SHOCK METAMORPHISM IN IMPACT MELT ROCKS FROM THE GOW LAKE IMPACT STRUCTURE, SASKATCHEWAN, CANADA. A. E. Pickersgill[1], M. R. Lee[1], D. F. Mark[1], and G. R. Osinski[2], [1]School of Geographical & Earth Sciences, University of Glasgow, Gregory Building, Lilybank Gardens, Glasgow G12 8QQ, U.K.; [2]Centre for Planetary Science and Exploration, Depts. of Earth Sciences and Physics & Astronomy, University of Western Ontario, 1151 Richmond Street, London, ON, Canada (a.pickersgill.1@research.gla.ac.uk).

Introduction: Meteorite impact craters are the dominant surface feature on most terrestrial planetary bodies [1] and are gathering increased interest with the continued exploration of the Solar System. It is worth, then, taking a fresh look at impact craters on Earth, in particular those which have not yet been studied in great detail, like Gow Lake, in order to see if new techniques will shed light on some of the remaining questions about them.

Gow Lake impact structure: The Gow Lake impact structure, located in northern Saskatchewan, Canada (56°27' N, 104°29' W), is roughly circular in shape, thus distinguishing it from the surrounding elongate lakes (i.e., it transects the structural grain of surrounding lakes). The structure is deeply eroded, and the lake occupies the depression of the crater. The crater diameter is approximately 4–5 km, making it the smallest impact crater in Canada to also have a structural uplift (visible as Calder Island at the centre of the lake) [2]. The target rocks in this area are Precambrian granites and Hudsonian gneisses of the Precambrian shield [2]. Impact melt rock mineralogy is dominantly potassium feldspar and plagioclase, consistent with granitic target rocks [3].

An age estimate of 100 Ma was given by [2] based on depth of erosion and comparison with the Deep Bay crater. One attempt has been made to date the impact event using $^{40}Ar/^{39}Ar$ geochronology, and an age was reported of <250 Ma [4].

Thus far, the crater has been minimally studied, with only the discovery paper [2] and a more recent abstract by Osinski et al [3]. This structure appears to be at the transition between the simple and complex crater size in crystalline targets on Earth, and may provide clues to development of crater morphology and the overall formation of impact craters. Gow Lake preserves an almost complete stratigraphic sequence of impactites (representing crater fill) which provides important insight into the stratigraphy of impactites from a relatively homogenous crystalline target [3].

Field work: Sampling was conducted by GRO during 10 days of field work to Gow Lake in July 2011. Samples were collected from a range of locations throughout the crater, including the shore and inland of both the lake perimeter and the island. This study focusses on impact melt rocks from Calder Island.

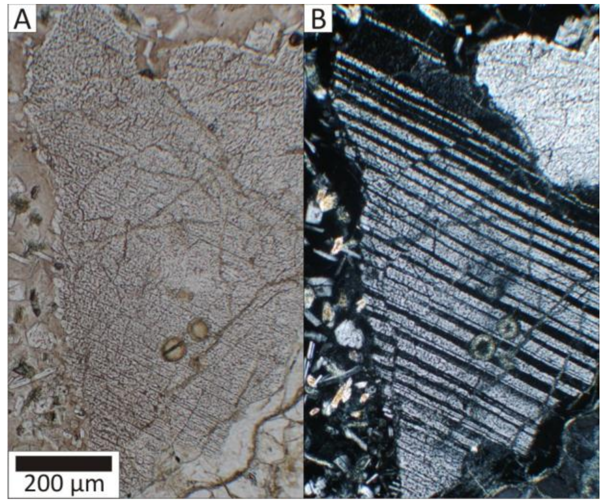

Figure 1: A grain of plagioclase feldspar from a thin section of green impact melt rock exhibiting sieve texture in plane polarized light (A), and preserved twinning in cross-polarized light (B).

Petrography: Polished thin sections were made from pink impact melt rock (n=5), green impact melt rock (n=3), and impact-generated breccias (n=3) collected from the central uplift, Calder Island.

Pink impact melt rock. This lithology is composed largely of quartz and feldspar. Feldspars are severely weathered but the quartz remains clear. All samples show pervasive undulose extinction of quartz and feldspar, as well as evidence flow textures in the overall fabric. Two samples show partial conversion of some feldspars to diaplectic glass. Decorated planar deformation features (PDFs) and ballen silica are visible in all but one thin section, which was made from a rock sample collected from the opposite side of the island from the others. The one outlying sample is also less weathered and has a much higher clast content than the others of this group.

