# IMPACT MELT-POND SCENARIO TESTED DURING THE KRASH 2011 ANALOGUE MISSION AT KAMESTASTIN IMPACT STRUCTURE.

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**Introduction:** The Mistastin Lake (Kamestastin) impact structure in Labrador, Canada, was the lunar analogue specified site selected for the operations of the KRASH 2011 analogue mission (see [1] and [2] for an overview). This was the third in a series of lunar sample return analogue missions funded by the Canadian Space Agency [2]. During August and September 2011, two separate human sortie missions were conducted at two different sites at the lake. Importantly, both sites were visited during a robotic precursor mission in 2010 [2]. This contribution focuses on the second scenario. During the second week of operations, a science hypothesis addressing the overarching mission objectives was developed and tested (see [3]). Two candidate hypotheses were evaluated for the origin of a possible impact melt deposit observed on top of "Discovery Hill" (Fig. 1) [3]: that the hill represents an erosional remnant of 1) the impact melt sheet of the crater-fill deposits; or 2) a distinct impact melt pond deposited on a crater terrace block. Here we present the "astronaut"-based field observations made during the KRASH analogue mission that address these particular hypotheses.

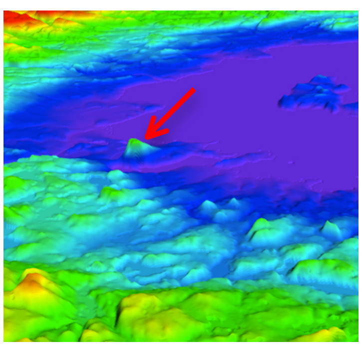

**Figure 1:** *10-m Digital Terrain Model (DTM; provided by Natural Resources Canada) of Mistastin Lake. View from SW of the west part of the impact. Note the colour-coded elevation differences between the central uplift and the summit of Discovery Hill (see [2]). Vertical exaggeration is 5x.*

**Field Observations:** Discovery Hill is located on the west shore of Kamestastin Lake. The hill has a long ramp-like "tail" that rises smoothly ~120 m over the lake level and abruptly terminates at an extensive outcrop of fine-grained, dark-grey rock which caps the summit of the hill and exhibits columnar jointing (Fig. 2). Based on these igneous textures and fabrics, the clast content and its position within the impact crater, we interpreted this unit to be an impact melt rock. The hill's long axis runs east to west, and generally appears to be symmetric on both the north and south sides, indicating that the glacial erosion activity that shaped the hill was roughly parallel to the long axis of the hill. The smooth, westward-ascending ramp is relatively flat (slope of ~0.5 over 100 m) and mostly covered with scarce low vegetation and unconsolidated erosional mantle material, consistent with the remote sensing data [3,4]. Erratic boulders of varying dimensions are found on top of the ramp. Their sizes vary from ~0.5–3 m and are interpreted to be mostly granites and occasionally gneisses, based on our observations and analyses with the field instruments [5].

*North facing side:* The north side of the hill shows a distinct division between its eastern and western parts. The east part of the slope face is covered by unconsolidated feldspathic talus. Moving westward the unconsolidated material thins out and reveals the wedge-like shaped (thickening towards west) of the impact melt. The impact melt outcrops as a nearly vertical wall of columnar jointed rock (Fig. 2) with scree deposits on the lower slopes consisting of sharp, angular, melt-fragments.


**Figure 2:** *North facing side of Discovery Hill. The general morphology of Discovery Hill, and its topographic dominance over the surrounding terrain is also visible.*

*South facing side:* The eastern section of the south facing side of the hill (Fig.4) is dominated by vegetation. The vegetation gradually recedes towards the west revealing outcrops of clast-rich melt and finally reaching the larger more extensive clast-poor impact melt that generally outcrops at the summit. In addition, an isolated outcrop of heavily eroded breccia underlies the melt near the east end of its full extension where it wedges out. The contact surface between melt and breccia is visible. The breccia is very friable and is characterized mainly of small (~1-5 cm) clasts of granitic composition.

