INVESTIGATING IMPACT MELT EVOLUTION THROUGH THE PETROGRAPHIC ANALYSIS OF THE COTE CREEK DEPOSIT AT THE MISTASTIN LAKE IMPACT STRUCTURE. G. D. Tolometti, G. R. Osinski, N. S. Chinchalkar, and J. P. Jaimes Bermudez. 1Department of Earth Sciences/Institute for Earth and Space Exploration, University of Western Ontario, London, Ontario, N6A 3K7(gtolomett@uwo.ca).

Introduction: Impact melt is the product of target rocks decompressing after experiencing high shock pressures during hypervelocity impact events. The thermal evolution of impact melt is still a much debated and important topic, as we can gain insight about how impact melt played a role in the devolatilization of early crustal material [1], impact melt cooling rates [2], and the solubility of elements essential for crustal differentiation [3]. Previous work has sought to deconstruct the thermal evolution of impact melt from various terrestrial impact structures by studying the composition and petrography of melt-bearing impactites [e.g., 3-4] and/or inferring P-T conditions from the crystallographic properties of accessory zircon and zirconia minerals [5-6]. However, no previous study at Mistastin has analyzed impactite samples taken along a detailed stratigraphy transect.

In this work, we study the composition and petrography of various melt-bearing impactites at the Mistastin Lake impact structure located in Labrador, Canada, one of few terrestrial craters exhibiting well-preserved impact melt deposits. We focus on a deposit at the Cote Creek locality (Figure 1) where impact melt rock units show clear transitions from impact melt-bearing breccias to clast-rich and poor impact melt rocks.

Cote Creek: Cote Creek is an impact melt locality located ~5–6.5 km from the crater center [7] and hosts impactite units from melt-free polymict breccias to clast-poor fine-grained impact melt rocks. This locality shows one of the most well-preserved contacts between lithic impact breccias (ballistic ejecta) and impact melt rocks, with a transition zone and an impactite stratigraphy containing melt-bearing breccias and crystalline impact melt rocks (Figure 1).

Preliminary Results: Fieldwork was conducted in September 2021. We cut polished thin sections from the impact melt rock samples from the Cote Creek transects to conduct petrographic analysis. The following subsections are petrographic descriptions of each melt-bearing unit moving from the bottom to the top of the impactite stratigraphy (Figure 2).

Impact Melt-Bearing Breccia. At the base of the transects are impact breccias comprising a matrix of mineral clasts and particles of impact glass. The impact glass is deep brown to black under plane-polarized light, with faint flow textures. Few to no clasts are present in the impact glass particles.

Figure 1. Field image of the impactite stratigraphy at the Cote Creek locality (55°55′16.62″N/63°23′41.81″W) at the Mistatin Lake impact structure. Dashed red lines and white dots mark the locations of transects and impactite samples.

As we move further along the transect, the isolated particles of impact glass transition to pockets of aphanitic impact melt intermingling with clastic material. The melt in the matrix is similar to the glass-bearing breccia impact glass, is deep brown, but exhibits more pronounced flow textures, localized zones of high vesiculality, and small visible microlites of plagioclase crystals. In some locations in the sample, the impact melt matrices exhibit coarsening textures.

Clast-rich Impact Melt Rock. Situated above the impact melt-bearing breccia is a clast-rich impact melt rock comprising a fine-grained melt matrix with a poikilitic texture. The melt matrix comprises needle-shaped plagioclases, centimetre-sized mangerite clasts, and quartz and plagioclase mineral clasts (>15 % abundance) exhibiting a range of shock metamorphic effects. In some samples, we identified multiple impact melt particles and lenses exhibiting different crystallinitities and textures (i.e., glassy v.s. fine-grained). Localized areas show intermingling between fine-grained melt and a medium-grained melt matrix, or fine-grained melt with particles of quenched deep brown impact glass.
**Clast-Poor Impact Melt Rock.** Similar to the clast-rich impact melt rock, this unit comprises a fine-grained impact melt matrix with shocked to non-shocked mangerite and mineral clasts, although fewer in abundance (<10%). The needle-shaped plagioclase crystals in the melt matrix are greater in size and no particles of impact glass are present.

**Figure 2.** Impactite stratigraphy at the Mistastin Lake impact structure Cote Creek locality. Left column shows field images of the melt-bearing units and the right column shows plane-polarized light thin section images of the impactites.

**Discussion:** Through our field and petrographic observations, we note the transitions in impact melt matrix crystallinity and decreasing glass abundance moving up the impactite stratigraphy. Multiple types of impact melt were identified throughout the sample transects, particularly in the glass-bearing and impact melt-bearing breccias. Both of these impactites are situated within a transition zone, between the basal polymict breccias and the crystalline impact melt rocks. We interpret that the transition zone at Cote Creek represents a region where mixing occurred during the impact crater excavation and modification stage, as evident from flow textures in the melt and glass matrices. The identification of multiple types of impact melt and glass opens a window into reconstructing the thermal evolution of the Mistastin Lake impact structure, since each of the melt and glass matrices could originate from a different locality in the crater and/or formed at a different temporal point during the impact cratering event.

**Next Steps:** For a more thorough investigation into the thermal evolution of impact melt, we will perform detailed geochemical analyses on the impact melt in the samples and identify accessory zircon and zirconia minerals that record high P-T conditions. Geochemical analysis will be performed on the impactite samples using the JEOL JXA-8530F microprobe at Western University. We will analyze the composition of impact melt using wavelength-dispersive spectroscopy (WDS) spot analysis and detailed images will be acquired using backscatter electron (BSE) imagery. In addition, we will analyze the crystallographic orientations of zircon and zirconia using a JEOL 7600F field emission Scanning Electron Microscopy (SEM) instrument in the E-beam analytical suite of the Astromaterials Research and Exploration Science division at JSC to constrain the temperature conditions of the melt.

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