UNIQUE HIGH-PRESSURE WATER FLUID INCLUSIONS IN SOME POPIGAI IMPACT GLASSES.
N. A. Gibsher[1] and S. A.Vishnevsky[1], [1]Inst. of Geology & Mineralogy SB RAS, Novosibirsk-90, 630090, RUSSIA <svish@igm.nsc.ru>

Introduction: The young, 35.7 Ma-age, well-preserved and good-exposed Popigai 100–km in diameter astrobleme in the Arctic Siberia, Russia exhibits a number of various peculiar features [1]. Among the features, there are high-pressure water fluid inclusions of various densities syngenetically-trapped in some Popigai impact glasses. Earlier, we reported the inclusions of so kind for the Popigai impact fluidizites [2], K–Na feldspar glasses [3] as well as for the lechatelierites and high-silica glasses from the suevites [4] and bottom megabreccia [5]. The inclusions from the Popigai suevite megabreccia and the summary on the phenomenon of these inclusions are reported below.

High-pressure water fluid inclusions in the Popigai suevite megabreccia: The suevite megabreccia is a rather specific impact formation whose origin is in contrary with the current Z–models of cratering and was explained by the hypothesis of the dynamic barrier [1, 6]. This hypothesis meets a definite support in [7]. Within the breccia, among the gneiss-derived impact melt glasses there are bombs, clasts and schlieren of the fresh lechatelierite, high-silica and K–Na feldspar glasses. All the glasses contain syngenetic co-existing water-fluid inclusions of various phase composition: gaseous, gas+liquid and entirely-liquid ones within the same glass sample (**Figs. 1, 2**). The major part of the inclusions are of spherical, rounded and elongated form typical for the fluid drops dispersed into the enclosing melt and then trapped during its solidification. The size of the inclusions is varying from 3–5 to 10–20 μ, rarely up to 50 μ. A very fresh state of the enclosing glass, which is known to be very sensitive to any hydrothermal alteration, rules out indubitably any secondary alteration as a course of the varieties in the phase composition of these co-existing inclusions.

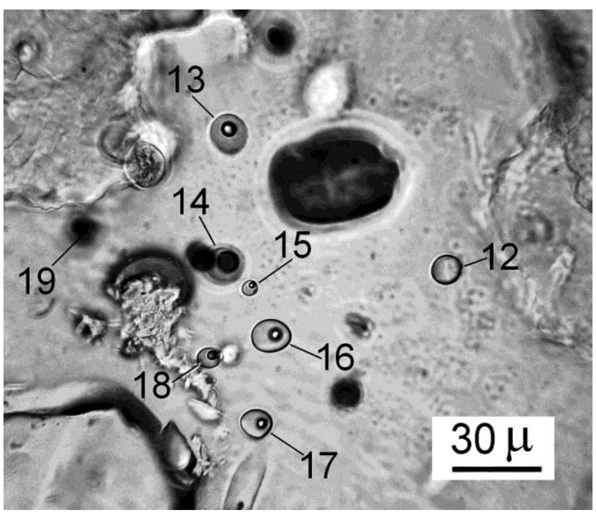

Fig. 1. Co-existing water fluid inclusions of various phase composition (gaseous G, liquid+gas L+G and entirely liquid L) in the lechatelierite from the Popigai suevite megabreccia. Micro photo at 20°C. Plane polarized light. *Note:* indicated in numbers, below there are the criometric data on the inclusions studied, number of inclusion/phase composition/salinity of water in NaCl-equivalent, in wt. %: 12/L/1.5; 13/L+G/6.2; 14/L+G/6.7; 15/L+G/3.0; 16/L+G/0.6; 17/L+G/2.2; 18/L+G/8.0; 19/G/6.1.

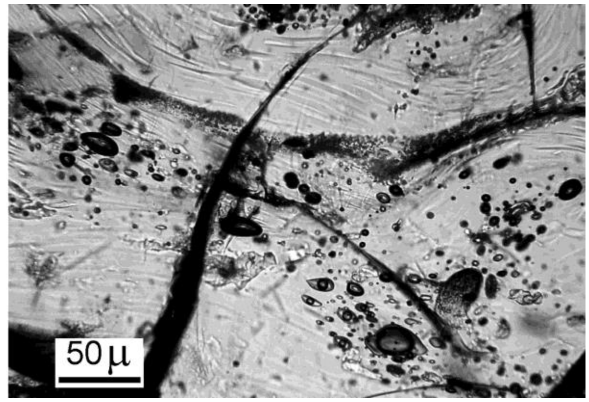

Fig. 2. Co-existing water fluid inclusions of various phase composition in the K–Na fused feldspar glass from the Popigai suevite megabreccia. Micro photo at 20°C. Plane polarized light. Kinked strips in the glass are the relics of the perthites in the parental feldspar.

Data on Cromarty: Some of the inclusions were subjected to standard cry metric study which includes the freezing at liquid Nitrogen state (–160°C) and measuring the temperatures of the eutectic and melting points of the ice. Following to the data obtained (melting point temperatures are from –0.1 to –4°C; eutectic temperatures are from –18.1 to –26.7°C) the liquid phase of all the inclusions is represented by water of low to moderate salinity in Nail-equivalent (**Fig. 3**).

P–T trapping conditions: All the glasses studied have the high melting point temperatures, namely: from ~1450°C to 1700°C for lechatelierite [8], from 1400°C to ~1550°C for high-silica glasses [9], and from ~700°C to 1200°C for K–Na feldspars [10]. Following to [11] (**Fig. 4**), the trapping pressures for the dense, 0,5–1 g/cm^3, water inclusions are estimated to be from ~0.8 to 3.3 GPa for lechatelierites and high-silica glasses, and from ~0.2–0.5 to 1.5–2.6 GPa for K–Na feldspar glasses.

