THE PRINCE ALBERT STRUCTURE, NORTHWEST TERRITORIES, CANADA: A NEW 28-KM DIAMETER COMPLEX IMPACT STRUCTURE. G. R. Osinski[1,2], S. Abou-Aly[1], R. Francis[1], J. Hansen[3], C. L. Marion[1], A. E. Pickersgill[1], and L. L. Tornabene, [1]Dept. of Earth Sciences & Centre for Planetary Science and Exploration, Western University, London, ON, N6A 5B7, Canada, [2]Dept. Physics and Astronomy, Western University, London, ON, N6A 5B7, Canada, [3]Canadian Space Agency, St. Hubert, QC, J3Y 8Y9, Canada (gosinski@uwo.ca).

Introduction: Impact cratering is a fundamental geological process in the Solar System. Meteorite impact craters are the dominant landform on all planetary bodies that retain portions of their earliest crust (e.g., Moon, Mercury) and are also common on more geologically active planets (e.g., Mars, Venus). On Earth, active processes, such as water- and ice-mediated erosion, plate tectonics, and volcanic resurfacing, continually erase impact craters from the geological record. Despite this, between 180 and 185 impact craters and structures – the eroded remnants of craters – have been confirmed to date based on the report of shock metamorphic effects in rocks and minerals. In recent years, on average, on the order of 1 to 3 new impact sites have been confirmed annually. The majority of these newly-discovered craters have been relatively small, simple craters (e.g., Carancas [1], Kamil [2], Ritland (d = 2.5 km) [3]). The discovery of large complex craters is a rare occurrence (e.g., Luizi (d = 17 km) [4]).

Here, we report on the confirmation and exploration of a new complex impact structure – the Prince Albert impact structure – located on Victoria Island in the Canadian High Arctic. This structure was discovered by K. Dewing and B. R. Pratt during reconnaissance mapping in 2010. A paper in revision at the time of writing this abstract provides the first confirmation of an impact origin through the documentation of possible shatter cones [5]. No detailed studies of the structure were carried out and K. Dewing and B. R. Pratt spent only a few hours on the ground.

Here, we report an impact origin for the Prince Albert impact structure, through the confirmation of shatter cones and the first report of planar deformation features (PDFs) in quartz. We also refine the diameter estimate, provide a preliminary geological map and structural measurements, and report the first occurrences of allochthonous impactites and post-impact hydrothermal alteration.

Geological setting: The Prince Albert impact structure is situated adjacent to the Collinson Inlet on the Prince Albert peninsula on northwestern Victoria Island, NWT, Canada. It lies in a polar desert environment with little to no vegetation over much of the structure. The target rocks consist of flat lying sedimentary rocks. The youngest rocks currently exposed at the surface today are the Ordovician to Silurian Thumb Mountain and Allen Bay Formations. Younger Devonian-age rocks may have been present at the time of impact but no preserved evidence was found. Older target rocks include [5], from youngest to oldest, the Cambro-Ordovican Victoria Island Formation, the Cambrian-age Stripey Unit, Tan Dolostone Unit, and the Clastic Unit. The oldest rocks exposed in the centre of the present-day structure are of the Neoproterozoic Wynniatt Formation of the Shaler Supergroup. Neoproterozoic diabase dykes intrude the latter.

Fig. 1. Field photograph of well-developed shatter cones in dolomite. 12 cm long pencil for scale.

Results: Fieldwork was carried out over a 2 week period in July 2012. Subsequent laboratory studies of collected samples are ongoing. Below, we summarize some of the major findings from these initial studies.

Macroscopic shock effects – shatter cones. A unique aspect of this structure is the presence of extremely well-developed shatter cones in fine-grained carbonates (Fig. 1). We have mapped them over an area 9 x 12 km across. Shatter cones display variable orientations with upwards- and downwards-pointing cones often present in the same outcrop.

Size. Mapping was carried out at both the outcrop and regional scale; the latter aided by the use of All-Terrain Vehicles (ATVs), which facilitiated access to all regions of the crater. We mapped evidence for inward-dipping listric faults out to a radius of ~14 km in several quadrants of the crater (Fig. 3). As such, based on accepted definitions [6] and comparisons with other craters in sedimentary targets – particularly the nearby Haughton impact structure [7] – we define the apparent crater diameter at 28 km ± 0.5 km, larger than the original estimate of “roughly 25 km” by [5].

