A SYSTEMATIC MULTI-YEAR FIELD CAMPAIGN AT THE MISTASTIN LAKE IMPACT STRUCTURE, LABRADOR, CANADA. M. M. Mader[1], C. L. Marion[1], G. R. Osinski[1,2], A. E. Pickersgill[1], A. C. Singleton[1], and L. L. Tornabene[1], [1]Centre for Planetary Exploration/Dept. Earth Sciences, 1151 Richmond St., University of Western Ontario, London, ON, N6A5B7, Canada (gosinski@uwo.ca).

Introduction: The systematic study of mid-size impact structures was one of the three main recommendations for focused research programs resulting from the first Bridging the Gap conference in 2003 [1]. For this reason, the research group at the University of Western Ontario, Canada, led by G. R. O., has been focusing on the comparative study of complex impact structures in the 20 to 40 km diameter size range in a variety of different target rocks. Structures being studied include Clearwater East and West (Canada), Haughton (Canada), Ries (Germany), Rochechouart (France), Slate Islands (Canada), Tunnunik (Canada), and Mistastin Lake – the focus of this contribution.

Mistastin Lake impact structure: The Mistastin Lake impact structure is located in northern Labrador, Canada (55°53'N; 63°18'W) has an apparent crater rim diameter of ~28 km and was formed ~36 Ma [2]. The original crater has been differentially eroded; however, a subdued rim and distinct central uplift are still observed [3]. The inner portion of the structure is covered by the Mistastin Lake and the surrounding area is locally covered by soil/glacial deposits and vegetation. The target rocks at Mistastin are dominated by granodiorite, mangerite, and anorthosite – the latter making Mistastin an ideal scientific analogue for the Moon. It is notable that this structure has only previously been mapped in reconnaissance fashion [4].

Methodology: Fieldwork was conducted over the course of 3 summers (2009 – 2011) and subsequent laboratory work is ongoing with a variety of undergraduate and graduate thesis work focusing on this structure. Below, we outline the highlights from these studies over the past 4 years.

Central uplift: The central uplift of the Mistastin Lake structure is in the form of the 3 by 4 km Horseshoe Island in the middle of Mistastin Lake. Field mapping has resulted in a new geological map for the island. A major finding has been the discovery of impact melt rock at one site located in the central area of the island and 4 sites along the eastern coast where impact melt-bearing breccia dykes are exposed. The latter have been interpreted as being intruded during the excavation stage of crater formation and injected into fractures in the host rock [5]. A systematic study of shock effects in the central uplift rocks is ongoing. Early efforts have focused on shock effects in plagioclase with some interesting results, including the scarcity of planar deformation features in distinct contrast to the co-located quartz [6].

Crater rim: Structural field geology combined with remote sensing images of the crater rim region have confirmed the presence of a topographic ring of hills at 28 km diameter, consistent with this being the apparent crater rim. The presence of several terraces formed by collapse during the modification stage of crater formation have been recognized both in the field and on satellite images [7].

Impactites: Despite the potentially multiple episodes of glaciation, one of the unique properties of Mistastin is the presence of several semi-continuous sequences of impactites exposed in streams and rivers draining in to Mistastin Lake. These exposures afford excellent opportunities to study the nature of impactites and their emplacement. A general sequence for exposed impactite units, from the base upwards, is: autochthonous to parachthonous lithic (monomict) breccias, allochthonous lithic (polymict) breccias, allochthonous impact melt-bearing breccias, and allochthonous impact melt (e.g., Fig. 1).

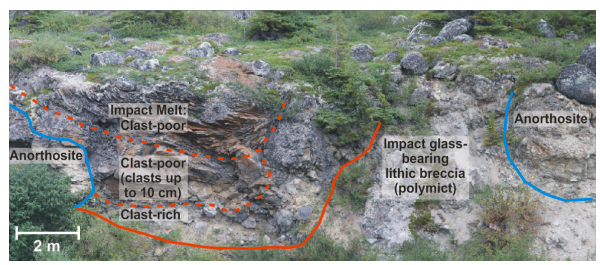

Figure 1. Impactites exposed at Coté Creek, Mistastin Lake impact structure. From [8].

Impact melt rocks at Mistastin have been studied in detail and demonstrate that the melt was derived from ~73% anorthosite, ~7% mangerite, and ~20% granodiorite [9]. The underlying breccia units are heterogeneous and studies are still ongoing; however, they are interpreted as proximal ejecta deposits [8].

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