PRELIMINARY PETROGRAPHY OF IMPACTITES FROM EL'GYGYTGYN CRATER, NE SIBERIA, INCLUDING CORES FROM ICDP-LAKE DRILLING HOLE D1.

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Introduction: The 3.6 Ma, 18 km diameter El'gygytgyn impact crater in NE Siberia formed in a target composed of 83.2 to 89.3 Myr old volcanic rocks [1]. A generalized pre-impact upper target stratigraphy was established by [2]: (top to bottom) 250 m rhyolitic ignimbrites, 200 m of rhyolitic tuffs and lavas, 70 m of andesitic tuffs and lavas, and 100 m of rhyolitic and dacitic ash tuffs and welded tuffs. Below the frozen crater lake, the ICDP drilling project recovered 315 m of lake sediments [3] that are underlain by impact breccias to a final depth of ~517 m.

Samples and Methods: The ~6 cm diameter drill cores from the depth interval of 318.83 to 517.09 m were inspected during the sampling party at the Museum of Natural History in Berlin. Altogether 26 core samples with typical lengths of 5 cm between 316.7 to 517 m depth were selected for petrographic and geochemical studies. In addition, 3 samples of glassy melt clasts that were collected near the crater rim were available for study; they weighed 12, 20 and 28 g, and were 2 to 5 cm in size. Altogether 32 petrographic thin sections, 6 from the melt clasts and 26 from the core samples, were studied under the microscope.

Preliminary Results: *Melt clast petrography:* The three glassy melt clasts have dull, dark brown colors and exhibit rounded surfaces. Fresh fractures have characteristic luster and layering occurs due to the inclusion of fine clasts. The glassy melt is translucent and colorless in thin tection (Fig. 1). Incipient devitrification is indicated by the presence of 50 to 100 µm-size pyroxene trichites. Shock features in entrained mineral clasts are rare, but quartz clasts were found with one to two sets of planar deformation features (PDF) in two of these samples; this confirms they are clast-bearing impact melts.

Drill core petrography: The basal section of hole D1 is composed of a green lithology with light, mm-size inclusions of crystals. Regularly, several cm-thick, elongated, brown, aphanitic melt particles with igneous contacts are embedded in the green groundmass. These melt particles are generally aligned in a uniform direction with dips of ~30-45°, which is considerably steeper than the original dip of the target rocks of 6° to 10° [2]. Also, a few mm-size angular, shard-like particles with a bright emerald color occur in this rock (e.g., at 508.2 m depth). The rock is frequently brittly deformed, which also affected the brown melt particles. Veins and vugs are commonly filled with secondary pink chalcedony (?) that rims white to beige carbonate. At a depth of 471.3 to 474 m, a polymict breccia occurs that has a fine-grained, pink-brown clastic matrix and contains cm-size angular clasts of the host rock, and some exotic, orange-colored clasts. Between 422.4 and 422.7 m, a dark green, highly fractured boulder occurs in the strongly brecciated green host rock. Macroscopically, the luster and schistose fracturing style of this inclusion is reminiscent of highly altered ultramafic rocks or soapstones. Between 420 to ~421.2 m depth, an inclusion that is less fractured but similar in colour and texture occurs. The three thin sections from this basal unit are unshocked ignimbrites with mm-size skeletal crystal inclusions and occasional volcanic melt. Feldspar and pyroxene crystals are strongly altered to sericite and chlorite and the ignimbrite groundmass is altered to phyllosilicates.

Above ~420 m, the lithology changes to a polymict breccia, which includes abundant clasts similar to the ignimbrite unit below. Notably, the rocks in this section are far less well consolidated and the groundmass is clearly clastic and mostly poorly consolidated. There are no clear indications for the presence of impact melt fragments such as the glassy melt clasts that were collected near the crater rim. No unambiguous impact melt was found in the 13 thin sections from the depth interval between 391.6 to 330.9 m. Instead, the lithologies appear to be polymict lithic breccias of volcanic rocks. Although more minerals exhibit undulous extinction and occasional planar fractures in quartz than in the unit below, features diagnostic of a shock metamorphic overprint are extremely rare. The only such feature was found in a quartz clast with "feather-features" that are branching off from planar fracture planes (Fig. 2); these features indicate shock pressures <10 GPa [4].

At ~328 m depth, the polymict lithic impact breccia changes to a breccia or conglomerate that frequently contains grey, up to ~30 cm thick, vesicular clasts. A thin section of such a clast captures a pervasively altered, vesicular melt rock that does not contain lithic clasts. Bubbly carbonate fills some of its vesicles and it seems plausible that these clasts were derived from tuffs of the Cretaceous target sequence. Six thin sections from the depth interval between 328.1 and 323.9 m contain mm-size glassy melt particles that are isotropic and translucent-white in color. Some are highly vesicular, and some contain layers of entrained fine sediment and flow textures. The latter are closely reminiscent of the glassy melt samples that were collected near the rim of the crater (Fig. 1). Dark, aphanitic melt particles occur as well, but so far, solid evidence for their impact origin is lacking. Voids and cracks throughout the upper sections contain secondary mineralizations of stubby, ~50 µm-size, euhedral tectosilicate crystals with very low birefringence (Fig. 3). In the sample from a depth of 326.7 m, a lone, ~0.3 mm diameter, round, clear, glassy bead occurs that could be a spherule. The sample also contains a ~4 mm diameter, dark, round particle with a ~1 mm thick, concentric rim, which could be an accretionary lapilli.

