CHARACTERIZATION OF IMPACT MELT-BEARING IMPACTITE DYKES FROM THE CENTRAL UPLIFT OF THE MISTASTIN LAKE IMPACT STRUCTURE, LABRADOR. A. C. Singleton[1], G. R. Osinski[1,2], R. A. F. Grieve[1], and C. Shaver[1], [1]Dept. of Earth Sciences, University of Western Ontario, 1151 Richmond St., London, ON N6A 5B7 (asingle2@uwo.ca) [2]Dept. of Physics and Astronomy, University of Western Ontario, 1151 Richmond St., London, ON N6A 5B7

Introduction: Asteroid and comet impacts are an important geological process on all solid planetary bodies, including Earth. They generate pressures and temperatures that may reach several hundred GPa and several thousand K over very limited spatial and temporal scales. This results in the vaporization and melting of target rocks [1]. Through this process both impact melt rocks and a variety of impact melt-bearing breccias are created. This study investigates the characteristics of such material located in the central uplift (Horseshoe Island and Bullseye Island) of the Mistastin Lake impact structure. These allochthonous impactites are particularly interesting as they represent intrusive melt-bearing bodies within the central uplift.

Geological Setting: The Mistastin Lake impact structure is located in northern Labrador, Canada (55°53′N 63°18′W). This structure is a complex impact structure that has a diameter of approximately 28 km [2]. The age of the Mistastin event is 36.4 ± 4 Ma [3].

The central uplift of the structure is in the form of a 3 by 4 km island in the middle of Mistastin Lake. This landmass, known as Horseshoe Island, is the main site for this study. This island was mapped in reconnaissance fashion by Currie [3], who suggested that it consisted mainly of mangerite and anorthosite.

Most of the rocks on the island are highly weathered and eroded and are primarily found in the form of glaciated outcrops scattered on the island. The remainder of the island is covered with dense brush and moss and some wooded areas.

Methodology: Fieldwork was conducted over two weeks during the summer of 2010 on Horseshoe Island in Lake Mistastin. On this island 103 sites were visited and documented and 76 samples were collected. The majority of these sites consist of glaciated outcrops and consist of either mangerite or anorthosite. One site located in the central area of the island also contained impact melt rocks and impact melt-bearing breccias, and 4 sites along the eastern coast contain other impact melt-bearing impactites. These 5 sites and the material from there are the focus of this study. Thin sections were made of samples from these locations which were then analyzed using optical spectroscopy and a scanning electron microscope (SEM).

Field Relationships: The way in which the impact melt-bearing impactites interacts with the surrounding material is an important part of understanding the emplacement processes of these materials. (Fig. 1)

Site 43 (samples 38 and 39). At this site there is mangerite, melt rock and impact melt-bearing breccia. The melt rock overlies the impact melt-bearing breccia which overlies the mangerite. There is no distinct contact between the melt and impact melt-bearing breccia visible and this seems to be the only occurrence of true melt rock on Horseshoe Island.

Site 67 (sample 56). At this site an impact melt-bearing breccia dyke is intruding into the mangerite. The dyke is nearly horizontal and there is a fairly sharp contact between the breccia and the host rock. (Note that in this work the term "dyke" is used as a generic term for an intrusive body as the original orientation of the intrusion is not clear and may have been rotated during uplift formation). The textures in the intrusion shows flow patterns and the melt matrix contains clasts that are sorted, with the larger clasts concentrated in the center of the dyke (Fig. 1).

Site 70 (sample 58). At this site a sloping impact melt-bearing breccia dyke is intruding into the mangerite with a fairly sharp contact. Flow is not apparent but clasts are less abundant on the edges.

Site 71 (sample 59). Like site 67, this site has a nearly horizontal sill of impact melt-bearing breccia intruding into mangerite. The contact seems fairly sharp at many points and more poorly defined at others. There is large variety in the size of the clasts at this site with clasts ranging from a half centimeter to approx. 10 centimeters.

Site 73 (sample 60). Again at this site there is horizontal sill intruding into the host mangerite. The contact is fairly sharp and the clasts are small and fairly uniformly distributed in the dyke. Towards the center of the dyke there are pods of melt that have been elongated by flow which is unique to this site.

Fig 1. Field site 67 where sample 56 was collected. This near horizontal dyke of impact melt-bearing breccia has clast concentration towards the center.

Petrography: The samples analyzed vary widely in clast content and overall physical appearance.

Sample 38. This sample is very different then the others involved in this study. It consists of tabular crystallites of plagioclase feldspar in a glassy matrix. (Fig. 2A).

