NEW INVESTIGATIONS OF THE GOW LAKE IMPACT STRUCTURE, SASKATCHEWAN, CANADA: IMPACT MELT ROCKS, ASTRONAUT TRAINING, AND MORE. G. R. Osinski[1], A. C. Singleton[1], A. Ozaruk[1], and J. R. Hansen[2], [1]Centre for Planetary Science and Exploration, Depts. Earth Sciences/Physics and Astronomy, University of Western Ontario, London, ON, Canada N6A 5B7, [2]Canadian Astronaut Office, Canadian Space Agency, 6767 route de l'Aéroport, Saint-Hubert, QC, J3Y 8Y9, Canada (gosinski@uwo.ca)

Introduction: Impact cratering is arguably the most ubiquitous geological process in the solar system. Impact craters are the dominant geological landform on the Moon and Mars, which represent the two highest priority targets for the Canadian and international planetary science communities. The motivation for this research was two-fold. First, with the continued exploration of the surface of the Moon, Mars, and Mercury, there is a growing need to ground truth observations based on remote data with the terrestrial impact cratering record. The terrestrial record stands at ~180 impact craters [1] but many of the newly discovered impact sites on Earth are heavily eroded. As such, we are spearheading taking a "new look at old sites", including several impact craters in the Canadian Shield that have never been revisited since their discovery. The second motivation for this research lies in the recognition by NASA and the Canadian Space Agency (CSA) of the need to train new astronauts in field geology. Following a series of classroom and fieldtrip-based activities as part of the basic astronaut training at NASA's Johnson Space Center, we instigated a program to involve one of the two new Canadian astronauts, J. R. Hansen, in the geological exploration of one of these understudied Canadian impact craters.

Fig. 1. Google Earth image of the Gow Lake impact structure. The Lake is ~4 km across and Calder Island is ~1x2 km.

Gow Lake impact structure: Gow Lake is a roughly circular lake with a prominant central island (Fig. 1) located in the Precambrian Shield of northern Saskatchewan (56°27' N, 104°29'W). The country rocks are predominantly quartzofeldspathic gneisses. It was visited during a regional gravity survey in the early 1970's and subsequently confirmed by Thomas and Innes [2] with the discovery of planar deformation features (PDFs) in quartz. These authors proposed that Gow Lake is a deeply eroded complex impact structure. This publication and the reconaissance visit of several hours represents the only study to date on this structure. Intriguingly, Thomas and Innes [1] documented the presence of "breccias containing large proportions of impact melt" at one locality near the north shore of the island. Furthermore, they noted the presence of two different varieties of impact melt rock with different colours, red versus green, and a 6 m high rock face of the former. The presence of impact melt rocks in such a small and apparently deeply eroded structure provided sufficient motivation for this study.

Results: Fieldwork was conducted over a 10-day period in July 2011 by the 4 authors, with travel aided by the use of canoes. The entire perimeter of the lake and the island, both shore and inland, were mapped and numerous samples collected. Recent forest fires in the area have provided excellent exposures along the perimeter of the lake. Exposure along the lakeshore of Calder Island is generally good, whereas inland it is poor and many outcrops had to be cleared of vegetation before they could be studied in detail.

Impactites − Field Relations: Over the course of the first couple of days it became apparent that a wide variety of impactite types were preserved on the island and that large areas and volumes of impact melt rock were preserved, including some outcrops with impressive columnar jointing. Systematic mapping of the island revealed an almost complete stratigraphy from the brecciated and fractured "basement", up through a series of lithic breccias, impact melt-bearing breccias, impact melt rocks and, towards the top, further impact melt-bearing breccias intercalated with the melt rocks (Fig. 2). It is notable that the highest point on the island comprises a large, steeply sided outcrop of green impact melt rock.

Impactites − Petrography and Geochemistry: Optical microscopy and Backscattered Electron Imaging (BSE) coupled with Energy Dispersive Spectroscopy (EDS) on a Scanning Electron Microscope (SEM), were used to charactize the microtextures and mineralogy and, in particular, the nature oif the fine-grained groundmass − this was often not easy to tell in the field (e.g., the clast-rich impact melt rocks in Fig. 2).

Overall, the mineralogy of the impact melt rocks is dominated by K-feldspar and plagioclase, consistent

with the predominantly quartzofeldspathic target. The relative dominance of the two feldspars differs between the 3 different melt rock types, with plagioclase being more common in the green impact melt rocks. The nature of the colour difference between the two clast-poor melt rocks remains to be determined.

