**VERTICAL TRANSECT THROUGH AN IMPACT MELT POND AT DISCOVERY HILL, MISTASTIN (KAMESTASTIN) LAKE IMPACT STRUCTURE, CANADA.** N.S. Chinchalkar[1], G.R. Osinski[1] [1]Department of Earth Sciences, University of Western Ontario, London, N6A 5B7, Canada.

**Introduction:** Impact melt shares physical properties with endogenic igneous melt [1], and hence, distinguishing between the two remains a challenge. Impact melt and endogenic melt are formed by completely different processes, and knowledge of physical and chemical properties of impact melt can improve our understanding of the impact melting process [*e.g.,* 1]. In addition to the differences in melt emplacement processes, impact melts are known to be superheated with respect to the igneous counterpart [*e.g.,* 1-3]. Recent evidence of superheated impact melt at Mistastin Lake impact structure highlighted the crater's importance as a site for understanding thermal evolution of impact melt [2,3]. Kamestastin (a.k.a. Mistastin) Lake impact structure in northern Labrador, Canada (55˚53' N; 63˚18' W), is a ~28 km diameter complex crater that formed in crystalline target rocks. The impact event has been dated at $37.83 \pm 0.05$ Ma by [4]. Mistastin offers the opportunity to study diverse impactite units in situ through its well-preserved outcrops. Discovery Hill is an impact melt unit up to `80 m length in thickness in the terraced crater rim region and is interpreted as a melt pond forming part of the impact ejecta. It occurs as a hill with steep cliff faces that have well developed columnar joints (Fig. 1).

**Discovery Hill Transect:** Sample collection over two transects of 45 m and 70 m vertical lengths was carried out by GRO by rappelling/abseiling over the west and south faces of Discovery Hill, from the top of the hill up to the contact with the target rocks below. This work discusses the transect along the western face (Fig. 1). A total of 17 samples of impact melt rock were collected in this transect and polished thin sections were prepared for each sample. Electron microprobe analysis on a JEOL JXA-8530F microprobe was done at the Earth and Planetary Materials lab. We conducted backscattered electron (BSE) imaging and quantitative spot analyses on 4 samples from different vertical heights (from the top, 1.7 m, 20.2 m, 35.1m and 43.5 m) in the melt to examine the geochemical variation in the mineral content from top to bottom in the melt using Wavelength Dispersive Spectroscopy (WDS).

**Results:** Petrographic analyses show that the texture of the melt is clast poor, fine grained and largely crystalline with rare interstitial glass. The mineral composition is dominated by inequigranular plagioclase. A noticeable feature of these samples is the diversity of plagioclase grain sizes (Fig. 2). Within each sample, plagioclase occurs as larger euhedral, prismatic crystals of 1–1.5mm size, as well as smaller subhedral laths of 50–80 µm. The top and middle portion of the transect (Fig. 2A, 2B) consist of a higher distribution of the larger plagioclase crystals, and moving downwards, the melt becomes dominated by the laths of plagioclase (Fig. 2C). Pyroxene is present in lesser abundance than plagioclase and occurs as anhedral crystals. As the melt unit overlies impact breccia, the rocks near the base of the unit can be entirely of crystals (holocrystalline), crystals and glass (hypocrystalline or merocrystalline), or entirely of glass (holohyaline). Sample recovered from the lower end of the transect and close to the base of the melt unit, i.e., at 43.5m has a hypocrystalline texture (Fig. 2D), and abundant clasts.

**Fig. 1:** Drone image of Discovery Hill impact melt unit. Red line denotes location of the transect.

*Feldspar composition:* Quantitative analyses of feldspars from the 4 samples are presented in Table 1. Results show that no significant variation is present in $SiO_2$ percentage in the feldspars, except in the case of the sample close to the base of the transect where the silica is seen to be higher. Notable trends, however, are seen in some of the other major elements. For example, $Al2O_3$ and CaO percentages are decreasing towards the base of the unit, and as seen in Table 1, $Na_2O$ content increases towards the bottom, indicating a subtle shift in plagioclase composition from top to bottom. Higher clast content in the sample from 43.5 m made it challenging to identify feldspars in the groundmass thus yielding only 2 spot analyses.

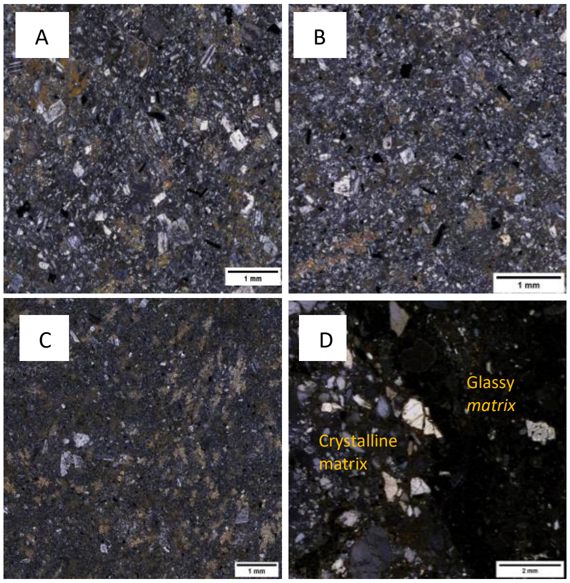


**Fig. 2:** Photomicrographs of impact melt at Discovery Hill in crossed polars. A: 1.7 m, B: 20.2m; C: 35.1m; D: 43.5 m.

