DEPOSITIONAL RECORD OF PRISTINE IMPACTITES AND TRACES OF THE PROJECTILE IN EL'GYGYTGYN CRATER. Axel Wittmann[1,2], Steven Goderis[3], Philippe Claeys[3], Marlina Elburg[4], Frank Vanhaecke[5], Jessica Zaiss[6], Gregory Ravizza[6], and Alex Deutsch[7]. [1]Washington University, 1 Brookings Dr., St. Louis, MO 63130, wittmann@levee.wustl.edu; [2]Lunar & Planetary Institute, Houston, TX 77058; [3]Vrije Universiteit Brussel, Earth System Science, Department of Geology, BE-1050 Brussels, Belgium; [4]Universiteit Gent, Dept. Geology & Soil Science, 9000 Ghent, Belgium; [5]Universiteit Gent, Dept. Analytical Chemistry, 9000 Ghent, Belgium; [6]Dept. Geology & Geophysics, University of Hawaii at Manoa, Honolulu; [7]Institut f. Planetologie, WWU Münster, Wilhelm-Klemm-Str. 10, D-48149 Muenster, Germany.

Introduction: The International Continental Scientific Drilling Program drilled ~225.3 m of lake sediments that are underlain by impact breccias to a final depth of ~517.3 m below the crater lake floor of the inner region of the ~3.6 Ma old, NE Siberian El'gygytgyn crater [1, 2, 3]. This continuous drill core section likely recoverd pristine impactites from a large (18 km Ø) terrestrial crater [e.g., 4].

A record of the response to shock metamorphism of the volcanic upper target rock succession [4, 5], impactite emplacement, and only minor alteration likely allow comparison to impacts on other terrestrial planets. The distribution of impactor traces in the continuous impactite section furthermore may validate previous reports of an achondritic (ureilite?) projectile at El'gygytgyn [6]. Impactor identification for El'gygytgyn could link a sub-recent "fossil" projectile to the present-day flux of meteoritic material to Earth.

Samples and Methods: Photographs and thin sections of 26 samples of the ICDP-lake drill core 1C in El'gygytgyn crater were used to describe the ~202 m thick, continuous section of impactites [7] (Fig. 1). Major and trace element abundances, including siderophile Cr, Co, Ni, and platinum group elements (PGE), as well as Os isotope ratios were determined using ICP-OES and ICP-MS on selected samples [8].

Results and Discussion: *Trace element geochemistry:* A relatively flat, non-fractionated CI-normalized PGE pattern was detected in the samples from the reworked fireball deposit and the lower polymict breccia (Fig. 1), concurrent to pronounced Cr and smaller Ni enrichments. Based on these siderophile element abundances and associated Os isotope signal [8], this diluted extraterrestrial component is on the order of ~0.05 wt% of nominal CI-chondrite. A primitive achondrite (including an ureilite as suggested by [6]) could be advocated as a possible impactor.

Emplacement of the impactite section: The drilling location ~2.3 km to the west of the crater's center [1] may lie on the outer flank of the central ring structure of collapsed central uplift material that was inferred from geophysical data [9]. The monomictly brecciated lower and upper ignimbrites (Fig. 1) likely represent allochthonous, tilted megablocks. They are separated by the lower polymict breccia that is mostly sourced from felsic volcanic rocks but contains exotic clasts and could bear traces of an extraterrestrial component.

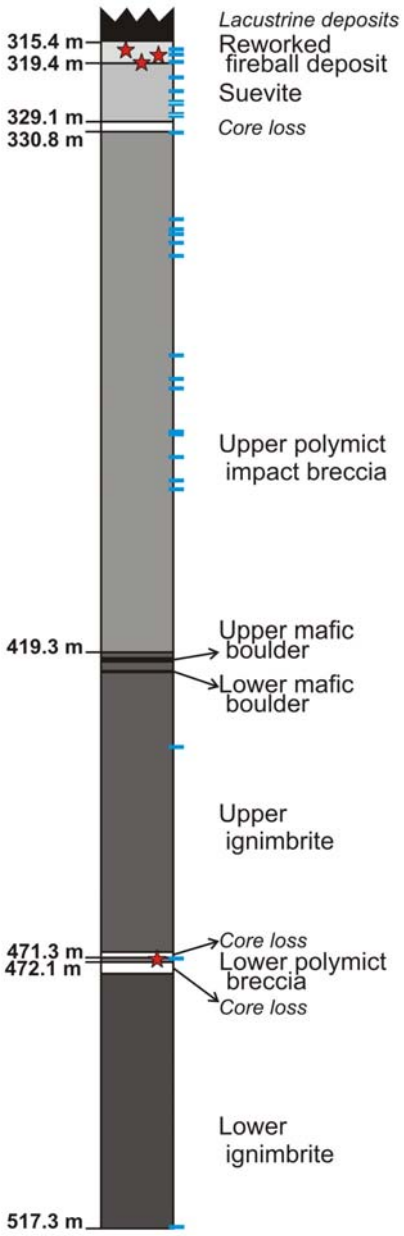

Fig. 1 Stratigraphy of the impactite section of El'gygytgyn ICDP-hole 1C. Sample locations are indicated as blue bars and associated extraterrestrial components with red stars .

