EL'GYGYTGYN, AN IMPACT CRATER IN SILICEOUS VOLCANIC ROCKS: PRELIMINARY CHARACTERIZATION OF THE ICDP DRILL CORE.

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Introduction: The 3.6 Ma old El'gygytgyn impact structure, in Arctic Russia, is the only known impact structure on Earth that was excavated in siliceous volcanic rocks, mostly ignimbrite, tuff, and rhyolite lava [1]. In 2009, the El'gygytgyn impact crater was drilled within the framework of an ICDP (International Continental Scientific Drilling Program) project. The aim of studying the drill core is to investigate shock metamorphism in these rocks, as a possible planetary analogue, and to find criteria to distinguish volcanic and impact-derived features.

The studied core begins at 318.83 m below the lake floor, underlying the post-impact sedimentary sequence, and was terminated at 517.30 m. The whole core can be subdivided into three main units: (1) sedimentary breccia with grey/reddish sandy/clay matrix and large clasts of melted rocks (mostly similar to white pumice and dark rhyolite); (2) highly fractured transition zone with breccia intercalated to suevite and melt layers, extended from ~382 to ~404 m depth; and (3) greenish suevite (Fig. 1).

Methods: From the over two hundreds samples collected along the core, about 60 samples were selected for microscopic investigation in thin section and 22 were used for the first geochemical analyses. The optical microscopy was supplemented by image analysis, using the "SXM Image" software. The chemical composition of the powdered samples was analyzed by X-ray fluorescence spectrometry. Further investigations, including instrumental neutron activation analysis (INAA), X-ray powder diffraction (XRPD), micro-Raman spectrometry, and scanning electron microscope (SEM) with an energy-dispersive X-ray (EDX) analyzer, are in progress for a better characterization of the samples, especially of the melt particles.

Geological setting: The El'gygytgyn impact crater, centered at 67°30′N and 172°34′E, is located in the central region of Chukotka, northeastern Russia. The age of the impact was determined on impact glasses using the $^{40}Ar/^{39}Ar$ method, yielding 3.58 ± 0.04 Ma [2], in agreement with earlier data. El'gygytgyn crater has a diameter of 18 km and the crater floor is covered by a lake, which is 12 km in diameter and up to 170 m deep in its central part. A complex of lacustrine terraces surrounds the lake.

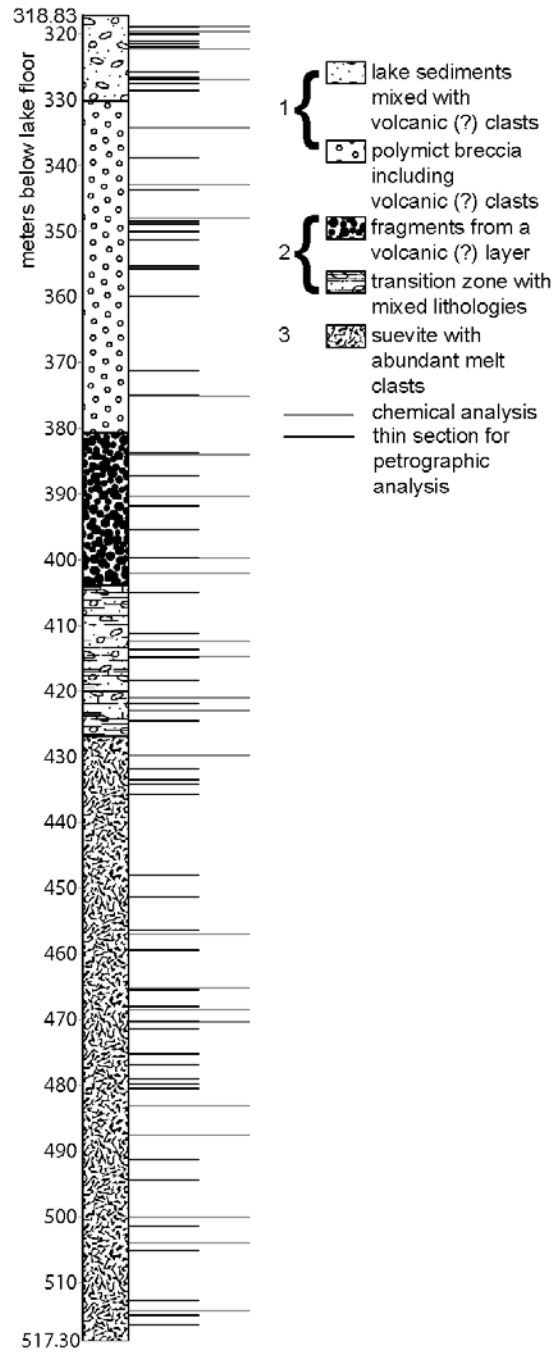

Figure 1. *Schematic lithology of the ICDP drill core. To the right of the core log, the positions of samples reported on here are shown.*

The crater was excavated in a volcanic sequence of predominantly siliceous composition of Late Cretaceous age, as is confirmed by K-Ar dating of 83.2 to 89.3 Ma [2], and belonging to the outer part of the Okhotsk-Chukotsky Volcanic Belt [3,4]. The volcanic sequence comprises rhyolitic and dacitic lava, tuffs, and ignimbrites, exposed in the southern, western, and northeastern sections of the crater, and rarely andesites and andesitic tuffs, mainly exposed in the southeastern part of the crater [3].

