HAUGHTON: A PEAK RINGED IMPACT STRUCTURE. J. B. Plescia, Applied Physics Laboratory, Johns Hopkins University, 11100 Johns Hopkins Road, Laurel MD 20723, jeffrey.plescia@jhuapl.edu.

Introduction: The Haughton Impact Structure on Devon Island in Canada (75° 22'N, 80° 40'W) is 23.4±1 Ma. The structure has been recognized since 1955 [1]; an impact origin was suggested by [2] and confirmed by [3, 4]. A multidisciplinary study was conducted in 1984 to better define the geology and geophysics of the crater [5] and people have been mucking around the place ever since [6]. Haughton's diameter is in the size range of complex craters, yet it lacks a recognized exposed topographic central uplift. It also has a relatively simple negative gravity anomaly [7]. That anomaly (more characteristic of a simple than a complex crater) to first order suggests that the mass-excess typical of a central uplift, is not present. To further explore the nature of a possible central uplift, gravity data were collected to supplement the data of [7].

Geology: The Haughton structure is formed in early Paleozoic carbonates overlying Precambrian gneiss and schist. The Paleozoic rocks are ~1700-1900 m thick beneath the structure [4, 7] and dip 1-4° westward. Exposed rocks include (from youngest to oldest): Eureka Sound (sandstone, shale and lignite); Allen Bay (dolomite, limestone), Irene Bay (limestone, shale), Thumb Mountain (limestone, dolomite), Bay Fiord (dolomite, gypsum), and Eleanor River (limestone, dolomite) [4, 8, 9, 10]. Large tilted blocks occur around the margin and within the interior of the structure. Impact breccia, filling the topographic low, extends to distances of ~7.5 km from the center. Lake beds also occur in the structure [11].

Various diameters have been proposed. [2] originally suggested 17 km, subsequent work [3,4] indicated a similar diameter. Later, the diameter was raised to 20.5 km [12] and finally to 24km. This large estimate was made on the basis of seismic data [13] which were interpreted to indicate the presence of additional normal faults beyond those mapped at the surface. More recently [15] cited a diameter of 20.5 km.

Gravity: Figure 1 illustrates the regional Bouguer gravity over Haughton. The anomaly associated with the structure is characterized by an overall negative anomaly (20 km in diameter, -13 mGal) and a smaller deeper negative at the center (5 km wide; -4.5 mGal). The anomaly is not perfectly circular and extends to the east beyond the mapped faults. The basic characteristics of the anomaly had already been established by previous studies [7, 12, 16].

Regionally, gravity decreases southward from about 0 mGal 30 km to the north of the structure to about -10 mGal 25 km to the south. A southward decrease would not be expected from the simple geologic picture of a westward-thickening Paleozoic section. The observed southward gradient indicates: a) that a large density contrast between the Paleozoic sediments and the crystaline basement does not exist (which is also consistent with seismic velocities [13, 14]), and b) that significant density contrasts exist within the crystalline basement.

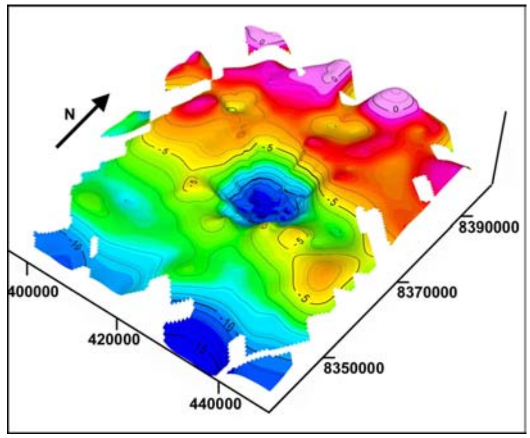

Figure 1. Regional Bouguer gravity field showing the anomaly associated with the structure and the southward decreasing field.

The structure also displays a magnetic high [7] coincident with the deepest part of the gravity low. Ground-based surveys show an amplitude of +330 nT. An airborne magnetic survey [17] indicated a +350 nT anomaly; however the flight altitude was not specified.

