Evolution of the Cote Creek Impact Melt Deposit at the Kamestastin Lake Impact Structure.

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Introduction: The thermal evolution of impact melt distributed and emplaced in different settings across an impact crater remains a topic of debate. Impact melt thermal evolution is an important story for understanding how impact melt devolatilized early crustal material [1], how impact melt cooled during and after deposition [2], and the solubility of elements essential for crustal differentiation [3]. The preferred approach to deconstruct the thermal evolution of impact melt is to constrain pressure and temperature conditions preserved within the microstructures and crystallographic orientations of accessory minerals zircon ($ZrSiO_4$) and zirconia (ZrO_2) [e.g., 4–6]. Recent work by [4] and [5] discovered that impact melt at the Kamestastin (Mistastin) Lake impact structure in Labrador, Canada exceeded temperatures >2370 °C, based off cubic zirconia phase orientations within baddeleyite. These superheated temperatures are vital information for understanding the early P-T conditions of impact melt formation, which is a period of the impact cratering process that is rarely preserved. To date, we only have recordings of these superheated temperatures from one sample, from one locality, within a single crater. Therefore, a question that stands is can we identify more recordings of these superheated temperatures and specific moments in impact melt cooling within an impact structures impactite stratigraphy. To address this, we seek to constrain the thermal evolution of the well-exposed impact melt deposit named Cote Creek, located near the northwest shoreline of the Kamestastin Lake impact structure, Labrador, Canada. We will study the thermal evolution of the Cote Creek deposit by analyzing the composition and petrography of the impact melt moving up the impactite stratigraphy and the diagnostic shock microstructures and crystallographic orientations of zircon grain and zirconia crystals encased in impact melt matrices. The impactite stratigraphy contains a collection of melt-poor and melt-rich impactites, including (base → top) melt-free polymict breccias, impact melt-bearing breccias, clast-rich impact melt rocks, and a clast-poor fine-grained impact melt rock.

Impactite Stratigraphy Petrography: We collected impact melt-bearing **s**amples from three sub-vertical transects at the Cote Creek locality during a field deployment to Kamestastin Lake in September 2021. Our petrographic analysis agrees with observations reported by previous workers at Kamestastin Lake impactites [7,8]; impact melt crystallinity increases moving up from the melt-free polymict breccias and target rocks, and petrographic textures transition from glassy-aphanitic to porphyritic in the clast-poor impact melt rock samples. In samples acquired from a contact between the clast-rich impact melt rock and the impact melt-bearing breccias, known as the "transition zone," we discovered three different impact melt textures: (1) cm-sized particles of deep brown impact glass, (2) black aphanitic impact melt, and (3) aphanitic-trachylitic impact melt. We interpret that this zone represents a region where clast content drops drastically and transitions from a clast-dominated impact melt-bearing breccia to an impact melt rock. The presence of flow textures within the transition zone also suggests turbulent mixing, where the multiple impact melts quenched before complete homogenization could occur.

Geochemical and P-T Analysis: We are investigating the composition of the impact melt moving up the impactite stratigraphy using both qualitative and quantitative methods. Using a Bruker M4 Tornado micro-x-ray fluorescence (XRF) instrument, we have acquired elemental maps of the impactite thin sections. Preliminary results show the major elemental composition of the Cote Creek impact melt to be homogenous, with the exception of localized pockets of impact melt exhibiting elevated concentrations of alkali elements (Na and K) and Si. These enrichments are the result of clasts not fully assimilating into the melt. The micro-XRF data also provides context for wave-dispersive spectroscopy (WDS) analysis, which will provide quantitative elemental information on the impact melt samples. Using an electron micro-probe analysis (EMPA) instrument and XRF zirconium maps, we have identified zircon grains in each impact melt-bearing impactite located in the Cote Creek outcrop. Our initial findings include the identification of fully granular zircon grains and partially granular zircon grains with lamellae-like textures. We will be analyzing the microstructures and phase heritage of these zircon grains using electron backscatter diffraction (EBSD), which will provide constrains on the P-T conditions of each impactite sample.

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