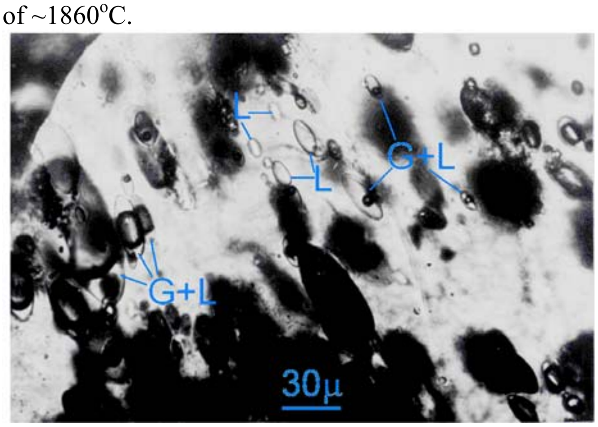


**Fig. 1.** Co-genetic liquid (L) & gas+liquid (G+L) $H_2O$ inclusions in high-silica glass Suevite, sample #1308, micro photo, at 20°C.

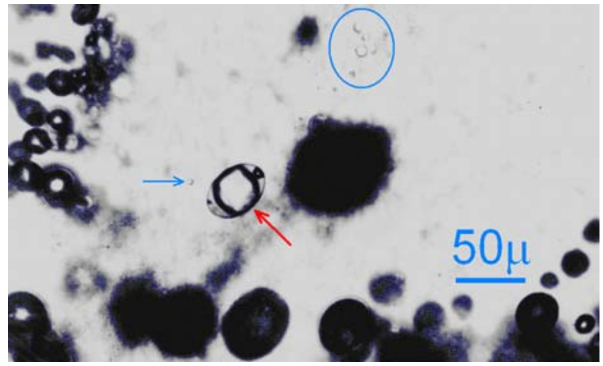


**Fig. 2.** G bubbles, salt-rich G+L inclusion (red arrow), and fine fluid-coated salt crystals (blue-indicated) in LCH. Suevite, sample #1308, micro photo, at 20°C.

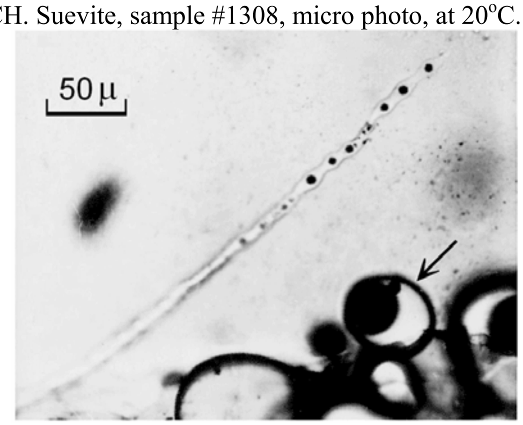


**Fig. 3.** "String" of molten ruthile (a chain of black Ti minerals in Ti-rich glass) and dense G+L inclusions (arrow-shown, one of them has a solid phase) in LCH. Suevite, sample #622, micro photo, at 20°C.

**K-Na FGs:** A great number of G+L fluid inclusions of various densities are present in fresh schlieren of the glasses **(Fig. 4).** Following to cryometry and thermometry, the L phase of the inclusions is made up of $H_2O$ with low to moderate salinity (8.3 to 13.5 wt. % of salts in NaCl-equivalent) [9].

**Discussion:** Origin of $H_2O$ inclusions described is related to specificity of shock metamorphism and is explained by its extreme irregularity, disequilibria and high speed of transformations. So, impact melt has initially very complex heat micro structure, presented by "hot" and "cold" spot volumes. Owing to thermo diffusion and quenching, the "cold" spots could trap the dense $H_2O$ inclusions, whereas the superheated fluid in the "hot" spots could expand to create a variety of low dense bubbles following to SPR. Dense, 0.5 to 1 g/cm$^3$, $H_2O$ inclusions in LCHs and FGs show high trapping pressures. Indeed, the melting point of quartz

