GEOLOGICAL MAPPING OF THE TUNNUNIK IMPACT STRUCTURE, VICTORIA ISLAND, CANADIAN HIGH ARCTIC. J. D. Newman[1] and G. R. Osinski[1,2], [1]Department of Earth Sciences & Centre for Planetary Science and Exploration, University of Western Ontario, London, ON, N6A 5B7, Canada, [2]Department of Physics and Astronomy, University of Western Ontario, London, ON, N6A 5B7, Canada (jnewma49@uwo.ca).

Introduction: The Tunnunik impact structure was first discovered in 2010 during regional mapping of northwestern Victoria Island [1] and its apparent diameter has been estimated at 28 km [2]. In a complex crater of such size, a continuous crater-fill melt sheet, central uplift, breccia dykes, faults and terraces are expected to form [e.g., 3]. However, in an eroded crater remnant such as Tunnunik these features are not prominent or have been completely removed through erosion. Furthermore, most of Tunnunik's structure is blanketed by a layer of Quaternary glacial sediments which obscures the underlying geology. The goal of this research is to conduct the first detailed study of the Tunnunik impact structure. One of the major findings from this field-based research is the widespread documentation of impact breccia dykes.

Geologic Setting: The Tunnunik impact structure near the Richard Collinson Inlet of northwestern Victoria Island, Northwest Territories, Canada is dominated by Cambrian to Silurian-aged sedimentary and carbonate rocks. The youngest exposed unit is the Thumb Mountain/Allen Bay Formation and the oldest is the Shaler Supergroup. Formations mapped between the west coast of Victoria Island to the central Shaler Mountains are nearly flat-lying or gently dipping Paleozoic sedimentary rocks of the Arctic Platform [4].

The four formations identified within the Tunnunik impact structure are Thumb Mountain/Allen Bay, Victoria Island, Mount Phayre and the Shaler Supergroup. Based on the regional geology and succession of units near the Shaler Mountains about 50 km southeast of the impact structure, the Uvayualuk and Quyuk formations are found between the Mount Phayre Formation and the Shaler Supergroup but were not observed within the impact structure. For continuity purposes, the Stripy Unit, Tan Dolostone Unit and Clastic Unit referred to in [1] and [2] have been given the provisional formation names as presented in [4] of Mount Phayre, Uvayualuk and Quyuk, respectively; these provisional names will be used henceforth.

Victoria Island is currently unglaciated but evidence of past glaciation persists across the Tunnunik landscape. Glacially derived features and landforms identified include polished and striated rocks, till, glacial erratics, gravel deposits, drumlins, kames and eskers. These features and landforms are sporadic but are distinctive when encountered. The persistence of glacial abrasions on some outcrops shows the lack of weathering and highlights how unchanged the impact structure has been since the last glaciation event.

Periglacial activity is also prevalent throughout the impact structure. Periglacial landforms observed include thermokarst, polygons and sorted and unsorted circles and stripes.

Methods: Five weeks of fieldwork was carried out in July and August 2015, building upon work from a reconnaissance visit in July 2012 [2]. Documenting outcrops within the impact structure was a primary objective of the 2015 field season. Outcrops varied greatly in size from several metres in height or length of exposure to over 50 m in height and up to several km in length within canyons. Outcrop information was recorded digitally with iPads and using ArcPad installed on handheld PDAs, both equipped with GPS.

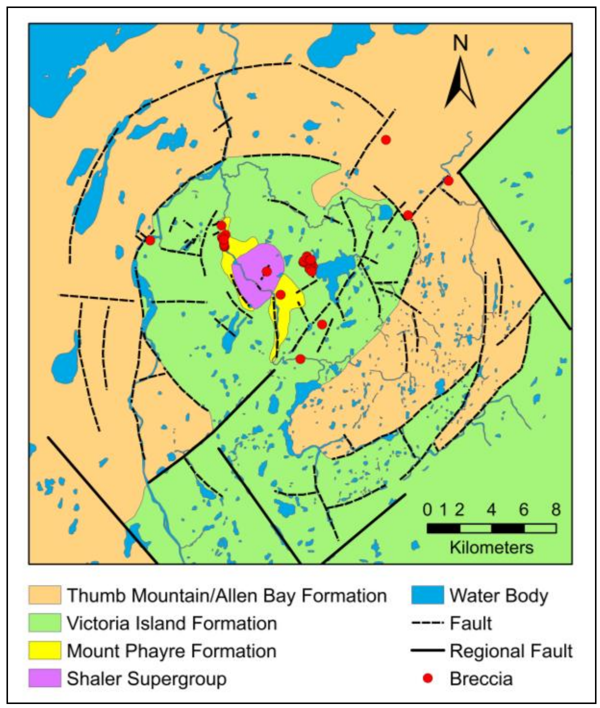

Figure 1: Preliminary geological map of the Tunnunik impact structure on Victoria Island, NWT.

