MAPPING THE HAUGHTON IMPACT CRATER, DEVON ISLAND, NWT: IMPLICATIONS FOR THE SHAPE AND SIZE OF THE EXCAVATION CAVITY. V. L. Sharpton[1], B. O. Dressler[1], and T. J. Sharpton[2], [1]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058 (sharpton@lpi.jsc.nasa.gov), [2]Clear Lake High School, 2929 Bay Area Blvd., Houston, TX 77058.

The ~24 km diameter Haughton impact crater is located at 75º 22´ N; 89º 41´ W on the western portion of Devon Island in the Canadian Arctic [1,2]. The geological map shown in Fig. 1 is derived from previous studies [3,4] with modifications resulting from our 1997 field expedition. These observations, combined with the results of reflection seismic studies [5] provide useful constraints on the target and how it was affected by the impact event. Here, we use these data to evaluate models of the size and shape of the excavation cavity generated during the formation of Haughton crater.

Target Stratigraphy [6]. The target is a layered sequence of platform rocks overlying high-grade crystalline basement. The nearly flat-lying Paleozoic platform sequence is at present ~1.8 km thick in the vicinity of the crater and consists of the follow units (Fig. 2): *1*. The Allen Bay Fm. (OSA) limestone and dolomites, ~450 m thick. This unit forms the present surface around the crater and is found to within ~4.5 km of the center. *2*. The Cornwallis Group (OCTI) shales and carbonates with a combined thickness of ~110 m. OCTI crops out along the walls of steep valleys to the northeast of the crater. *3*. The Bay Fiord Fm. (OCB) carbonates and gypsum, ~330 m thick. Large exposures of OCB occur within 5-7 km of the crater center, as well as in valley floors as close as 8 km east of the crater center. *4*. The Eleanor River Fm. (OE) chert-bearing carbonates, ~400 m thick. Inliers of OE, representing the central uplift, occur between 0.7 and 4.8 km from crater center. The closest authochthonous OE outcrops occur ~16.5 km from the crater center. *5*. Undifferentiated Lower Ordovician-Cambrian (OCU) shale, sandstone, dolomite, and conglomerates, ~420 m thick. No parautochthonous units of OCU have been discovered within the crater; however, near the center abundant highly shocked blocks of sandstone probably represent the OCU Blanley Bay Fm. Authochthonous exposures have been mapped 32 km east of crater center.

Crater and Post-crater Units. Filling the shallow central basin (radius of ~5 km), the allogenic impact breccia forms a nearly continuous unit that ranges from ~10 m to over 100 m in thickness. Extensive breccia outliers exist beyond this deposit, with the farthest mapped deposit located ~7.8 km southeast of center. The matrix and clasts of this breccia were derived primarily from the platform rocks; however, clasts of partially melted, highly shocked, and weakly shocked clasts of Archaean high-grade metamorphic rocks (AG, Fig. 2) prove that the excavation cavity penetrated into the subjacent crystalline basement. Modal analysis [3] indicates ~10-15% of the breccia clasts are derived from the crystalline basement. Extending ~1 km from the crater center are two outcrops of OE (with minor OCB) that are ~ 2 km in width (Figs. 1 and 2). These and other inliers appear to be the discontinuous exposures of the central uplift (broad peak or discontinuous ring?) and have been interpreted as such by others [e.g., 6]. The limestones show fracturing and faulting and contain abundant shatter cones but no evidence of higher shock pressures is discernible.

Toward the west and south, at a range of 3-5 km, are broad deposits of calcareous silts and sands laid down in the Tertiary lake that filled the crater shortly after it formed. These post-crater deposits were probably more extensive in the past; the crater has experienced ~200 m of erosion [7]. These sediments contain reworked palynomorphs suggesting that the Cretaceous-Tertiary Eureka Sound Fm. may have capped the Paleozoic sequence and has been subsequently removed. If so, The platform section would be ~ 200 m thicker than described above.