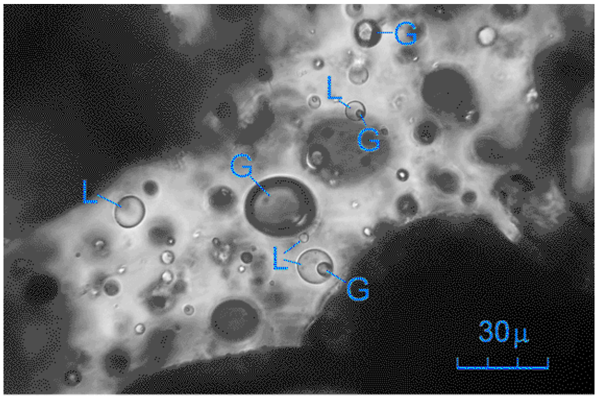


**Fig. 4.** Co-genetic G, G+L and L $H_2O$ inclusions in K-Na FG. Tagamite, sample #2189, micro photo, at 20°C.

can vary from ~1450°C (unstable melting, see [10]) to ~1700°C ("dry" melting). So, the trapping pressures for the inclusions in LCHs were~0.8 to 3.3 GPa [7] **(Fig. 5)**. Melting temperatures for K-Na FGs can vary from ~1100-1200°C ("dry" melting at stage III of shock metamorphism) to 695-770°C ("wet" melting). Correspondingly, trapping pressures for the inclusions were ~0.2-0.5 to 1.5-2.6 GPa **(Fig. 5).** The glasses studied were near-surface products (depths <0.3-0.5 km). So, the lithostatic pressure have to be ruled out for the trapping. The trapping could be at the residual shock pressures of the compressed media. However, thermo diffusion and quenching of the melts in hundreds of μs to first mms scale is rather problematic for the fast adiabatic SPR for the "dry" systems, when the rarefaction waves move at fast sound speed common for compressed media. Prolonged SPR is needed. Such SPR is known in experiments with "wet" systems [2]. On the other hand, much of the Popigai impact melt rock is rich in $H_2O$ [4], derived from the target, and is divided into "dry" ($H_2O$ mean = 0.74±0.18 wt. %, 14 analyses) and "wet" varietes ($H_2O$ mean = 2.39±0.48

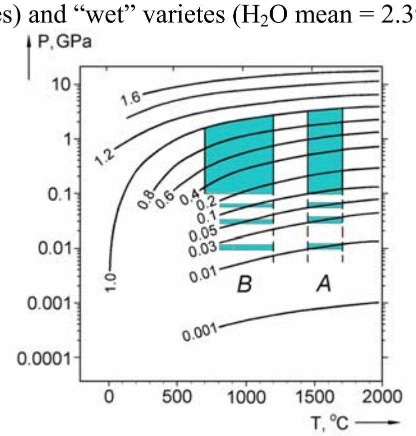


**Fig. 5.** Trapping pressures of dense (0.5 to 1 g/cm$^3$) $H_2O$ inclusions in LCHs (A) and K-Na FGs (B) on the phase diagram of water after [11].

wt. %, 17 analyses). Based on the data, we supposed the delay of SPR in huge Popigai impact melt masses by the action of $H_2O$ buffer [6,12]. Study of Popigai impact fluidizites confirmed the hypothesis, estimated the action time of $H_2O$ buffer (up to 10-12 s) and show that "long-living" and very mobile fluid systems with residual shock pressures and high penetration ability could originate in "wet" impactites of large astroblemes [13]. Dense $H_2O$ inclusions in LCHs and FGs are common for the "wet" Popigai impactites, but G or "exploded" fluid inclusions are found in "dry" impactites **(Fig. 6).**

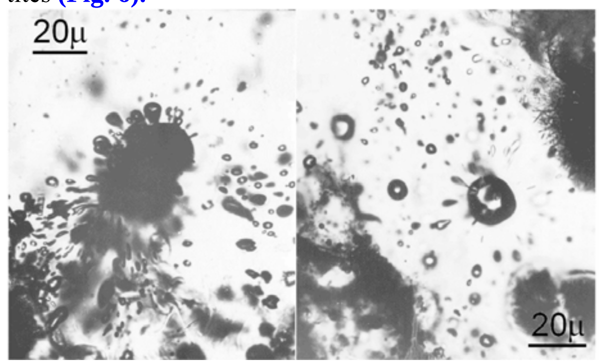


**Fig. 6.** "Exploded" bubbles in LCH in "dry" tagamite ($H_2O$ 0.78 wt. %). Sample #1005, micro photo at 20°C.

**Conclusion:** Dense $H_2O$ inclusions in the Popigai glasses indicate high, up to 0.8-3.3 GPa trapping pressure and are the unique evidence of impact melting. Their near-surface trapping was due to the action of the water buffer which delayed SPR for compressed water-rich lithologies. Possibly, high-pressure $H_2O$ inclusions are the specific feature of the large astroblemes only.

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