**Impact melt rocks:** The impact melt rock is dark gray in colour, aphanitic, clast-poor to clast-rich, and is lightly vesiculated. Impact melt rock of variable clastic content appears in different localities throughout the hill. Clastic content of the melt rock is dominated by smaller clast-sizes of ~1–50 mm in size. At the base of the columnar jointed impact melt outcrop (as well as the near east-end of it), the melt rock appears more chaotic, due to massive (meter-scale) granitic boulders (i.e., megaclasts) that have been included in the melt. Such large boulders have been detached from the cliff side and rolled down to the base of the slope . Many boulders are coated with a thin veneer of melt (Fig. 3). The interface between the boulder and the melt show complex textures consistent with comminution along the melt/boulder contact. We suggest that the melt cooled faster in contact with these boulders and the cooling joints developed parallel to the boulder surfaces.

***Figure 3:*** *Coarse crystalline boulder of granitic composition covered in a thin veneer of impact melt (red arrow). The boulder was detached from the overhanging wall of melt outcrop on the north facing side of Discovery Hill.*

**Testing the impact melt sheet versus melt pond hypothesis:** There are several observations that lead us to favour an impact melt pond scenario for the Discovery Hill locality.

*1) Location:* The location of Discovery Hill with respect to the proposed listric faults [3] and the highly raised elevation of the terrace with respect to the central uplift, as seen in remote sensing data [2,3], are consistent with a terrace pond origin.

*2) Basal Contacts:* Observations from the field show that the lower contact of the impact melt rocks is sharp. At the "Fredericton" locality (Fig.4), there is a sharp contact with impact breccias that may represent the ballistic ejecta deposited within the terraces prior to melt emplacement at that location [3,5].

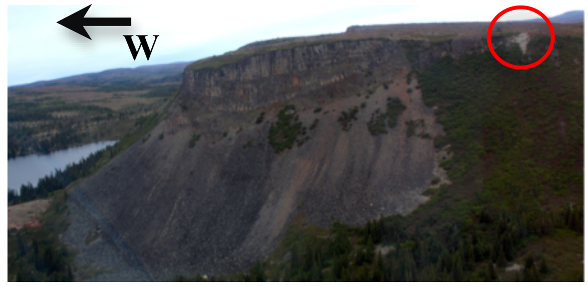


***Figure 4:*** *West end of Discovery Hill looking north. A large scree slope dominates the south side of the hill. Above the scree the wedge-like shaped outcrop of impact melt rock pinches out to a breccia outcrop, (Fredericton - red circle). The contact between the two units is sharp and the melt appears to be overlying.*

*3) Anatomy of the Deposit:* The general appearance and shape of the impact melt outcrop also contributes to an impact melt pond hypothesis. The melt deposit/outcrop can be described as a "wedge" which is thickest in the west and thins out toward the east (Fig. 4), consistent with a terrace setting (i.e., the geometric structure of the listric faults and rotation of the terrace blocks). We know that this is not an erosional expression because further to the west where the melt is thickest, we observe the well-formed cooling joints (i.e., columnar), which are less well-formed to absent as one proceeds eastward. Large boulder-sized clasts rest near the bottom of the "shallow" part of the melt outcrop. The coated melt veneers and complex contact textures suggest some movement and interaction between megaclasts and the "shallow" body of the melt pond.

**References:** [1] Marion C. et al. (2012) *LPSC XLIII* (this meeting). [2] Osinski et al. (2010) LEAG, Abstract #3047. [3] Tornabene L.L. et al. (2012) LPSC *XLIII* (this meeting). [4] Shankar B. et al. (2012) LPSC *XLIII* (this meeting). [5] Pickersgill A. E. et al. (2012) LPSC *XLIII* (this meeting). [6] Osinski G. R. et al. (2011), *EPSL,* 301(3-4), pages 167-181.

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