Results and discussion: The sedimentary breccia in the upper part of the core has a fine-grained matrix, with grain-size ranging from mm to µm. The matrix is composed of glassy clasts, of alteration products from feldspars and devitrification, and quartz and other not yet identified minerals (Fig. 2a). Abundant clasts are present in the matrix, with sizes from few mm for single minerals of quartz and calcite, to several cm for glass and porous volcanic-like rocks, similar to pumice and solidified lava. The latter is comparable to the glasses collected along the crater rim already studied by [5], with a rhyolitic composition. There are few quartz clasts, and none have yet been found to contain PDFs or PFs; they are just severely fractured.

In the transition zone, the most interesting feature is the presence of a dark, only slightly altered, melt layer that is characterized by well-preserved or recrystallized mm-sized white quartz clasts. The chemical analysis of these samples shows an elevated content of Co, Cr, and Ni, which might be interpreted as either being the result of meteoritic contamination or hydrothermal alteration. Additional studies are in progress.

The suevite in the lower part of the core is green in color, possibly as a result of alteration. Under the optical microscope, this rock comprises a fine-grained matrix, lithic fragments and melt clasts, with a matrix-supported fluidal fabric (Fig. 2b). The matrix varies from clastic to glassy; in the latter case it is completely devitrified and replaced by clay minerals or is recrystallized as microcrystalline quartz. Lithic clasts consist of rounded and slightly elongated single quartz grains (Fig. 2c), highly altered feldspar (almost completely, pseudomorphically replaced by saussurite and sericite, with development of secondary calcite in some cases), and rare altered kinked or deformed biotite (Fig. 2d) and amphibole. The TiO_2 in the biotite is exsolved as titanite along the cleavage planes; both biotite and amphibole are highly altered and partially to completely replaced by chlorite and sodian amphiboles, respectively. The unit is called a suevite because some quartz grains contain evidence of shock melting, such as lechatelierite, or some quartz grains have a toasted appearance. Unfortunately, no PFs or PDFs were observed so far; as most quartz grains seem to have been recrystallized to stable α-quartz, obliterating previous structures; this will be further investigated. Black melt clasts, mm to tens of cm in size, with fluidal structure and containing schlieren, are abundant (Fig. 2e). They appear brown to green in color, depending on the alteration of the glassy groundmass. The chemical analysis of these samples does not reveal any anomaly and their bulk composition is similar to that of the glasses.

Fractures crosscutting the suevite are common, in some case they are filled by cm-thick veins of greenish clay minerals or white-reddish carbonates.

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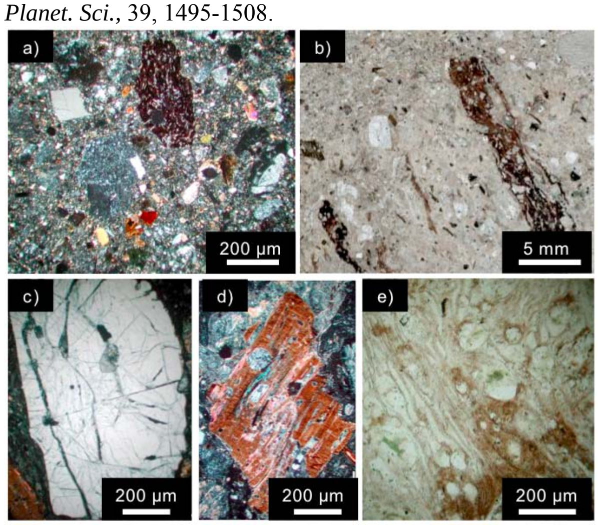

Figure 2. *Selected microphotos of El'gygytgyn drill core samples. a) Sample 99Q1W17-19, 319.05 m below lake floor (blf). Impact breccia from the upper core section, containing melt clasts (brown-reddish) and lithic clasts in a clastic matrix. Cross-polarized light. b) Sample 107Q4W3-5, 343.80 m blf. Clast of suevite with elongated melt fragments, included in layer 1 breccia but representative of layer 3 suevite. Plane-polarized light. c) Detail of a quartz grain with random fractures from (b). Cross-polarized light. d) Detail of deformed biotite from (b). Cross-polarized light. e) Sample 178Q1W50-52, 512.63 m blf. Detail of the internal fluidal structure marked by schlieren in a melt clast. Plane-polarized light.*