The mafic boulders towards the top of the upper ignimbrite likely formed as Paleocene basaltic intrusives and could have provided structural weakness in their host block that accommodated faulting and separation-from the original location. However, because ignimbrites occur in the upper ~450 m of the target sequence [10], it seems unlikely that these blocks represent surviving, parautochthonous rocks from the central crater region. Furthermore, because these ignimbrite blocks appear unshocked, they were likely located outside the 10 GPa pressure isobar of the crater during the contact and compression phase of the impact, which is not compatible with material that was part of a shallow region near the center of the impact.

The ~89 m thick upper polymict impact breccia section varies from blocky debris that is mostly derived from felsic volcanics to matrix-supported sections that are mixtures of felsic and mafic volcanics. This section contains scarce shock metamorphic features and generally lacks impact melt. The stratigraphic position of these breccias suggests they could be part of a ground surge, or represent remnants of the ballistic excavation flow [11], analogous to polymict lithic "Bunte Breccia" from the Ries crater (e.g., [12]).

A ~10 m thick section of suevite is characterized by the occurrence of tuff clasts and very minor amounts of angular impact melt particles up to ~1 cm in length. Frequent shard shapes and a general lack of igneous contacts with the host breccia matrix suggests the impact melt particles were rapidly quenched below the glass transition temperature and fragmented before deposition. Rare glass beads and mantled clasts could be additional indicators for the emplacement of this unit as fallback from an ejecta plume. However, shock metamorphic features in the rock forming minerals in this unit are scarce, which might be a characteristic effect of the porous volcanic target lithologies.

A transitional zone of breccias, conglomerates and layered sands, the reworked fireball deposits, displays an extraterrestrial signature. It contains glassy spherules, small, glassy impact melt particles, diaplectic quartz glass with coesite, and planar deformation features and planar fractures in quartz and feldspar clasts. The abundance of spherules in the three samples from this deposit suggests that they could have been derived from a fallout layer of spherules, on the order of ~3.5 to 9 mm thick, that precipitated from El'gygytgyn's vapor plume. It is worth noting that the reworking process apparently affected only a minor amount of impactite, because spherules are typically part of the last fallback material that is deposited in the aftermath of an impact. The spherules range in composition from rhyolitic to dacitic, trachytic, and andesitic (Fig. 2; compare [13]). In contrast, impact melt particles have relatively similar, rhyolitic compositions, suggesting derivation from the upper target sequence of predominantly felsic volcanics (Fig. 2). This observation implies that apparently, tiny, rapidly quenched impact melt particles underwent a pronounced homogenization, while vapor plume-condensed spherules record an extended compositional variation of target components. Moreover, [13] showed that El'gygytgyn spherules contain siderophile enrichments with Ni/Co ratios of 11-14. This ratio agrees with ureilites (Ni/Co ~14), but is inconsistent with chondrites (Ni/Co 19-20) and the Upper and Lower continental crust ~1.60 and ~2.60, respectively [14].

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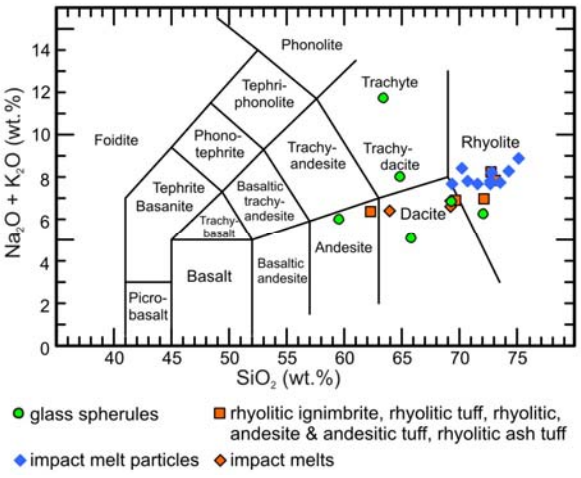

Fig. 2 Total alkali-silica diagram with electron microprobe data of glassy impact melt particles (blue diamonds) and spherules (green circles) of suevite and reworked fireball deposit samples of ICDP-El'gygytgyn hole 1C; whole rock data for volcanic upper target rock members (orange squares) and three impact melts (orange diamonds) after [4]. All data normalized to 100 wt%.