Allochthonous impactites. We have documented the presence of two main types of allochthonous impactites at this structure. Both are comprised largely of carbonates. The first consists of monomict breccias with a pale yellow groundmass, occurring as dyke-like bodies in target rocks up to ~1 m across and traceable for >50 m in length. The second type are polymict in nature with a pale grey groundmass, present as cm- to dm-scale dykes and sills in target rocks. The nature of the groundmass is yet to be ascertained and so it is not possible to say whether these are lithic impact breccias or clast-rich impact melt rocks.

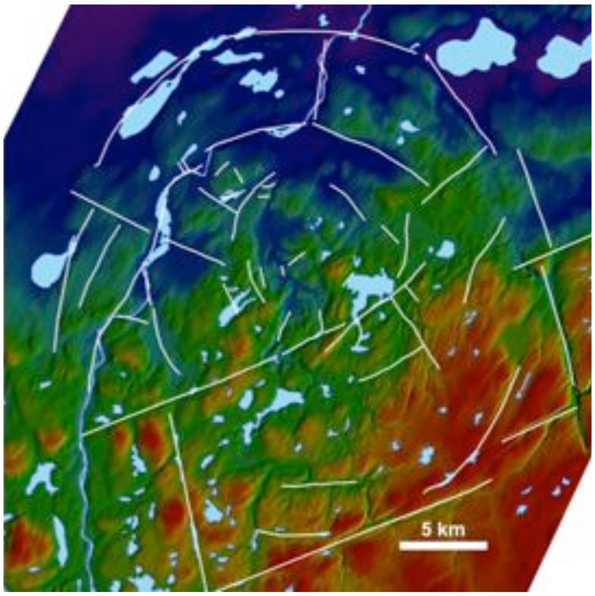

Fig. 2. Preliminary structural map of the Prince Albert impact structure superposed on a digital elevation model (red is high, blue is low elevation; lakes are in pale sold blue). White lines are faults. North is up.

Impact tectonics. As noted above, our preliminary mapping has documented the presence of listric faults in the rim region out to a radius of 14 km (Fig. 2). The central uplift of this structure comprises a series of imbricated blocks of variable thickness bounded by thrust faults (Fig. 3); many of these fault blocks are too small to be shown in Figure 2. We also mapped several long linear faults trending ENE–WSW and NNW–SSW, visible in the bottom of Figure 2. They appear to cut across the structure suggesting some post-impact movement. We interpret these as regional faults.

Impact-generated hydrothermal alteration. Evidence for impact-generated hydrothermal deposits – in the form of vugs and veins – was documented at several locations within the central uplift. The mineralogy consists of dolomite, quartz and marcasite with accessory amounts of sphalerite, pyrite and an iron oxide/ hydroxide. Fluid inclusion studies reveal temperatures of between 80 and 95 ^{o}C. For further details of the impact-generated hydrothermal alteration see Marion et al. [8, this conf.].

Microscopic shock effects – PDFs. Quartz-rich samples were collected during fieldwork and studied using a four-axis universal stage microscope. While rare, because of the carbonate-dominated target rocks, we have documented 14 grains displaying PDFs so far. Details are provided in Pickersgill et al. [9, this conf.].

Fig. 3. Originally flat-lying rocks deformed by inwards-directed thrust faulting in the centre of the structure. Group of 5 people in the middle ground for scale.

Discussion: We have been able to confirm an impact origin for the Prince Albert structure through the confirmation of the presence of shatter cones and the first report of PDFs in quartz. Our mapping defines an apparent crater diameter of 28 km ± 1 km, making this one of the largest structures to be documented in recent years. Despite erosion of the ejecta and crater-fill deposits, this structure preserves allochthonous impactites, in the form of breccia dykes and sills, and evidence for impact-generated hydrothermal alteration. Exposure is patchy at this site due to recent glacial deposits; however, the polar desert environment and unique exposures in several canyons, offer potentially important insights into complex crater and shatter cone formation. Stay tuned for further details!

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