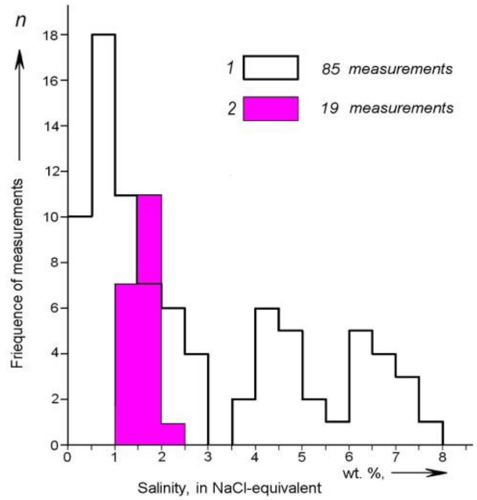

Fig. 3. Cryometric data on the individual water fluid inclusions from the glasses of the Popigai suevite megabreccia. *Note:* 1 – lechatelierites; 2 – melt glasses derived from the K–Na feldspars.

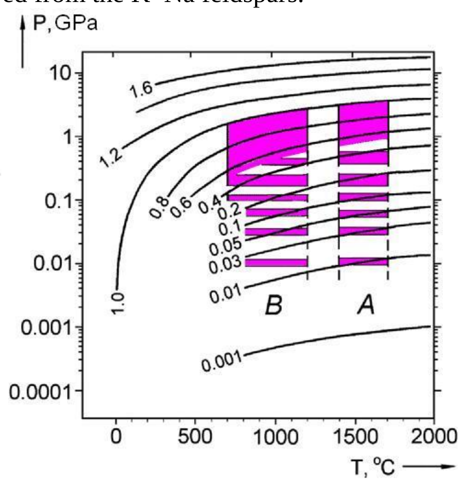

Fig. 4. P–T trapping conditions for dense (0.5–1 g/cm^3) water fluid inclusions from the impact melt glasses of the Popigai suevite megabreccia following to the phase diagram of water after [11]. A – Lechatelierites & high-silica glasses; B – K–Na feldspar glasses.

Origin of the inclusions: Any lithostatic variant has to be ruled out for the dense water inclusions trapped at near-surface conditions. We explain the origin of co-existing inclusions of various densities by the next: 1) the high speed and inequality of the shock metamorphism (a complex thermal microstructure of the impact melts was originated): 2) the delayed shock pressure release as a result of "water buffer action", which is known for the "wet" compressed media [12]; it was estimated to be up to the times of 10–12 s in the Popigai case [13]. These times seem enough for the micro-scale local thermo diffusion between the melt points. At this, the dense water bubbles could be trapped in the "cold" points of the melt, whereas the bubbles in the "hot" points could expand and finally trapped in a low-dense state. High solidus points of the host melts were favor to the process. So, inequality of the shock metamorphism and the "water buffer" action can explain the origin of the unusual water fluid inclusions in various Popgun glasses [4, 5 and 14].

Summary: The syngenetic water fluid inclusions of various densities in some Popigai impact glasses are rather specific products. No examples of such kind of the inclusions are still reported in impactites from other terrestrial impact sites (due to: a large scale of the impact event? a lack of the proper investigations? any other still unknown causes?). These inclusions, including their high-pressure species, may be a new geochemical criterion of the shock. The explaining of their origin was a problem for a long time until the inequality of the shock melting and the post-shock evolution of the melts at the delayed shock pressure release under the action of water buffer had been taken into account. We welcome any new explaining of the phenomena from our colleagues involved in impact investigations.

An important role of water in case of a shock compression of the wet media was still pointed out by [12]. Some other data (an earlier impact anatexis [1], an extremely mobile state of the wet compressed media [1, 4], selective separation of the main petrogenic elements [1, 6], etc.) show an important role of water regime of the impactites. These data may be of an interest for the future studies of the Martian and some other impactites from the water-containing planets of the Solar system.

References: [1] Vishnevsky S., Montanari A. (1999) *GSA Special Paper 339*, 19–59. [2] Gibsher N., Vishnevsky S. (2006) *LPS XXXVII*, Abstract #1234. [3] Vishnevsky S. et al. (2007) *Meteoritics & Planet. Sci., 42,* Supplement, A157. [4] Vishnevsky S. et al. (2010) *Geochemistry International, 48, # 8,* 752–764. [5] Vishnevsky S. et al. (2010) *Doklady Earth Sciences, 432, part 2,* 518–523. [6] Vishnevsky S. (2007) *Astroblemes.* Novosibirsk: Nonparel Publishing, 288 pp. (in Russian). [7] Sharpton V., Dressler B. (2003) *LPI Contr. #1155*, Abstract #8059. [8] Valter A. et al. (1982) *Pis'ma v Astronomichesky Zhurnal, 2,* 115–120 (in Russian). [9] Yasinskaya A. et al. (1981) *Doklady Ukrainian AN, B, 9,* 38–41 (in Russian). [10] *Minerals. Reference Book. Vol. V, Issue 1* (2003) Moscow: Nauka Press, 583 pp. (in Russian). [11] Juza J. et al. (1986) In *Proc. of the 10th Internat. Conf. on the Properties of Steam.* Moscow: Mir Publishing, 106–116. [12] Kieffer S., Simmonds C. (1980) *Reviews of Geophysics & Space Physics, 18 (1),* 143–181. [13] Vishnevsky S. et al. (2006) *LPS XXXVII,* Abstract #1268. [14] Vishnevsky S., Gibsher N. (2006) *Doklady Earth Sciences, 409, #6,* 981–984.