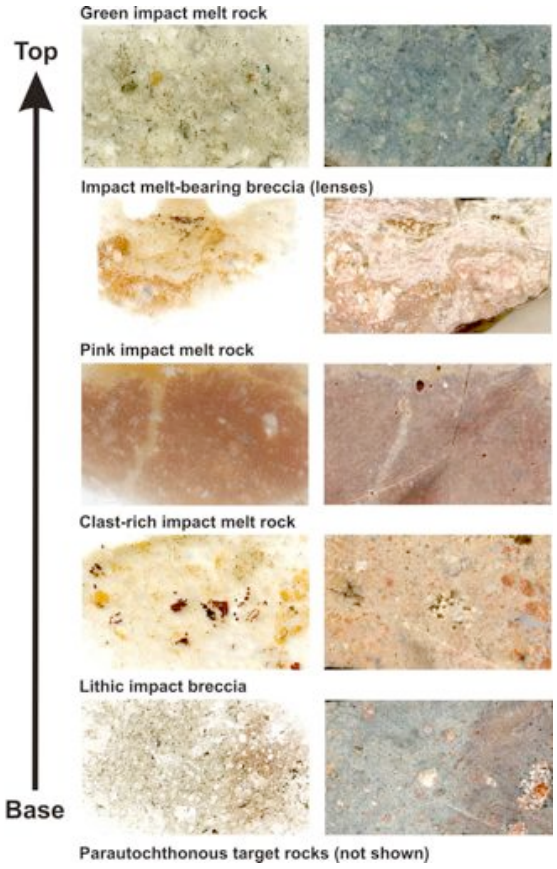

Fig. 2. Stratigraphic and petrographic overview of impactites at the Gow Lake structure. An almost complete sequence ~30-50 m thick is preserved, from the target rocks upwards through a series of allochthonous impactites.

Discussion: This research demonstrates the need, and the rewards, of revisiting understudied craters in the terrestrial record. This is particularly relevant for ground truthing observations of impact melt-bearing deposits that are increasingly being recognized in high-resolution image datasets being returned from the Moon and Mars (e.g., [3, 4]). This work also demonstrates the validity of training astronauts in conducting exploratory science in a real and relevant geological terrain in preparation for future missions.

An unexpected outcome of this research has been the discovery of an almost complete sequence of impactites that represents the crater-fill of the Gow Lake impact structure. Such sequences of rocks are very rare at terrestrial impact structures and rarer still exposed at the surface. As such, Gow Lake offers important insights into the stratigraphy of impactites produced during impact into relatively homogenous crystalline target. Of particular interest are the presence of flow-textured impact melt-bearing breccias intercalated with impact melt rocks. Importantly, it is widely accepted that crater-fill impact melt rocks are never airborne but rather form a lining to the transient cavity that subsequently pools in the crater interior [5]. The textures in the melt-bearing breccias are reminiscent of "suevites" from the Ries impact structure, Germany, where such apparently "aerodynamically-shaped glass bombs" are interpreted to mean an airborne mode of origin [6]. However, as pointed out by Osinski et al. [4], similar rocks at the Mistastin impact structure, Labrador, can be found in a dyke intruding in to the crater floor and were, therefore, never airborne (see [7] this conference). These flow-textured impact melt-bearing breccias present as lenses within columnar jointed impact melt rocks provides further evidence that such textures do not equate to and airborne mode of formation.

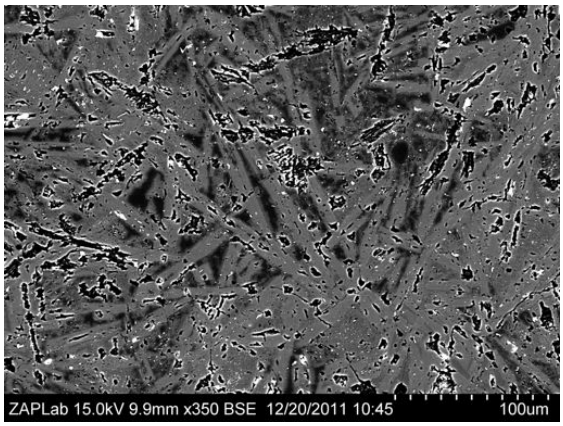

Fig. 2. BSE SEM image of the red impact melt rock showing the fine-grained groundmass comprised of K-feldspar laths (pale grey) and glassy mesostasis (dark grey).

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