CHARACTERIZATION OF BRECCIA DYKES IN THE DEEPLY ERODED TUNNUNIK IMPACT STRUCTURE, CANADA.

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Introduction: The Tunnunik impact structure is a 28 km eroded complex crater remnant on northwestern Victoria Island, Northwest Territories, Canada [1,2]. This area of Victoria Island comprises Cambrian to Silurian-aged sedimentary rocks consisting of dolostone and limestone with minor mudstone beds, chert, and small isolated sandstone lenses. Breccia dykes are ubiquitous features in complex craters and the only allochthonous impactite to remain in deeply eroded structures [3,4]. Breccia dykes can preserve crater-fill deposits and fragments of overlying rocks that are otherwise nonexistent due to erosion. The carbonate-rich target sequence of the Tunnunik impact structure is reflected in the composition of breccia dykes and their characterization is the focus of this study.

Breccia Dykes: Breccia dykes are associated with bedding planes, faults, and fractures in the target rock and most occurrences are located within the well-mapped distribution of shatter cones in the central uplift [5]. Impact melt-bearing breccia samples from 14 dykes within the shatter cone distribution and one lithic impact breccia from the eastern rim were examined in detail. Impact melt-bearing breccia dykes are polymict with a carbonate-rich matrix and contain impact glass fragments and each dyke varies slightly in clast assemblage, clast size, and groundmass colour. The lithic impact breccia dyke is a monomict breccia derived from the chert-bearing dolostone host rock.

Impact Glass: Impact glass fragments present in melt-bearing breccia range in size from 50 to 4400 µm and vary in their appearance through composition and texture. The overall abundance of glass fragments is low and account for less than 5% of the silicate fraction of clasts in the breccia samples examined, except for one sample where 20% of silicate clasts are glass. Impact glass is absent in the monomict dyke from the east rim of the structure.

Composition. In transmitted light, glasses are colourless to orange-brown and are isotropic in cross polarized light. Fragments are hypocrystalline with varying amounts of silicate and carbonate grains. Glass fragments are primarily composed of quartz and K-feldspars while nonmelted or recrystallized portions are comprised of quartz, feldspar, dolomite and calcite. Most glass fragments do not have a fresh appearance when imaged in BSE and compared to impact glasses from younger impact sites such as Ries and Haughton, e.g. [6,7]. Silicate totals determined by WDS are 88 to 100 wt% and an average of 97 wt% for these analyses indicate glasses are relatively volatile-poor.

Texture. Fragments may display schlieren or flow textures and are more common in fragments larger than 500 µm but have been observed in several smaller pieces. The flow banding and schlieren have similarities in appearance to some of the type 1 glass clasts from the Ries impact structure [6] but differ in composition. Several glass-bearing fragments are more than 50% dolomite in composition where the dolomite is partitioned in irregular forms in an apparent recrystallization of dolomitic melt. Partial melting of large clasts has also been observed where a portion of the clast displays orange-brown glass while the remaining portion of the clast appears unchanged.

Discussion: The discovery of impact glass in breccia dykes is the first report of impact glass at the Tunnunik impact structure. The variation observed in glass fragment textures suggest the processes of generating and transporting the glasses were not uniform within the impact structure since fragments are not identical. Likewise, variations in composition indicate the silicate source of the glass was not the same for all fragments. The scarcity and small size of glass fragments identified in Tunnunik breccia dykes is attributed to the low abundance of silicates present in the target material. Currently there are only isolated sandstone lenses, chert-bearing dolostones, and detrital quartz and feldspar grains that provide a source of silicates within the impact structure. The primary silicate source for the impact glass fragments was most likely nearer to the pre-impact surface than what is presently exposed and has since been eroded due to multiple past glaciation events.

With sedimentary sequences present in about 70% of impact structures, the response of carbonates to hypervelocity impacts continues to be understudied and has yet to be fully understood [7]. The carbonate-rich sedimentary target sequence of the Tunnunik impact structure provides an ideal opportunity to investigate carbonate impact events. Evidence of large-scale impact melt rocks is not preserved at the Tunnunik impact structure, but the preservation of impact glasses in breccia dykes is an important clue in understanding the formation processes that occurred during this impact and will be continued to be investigated.

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