Above ~319.2 m, another lithological change is recognizable towards a polymict, conglomeratic succession that contains several dm-thick, size-sorted, sandy intercalations. However, truly laminar (lacustrine ?) sediments that are intercalated with occasional dropstones only occur above ~315.6 m. Thin sections from depths of 318.9 and 316.7 m capture size-sorted domains of mostly polymict lithic breccias. Another thin section from a depth of 317.6 m contains some altered melt particles, and possibly some that are still partly isotropic. However, at least 2 clear, round glass beads with diameters of ~300 µm (Fig.3) occur in each of these 3 thin sections. These beads are likely impact melt spherules, alike the ones described by [5].

Summary: The drilled sequence contains a basal, ~97 m thick section dominated by fractured, unshocked rhyolite. The lack of shock metamorphic features in this unit suggests these rocks may be allochthonous block(s) of target rocks that were moved to their current position from an original location outside the 5 to 10 GPa pressure isobar. This unit is overlain by ~92 m thick polymict lithic impact breccias with very scarce shock metamorphic features. These breccias are succeeded by a ~11 m-thick unit that likely represents suevite with typically <10 vol% angular, glassy impact melt particles. Very tentatively, airfall components may be present in this section. The uppermost sub-unit that could be studied is ~3.6 m thick, contains size-sorted intercalations and glassy melt spherules; it may represent reworked ejecta plume deposits. Above ~315.6 m depth, lacustrine background sedimentation from a post-impact crater lake appears to be present. Judging from the scarcity of impact melt in the drilled sequence, El'gygytgyn crater is also likely deficient in impact melt for its size.

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References: [1] Gurov et al. (2007) *MAPS 42*, 307-319. [2] Gurov & Gurova (1991) *Geological structure and rock composition of impact structures*, Naukova Dumka Press, Kiev, 160 p. [3] Koeberl et al. (2009) *GSA Ann. Meeting*, abstract #207-11. [4] Poelchau & Kenkmann (2010) *LPSC XLI*, abstract #1987. [5] Adolph & Deutsch (2009) *LPSC XL*, abstract #1116.

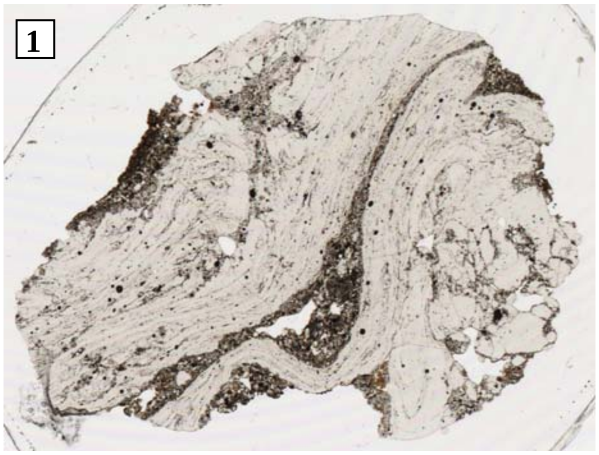

Fig 1 Thin section scan of glassy melt clast collected near the rim of El'gygytgyn crater; clast is 2 cm wide.

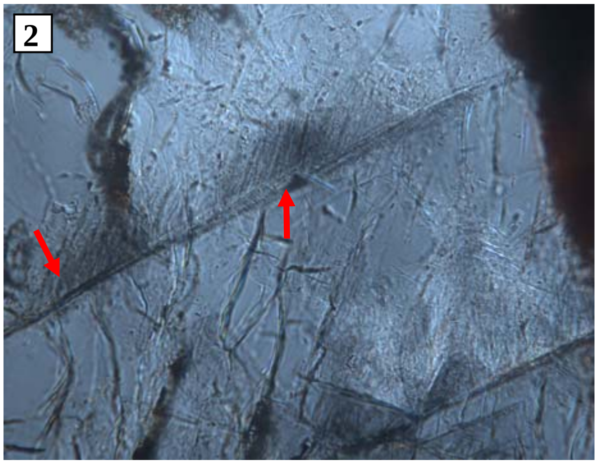

Fig. 2 Feather features (arrows) in quartz, core sample depth 390.1 m, X-pol; image is ~280 µm wide.

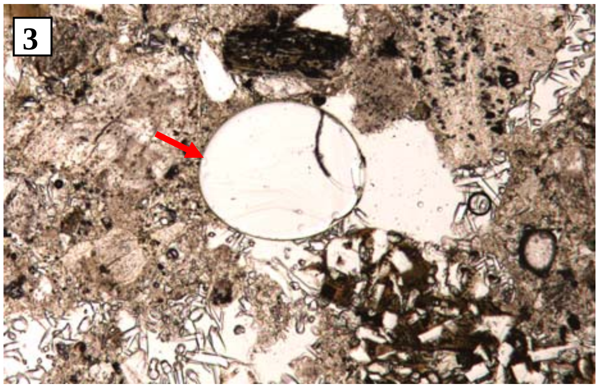

Fig. 3 Possible 300 µm-Ø impact spherule (arrow); note stubby crystals in voids; core sample depth 316.7 m, ppl.