Results: Over 100 different outcrops were examined to give a good representation of the rocks present within the Tunnunik impact structure. Information from these outcrops was combined with the data collected during July 2012 [2] to produce a preliminary geologic map (Fig. 1). The map is preliminary until the rock samples can be examined more closely to better refine the units. Accessing outcrops in some areas to the west and south was hindered by a wide deep river and very rough terrain.

Outside the inferred extent of the impact structure and beyond what is shown in Figure 1, 13 outcrops to the southeast and 13 to the southwest were sampled by helicopter. These additional 26 outcrops are thought to be unaffected by the impact event and will be compared with corresponding units identified within Tunnunik to help understand the regional geology.

Formations. Outcrops were identified as the Thumb Mountain/Allen Bay Formation, Victoria Island Formation, Mount Phayre Formation or Shaler Supergroup and represent a detailed occurrence of formations within the Tunnunik impact structure. Refinement of unit composition and variation will be resolved by analyzing field samples. The Uvayualuk and Quyuk formations identified by [1, 4] were not observed at any of the outcrops examined. The absence of the Uvayualuk and Quyuk formations in the stratigraphy of the Tunnunik area could indicate these units have simply pinched out of the sequence. These two formations can be quite thin in other areas on Victoria Island [4] so this is a possibility.

Contacts between formations appear to be gradational, no sharp lithology changes were observed. The best example of this is the transition between Victoria Island and Mount Phayre formations. This was observed in a large canyon in the area mapped as the upper left occurrence of the Mount Phayre formation (Fig. 1). The south end of this canyon is unmistakably Mount Phayre with its alternating red and green mudstone and shale beds and the light grey dolostone of the Victoria Island formation present at the north end.

Faults. The faults mapped in Figure 1 have been documented in the field or inferred from topography and digital elevation models. Direct observation of each fault is difficult due to overlying Quaternary sediments and an inability to access all areas of the impact structure. Faults are best observed in canyons where large outcrops are exposed.

Regional faults are straighter and more pronounced than the faults that appear to be directly associated with the impact event. Regional faults are successive and parallel trending NW-SE and NE-SW throughout the greater Tunnunik area. The NE-SW regional faults trend in the same direction as the Shaler Mountains east of the impact structure. Several regional faults cut across and into the impact structure to its east and southern extents.

Impact breccia. Dykes of impact breccia were documented at 52 locations within the impact structure and two areas in the central region contain the majority of breccia occurrences. Even though some of the breccia dykes are close in proximity, the dykes can be quite varied in their initial appearance. Breccias appear to be polymict and comprise of carbonates but differ in their clast size and colour of groundmass and clasts. Average clast sizes are several mm in length up to about 1 cm and clasts larger than several cm are rare but have been documented. The colour of the groundmass is used as a preliminary identifier of breccia and varies between light grey, dark grey, blue-grey and yellow. The exterior surface colour may or may not be the same as the interior colour of a fresh exposed surface and several combinations of yellow and grey surfaces have been observed. Variations in groundmass colour will be examined to determine if colour is an indicator of weathering or if it corresponds to a more specific aspect of the breccia dyke such as its composition. The colour of the clasts among breccia dykes can be varied, but a single dyke appears to have a consistent range in clast size and colour. Detailed investigation and characterization of sampled breccia dykes will help determine their composition, texture and how they may have formed.

Discussion: A considerable amount of information was collected during the 2015 field campaign and combined with data collected in 2012, will help understand of the geologic history and formation processes of Tunnunik. Much of the work associated with the Tunnunik impact structure is forthcoming but the production of a detailed map is a significant component that will provide a good reference for future results and interpretations.

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