Green impact melt rock. All samples of green impact melt rock are clast-rich and dominated by quartz and feldspar, but beyond that, this group can be divided into two types.

Two thin sections show a matrix of cloudy brown glass with small laths of plagioclase and biotite dispersed throughout. The cloudiness of the glass is reduced near large quartz clasts with biotite microlites nucleating at the edges.

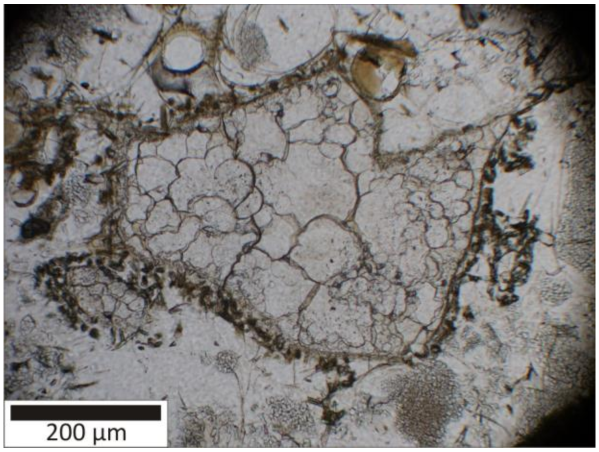

Figure 2: A quartz crystal embedded in a glassy matrix from a green impact melt rock showing ballen texture.

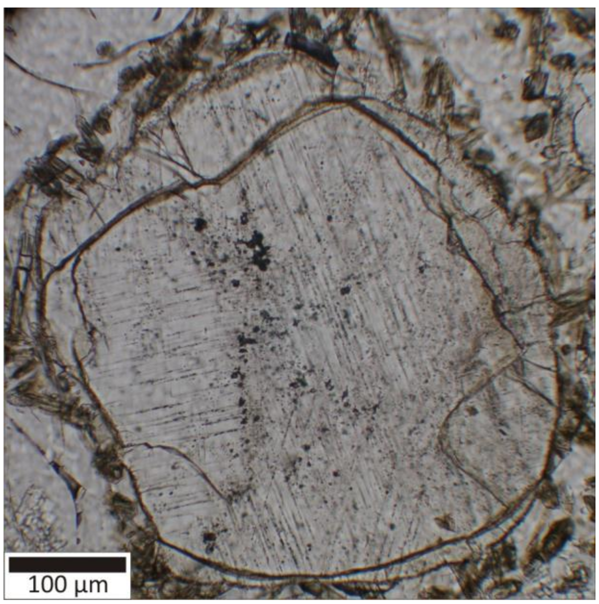

Figure 3: A quartz crystal from green impact melt rock showing three sets of decorated planar deformation features.

The majority of plagioclase clasts (80–100% depending on the thin section) show a sieve texture, overprinting the original twinning (Fig. 1).

Quartz clasts show ballen texture (~60%) (Fig. 2) and, less commonly, decorated PDFs (~15%) (Fig. 3), and toasting (~5%); the remaining 20% of the quartz present shows no specific texture.

The second type of green melt rock has a matrix with very little glass content, but rather the space between large mineral clasts is composed of small crystal aggregates dominated by plagioclase. A significantly smaller portion of the quartz clasts in this section show ballen texture, and the plagioclase clasts show an incomplete transition to sieve texture. Many of the clasts appear to have been partially absorbed into the melt.

Breccias. Of the breccias examined none showed shock effects beyond undulose extinction of quartz and feldspar, which could be pre-existing.

40Ar/39Ar dating: There is clearly a great deal more work that can be accomplished on this crater, with a wide range of impact melt rocks and breccias available. The presence of seemingly pristine samples in the green impact melt rocks suggests that with a careful petrographic examination of the various textures observed in the Gow Lake impactites then it may be possible to obtain both an accurate and precise 40Ar/39Ar age. We plan to adopt a similar strategy to that outlined in [5] and to use high-resolution 40Ar/39Ar incremental heating to attempt to resolve an age for the Gow Lake impact structure. As noted by [5] and [6], an added complication could be the presence of inherited and/or excess 40Ar. Because the target rocks are geologically old there will have been ingrowth of large amounts fo radiogenic 40Ar (40Ar*) and as they are granitic in nature they tend to form viscous melts upon impact. Viscous melts have a tendency to retain 40Ar* and not degass completely thereby not resetting the 40Ar/39Ar chronometer to the age of impact. It is hoped that the high-resolution step-heating approach coupled to a 40Ar diffusion study may be able to resolve different Ar reservoirs within the impact rocks and thereby allow us to calculate an age for impact.

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