**Table 1:** Quantitative analyses of major elements in feldspars. Composition is shown in weight percentages.

| Feldspar | 1.7 m (Mean; n=10) | | 20.2 m (Mean; n=10) | | 35.1 m (Mean; n=10) | | 43.5 m (Mean; n=2) | |
|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 52.32 | 1.50 | 52.56 | 1.66 | 54.02 | 0.95 | 60.56 | 0.03 |
| $Al_2O_3$ | 29.84 | 1.12 | 29.53 | 1.14 | 28.27 | 0.67 | 24.47 | 0.07 |
| $Na_2O$ | 4.35 | 0.64 | 4.48 | 0.69 | 5.40 | 0.42 | 7.34 | 0.19 |
| MgO | 0.04 | 0.01 | 0.04 | 0.01 | 0.03 | 0.01 | 0.01 | 0.00 |
| CaO | 12.16 | 1.38 | 11.98 | 1.28 | 10.64 | 0.77 | 5.94 | 0.02 |
| $TiO_2$ | 0.08 | 0.01 | 0.08 | 0.02 | 0.08 | 0.02 | 0.01 | 0.00 |
| FeO | 0.61 | 0.10 | 0.48 | 0.03 | 0.55 | 0.08 | 0.16 | 0.01 |
| $K_2O$ | 0.35 | 0.08 | 0.39 | 0.10 | 0.39 | 0.06 | 1.36 | 0.27 |
| **Total** | 99.75 | 0.57 | 99.53 | 0.26 | 99.38 | 0.41 | 99.85 | 0.13 |

**Table 2:** Major oxide composition of pyroxenes in weight percentages.

| Pyroxene | 1.7m (Mean, n =10) | SD | 20.2m (Mean, n = 10) | SD | 35.1m (Mean, n = 10) | SD | 43.5m (n=1) |
|---|---|---|---|---|---|---|---|
| $SiO_2$ | 49.40 | 0.81 | 49.47 | 0.76 | 49.21 | 0.58 | 50.07 |
| $Al_2O_3$ | 0.59 | 0.06 | 0.62 | 0.16 | 0.84 | 0.26 | 0.74 |
| $Na_2O$ | 0.04 | 0.01 | 0.04 | 0.01 | 0.11 | 0.06 | 0.21 |
| MgO | 14.67 | 1.90 | 14.51 | 2.15 | 12.13 | 2.46 | 7.49 |
| $TiO_2$ | 0.43 | 0.07 | 0.46 | 0.04 | 0.65 | 0.17 | 0.35 |
| CaO | 3.27 | 0.91 | 3.46 | 0.88 | 9.02 | 5.35 | 16.86 |
| $K_2O$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.07 |
| NiO | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 |
| FeO | 29.19 | 1.68 | 28.97 | 2.08 | 25.85 | 5.01 | 23.28 |
| MnO | 0.64 | 0.05 | 0.62 | 0.06 | 0.56 | 0.11 | 0.51 |
| Cr2O3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| V2O3 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.00 |
| **Total** | 98.26 | 1.29 | 98.18 | 0.36 | 98.41 | 0.25 | 99.62 |

*Pyroxene composition:* Results of major elemental composition of pyroxenes in groundmass of the melt from the 4 samples is shown in table 2. $SiO_2$ content does not show noticeable trends in the 4 samples, but MgO and FeO percentage is seen to decrease from the top to bottom of the unit (Table 2).

*Glass composition:* Out of the 4 samples examined here, the sample at 43.5m was the only sample in which glass is a significant component. The glass composition varies widely with an average SiO2 content of 60.2 ± 6.02 (wt%).

**Discussion and planned work:** In this work, we sought to understand variation in impact melt composition over a vertical transect at Discovery Hill.

Previously, estimates of initial melt composition at Mistastin have been modeled using bulk matrix composition of the melt [5]. Observations by [5] indicate that the thinner melt units at Mistastin may be closer in geochemistry to the initial composition of melt, as compared to the thicker melt units such as the one at Discovery Hill, where clast assimilation would be more pervasive, resulting in an altered bulk chemistry. This interpretation is supported by the clast poor nature of the melt observed in our samples.

Our work is the first attempt to investigate the vertical geochemical variation in a thick melt pond. Our preliminary results show that compositional changes in feldspars and pyroxenes from the top to the base of the melt are subtle but distinct. To resolve the changes in more detail, quantitative analyses of other samples from the transect is ongoing. It is yet unresolved whether differences in plagioclase composition are dependent on the crystal size, and this requires further analyses. A comparison of melt properties between the two transects is also indicated to account for lateral variation in the melt.

**References:** [1] Osinski G. R. et al. (2018) *JVGR, 353*, 25–54. [2] Timms N.E. et al. (2017) *Earth and Planetary Science Letters, 477*, 52–58. [3] Tolometti G.D. et al. (2022) *EPSL, 584, 117523.* [4] Sylvester et al. (2013) *Mineralogical Magazine, 77(5) 2295*. [5] Marion C. L. and Sylvester P. J. (2010). *Planetary and Space Science 58:552–573.*