Sample 39. This sample consists of a glass matrix with clasts of quartz and feldspar. Some of the quartz grains have planar deformation features (PDFs), which indicates that the clasts have undergone shock metamorphism before being incorporated into the impact melt-bearing breccia. (Fig. 2B)

Samples 56 and 58. These samples are very similar to sample 39 and consist of melt with small clasts of feldspar and quartz and some other minerals. (Fig. 2 frame C)

Sample 60. This sample consists of a glass matrix and clasts of quartz, feldspar and sulfide grains. There are a number of different types of glass that appear dark and light in plain and cross-polarized light. The light class is the material from the flowing melt clasts that can be seen in the outcrop and hand sample scale. (Fig. 2 frame D)

Backscattered electron images (BSE) were taken of the melt and impact melt-bearing breccia samples (Fig. 3) and confirm the optical microscopy observations. In sample 39 some flow structures were also noted. Energy dispersive spectroscopy (EDS) was also used to qualitatively determine the elements present in various phases. EDS spectra were taken of the clasts and glass matrix of all samples. It is interesting to note that in most cases the matrix appears to have a very different composition than the surrounding clasts.

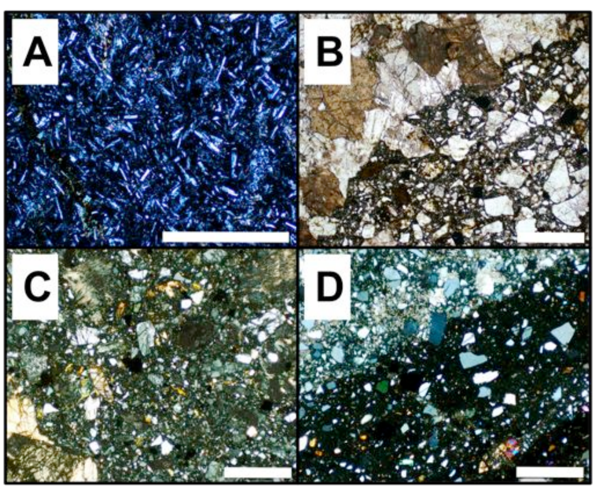

Fig 2. Optical images of melt and impact melt-bearing breccias. A: Plagioclase crystallite in sample 38 (site 43). B: Glass matrix filled with small clasts and the edge of a larger clast in sample 39 (site 43). C: Glass matrix and small clasts in 56a (site 67). D: Two types of glass with small clasts from sample 73. Scale bars are 50 μm. All images are taken in cross-polarized light with the exception of B.

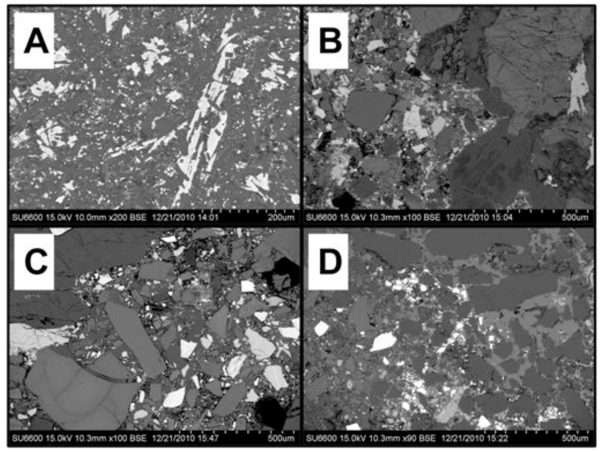

Fig 3. SEM backscatter images of melt and impact melt-bearing breccias. A through D shows samples 38, 39, 58 and 60 respectively.

Discussion and Summary: Detailed mapping of the central uplift of the Mistastin Lake impact structure has revealed the presence of a series of impact melt-bearing dykes. One site consists of clast-poor impact melt rock, while the others contain dykes of impact melt-bearing breccia that have intruded into the mangerite target rock.

Given the context within the central uplift, the level of erosion, and the stratigraphic position with respect to the coherent melt sheet that originally existed at Mistastin, the most plausible explanation is that the sites examined here are dykes of impact melt of varying clast content that were likely produced during the excavation stage of crater formation and injected into fractures in the host rock. Based on textural and geochemical evidence, an injection origin is preferred over an *in-situ* (i.e., pseudotachylyte) origin in the case of these dykes. This hypothesis is further supported by the presence of flow textures at the outcrop and microscopic scales, and the sorting of clasts in some dykes with larger clasts concentrated in the center indicating a faster flow velocity.

In order for complex craters to collapse in the manner we observe in nature a mechanism is required that would temporarily degrade the strength of the rocks at the impact site [4]. The formation of fractures filled with melt, such as the ones present in the central uplift at the Mistastin Lake impact structure, creates areas of very low friction and could contribute to crater collapse.

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