Reconstructing the Excavation Crater. The excavated diameter D_e=2R_e has been estimated at 10 km based on the incoherent zone in reflection seismic data [5]. Redeker and Stöffler [3] prefer D_e=15 km, based on shock isobar constraints from the Kieffer and Simonds [8] model and the need to excavate crystalline rocks.

The Z-model cratering flow field is a widely used tool for describing the geometry of the excavation crater [9] typically taken with a constant exponent Z=2.71 and an effective depth of burst (EDOZ) of ~1 projectile diameter [e.g. 3]. Fig. 2 shows the half-space shape of model 10-km (*red line*) and 15-km (*blue line*) excavation craters predicted for Haughton crater. When assessed against the geological constraints provided by outcrops of parautochthonous target rocks, substantial problems with these models become evident:

1. The R_e=5 model predicts excavation completely through OE to a distance of ~3.3 km; R_e=7.5 removes OE to a distance of nearly 6 km. Both therefore fail to account for the central uplift (OE derived from beneath the excavation crater) that are observed within 1.2 km of the center.

2. Similarly, the models predict that OCB would be completely removed within 4 km (R_e=5) or 6.8 km (R_e=7.5); yet outcrops occur within 3 km of center and are abundant within a radius of 5 km.

3. The R_e=5 model does not account for the proportion of crystalline rock clasts observed in the allogenic breccia [3]. Addition of 200 m of Eureka Sound to the platform section, as suggested by [7], exacerbates this problem.

Discussion. The geological constraints at Haughton crater are not compatible with a constant Z≈2.71 excavation flow field. Large R_e yields deep excavation that is too broad to retain the observed occurrences of uplifted target strata for Smaller R_e models do not excavate the required proportion of crystalline basement. Observations presented here constrain the zone of deep excavation is to be less than 1 km from center. The *yellow line*, Fig. 2 indicates the maximum depth to the excavation crater boundary permitted by geological constraints. The resulting shape is characterized by a localized near-center zone of deep excavation -- from which the crystalline rocks originate -- flanked by a broad zone of shallow excavation at least 4-5 times the width of the central zone.

Off-axis, deep excavation, and thus a Z-model type of excavation flow is not incompatible with the observations at Haughton crater *if* Z is time varying. High Z flow (deep near-center excavation, steep ejection angles) would occur during the earliest excavation flow and as ejection proceeded, Z, excavation depth, and ejection angle would decay.