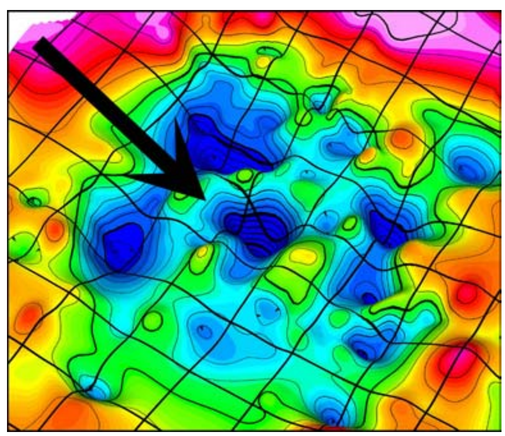

Figure 2. Band-pass filtered gravity showing the central low and surrounding high of the central uplift (denoted by arrow).

In order to more closely examine the interior structure, data at the center were regridded with a smaller grid spacing and filtered to remove the longer wavelength components of the anomaly. Figure 2 illustrates the filtered Bouguer gravity of the central area.

The filtered gravity more clearly defines the character of inner gravity low. It is about 3.6 km in diameter surrounded by a relative high (denoted by the arrow in Figure 2). The anomaly is about 2.6 mGal deep with respect to that surrounding annular high. The presence of this inner low with its annular high suggests that a central uplift is present and that it is in the form of a peak ring.

The gravity data was modeled to estimate the dimension of such a peak ring (Figure 3). Using a density contrast of -0.50 g cm^{-3} between the breccia that fills the interior of the structure (2.2 g cm^{-3}) and the surrounding Paleozoic sedimentary rock (2.7 g cm^{-3}) – densities derived from sample analysis [7, 18] and seismic velocities [13, 14] – modeling suggests a peak ring about 2.5 km in diameter rising ~100 m above the surrounding floor. The interior of the ring descends some 200-300 m below the ring and about 150 m below the surrounding floor.

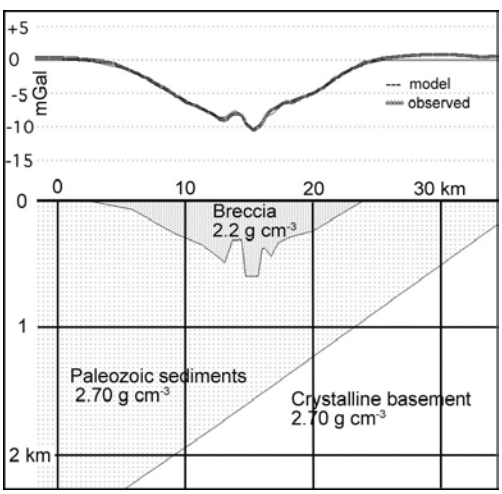

Figure 3. Modeled and observed gravity along profile crossing the Haughton impact structure.

[6] have suggested that Haughton is a peak ring structure on the basis of the exposures of parauchthonous Eleanor River and Bay Fiord rocks that form a discontinuous ring at the center of the structure with a radius of 2.2 km. The gravity model does not show the high-density ring as extending to the surface as would be expected if the Eleanor River and Bay Fiord rocks were the surface expressions of the peak ring. It may be that the Eleanor River and Bay Fiord rocks have been shocked thus lowering their effective density and making their densities more similar to the breccia than the unaltered country rocks.

The suggested 3.6 km diameter for the central peak ring is small when compared to other peak ring craters, as would be the 4.4. km diameter suggested by [6]. [19] defined a relationship showing that peak ring diameter is 0.5 the crater diameter. Even for a central uplift, the width is small. Central uplifts typically are ~0.22 the crater diameter. It is possible that the central uplift is not a true peak ring and that it is simply a complex central peak whose true dimensions are obscured in the gravity field due to subsidence and burial.

Summary: Gravity data suggest that the Haughton structure is a complex crater with a peak ring. The peak ring is ~ 3 km wide and 100 m tall with a 200-300 m deep interior. The diameter of the peak ring is small when compared with other terrestrial craters indicating differences in the excavation and modification of Haughton with respect to other structures.

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