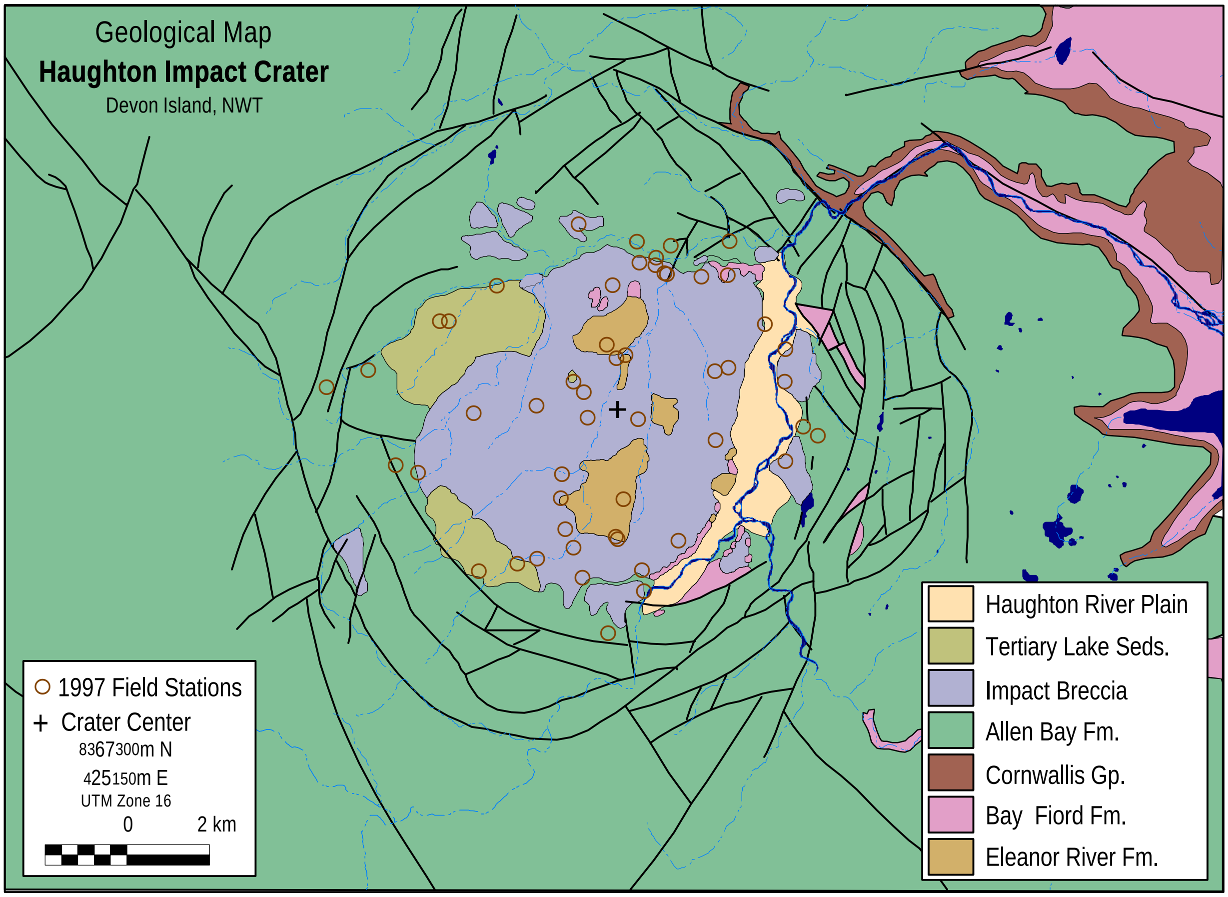

Figure 1.

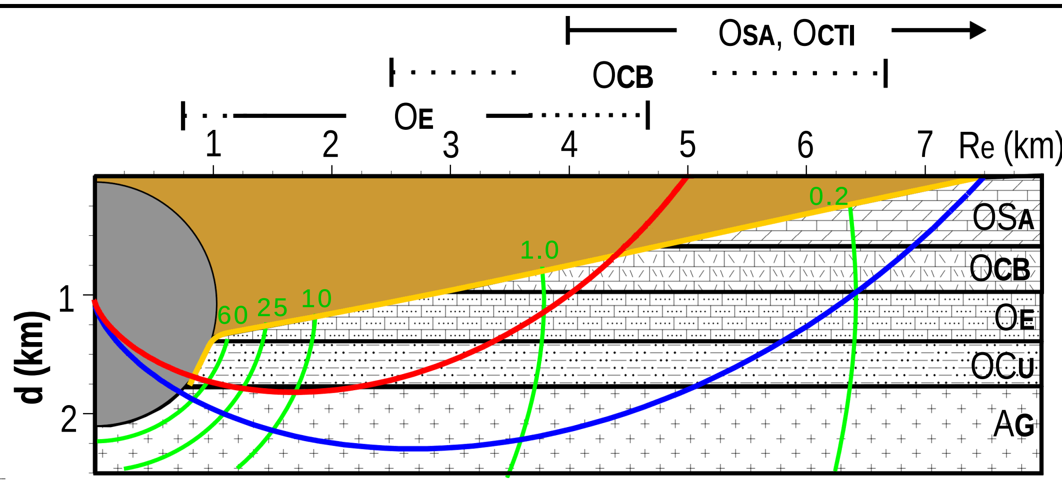

Figure 2. Green lines indicate isobars in GPa after [8]; shaded circle bounded by 100 GPa isobar

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