CONSTRAINING THE DIMENSIONS OF THE MANICOUAGAN IMPACT STRUCTURE: ANALYSIS OF THE GRAVITY ANOMALY. J. J. Brown, J.G. Spray, Planetary and Space Science Centre, University of New Brunswick, 2 Bailey Drive, Fredericton, New Brunswick E3B 5A3, Canada.

Introduction: The Manicouagan impact structure, formed at 214±1 Ma, is one of the largest, best-preserved impact structures on Earth, and provides an exceptional opportunity to ground-truth models of impact crater formation [1]. The diameter of the structure has not been clearly established. In this study, gravity anomaly data acquired in the 1950s and 1960s has been re-analyzed to provide a more accurate estimate of the collapsed transient cavity diameter of the impact structure. The gravity data has also been used to create a basic crustal density model for the Manicouagan region.

Related Work: The gravity data examined in this study has been previously analyzed in a 1976 paper [2] focusing on determining the depth of excavation of the transient cavity. In this work, the Bouguer gravity anomaly was modelled in two dimensions, and the collapsed crater diameter was assumed to be 70 km [2]. This paper was subsequently cited in the 1983 work of Grieve and Head [3], in which the Manicouagan impact structure is interpreted as having a collapsed transient crater diameter of 100 km.

Support for a Revised Collapsed Transient Cavity Diameter: The collapsed transient crater diameter value of 100 km has been subsequently downsized [4]. However, a definitive value has not yet been assigned to the structure. This study combines gravity data with field observations to provide an authoritative value for the diameter of the collapsed transient crater of the Manicouagan structure.

Bouguer gravity anomaly. The Bouguer gravity anomaly has been re-examined in three dimensions. Figure 1 shows the Bouguer gravity anomaly in the Manicouagan region. The regional pattern (decreasing gravity values to the north) is disrupted in the area of the impact structure, where there is a roughly circular zone of low gravity surrounding a central gravity high. The circular anomaly associated with the impact structure is partially obscured by a large positive anomaly to the northeast of the structure. The circular low is modelled as deriving from the impact event, which is expected to decrease gravity due to increased porosity (via impact-induced fracturing and brecciation). The gravity low associated with the impact structure is roughly 65-75 km in diameter, with crenulated margins locally increasing or decreasing the diameter value. The increased gravity at the structure's center is modelled as deriving from uplifted higher-density material. The gravity high to the northeast of the impact structure is interpreted as a pre-existing high-density intrusive mafic body [5] and is incorporated into the model.

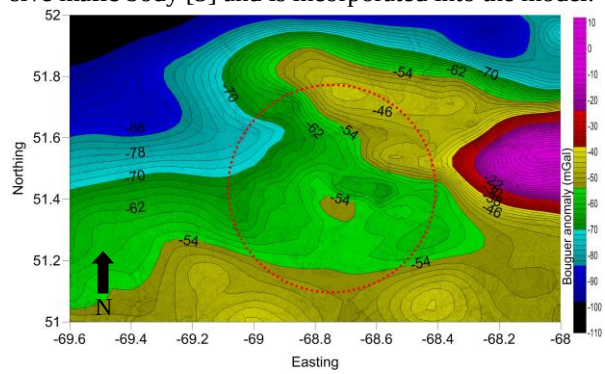

Figure 1: Bouguer anomaly (numbered contours and color) overlaid on contour map of the Manicouagan impact structure. The red dotted circle is approximately 75 km in diameter and is concentric with the structure's geometric center.

Field evidence. The Manicouagan impact structure was formed in a target dominated by Precambrian metamorphic rocks, including gneisses assembled during the ~ 1 Ga Grenville orogeny [1]. In addition, a veneer of Ordovician carbonates and shales capped the Grenvillian gneisses at the time of impact [6]. This cover sequence was regionally eroded and largely erased from the Canadian Shield following impact, leaving only down-dropped units preserved within the impact structure itself. It is inferred that locations where blocks of the carbonate/shale unit are found are within the limits of the collapsed transient crater. Thus, the carbonate exposure found furthest from the structure's geometric center provides a minimum value for the radius of the collapsed transient crater. Murtaugh [5] found exposures of limestone blocks at radial distances of up to 33 km. This value was verified during the 2014 field season, when a limestone exposure was located on the outer shore of the Manicouagan Reservoir at approximately 33 km from the structure's geometric center.

Discussion: The diameter of the collapsed transient crater of the Manicouagan impact structure is found to be between 65-75 km, a smaller value than has been assigned to the structure in the past [1], [3], [4]. This new value will be used as a constraint in a future numerical model of the impact structure's formation. Furthermore, the gravity data suggests an asymmetric structure with crenulated edges. The crustal density model produced from this gravity data, combined with

field observations and drill core logs held at the University of New Brunswick, will be used to constrain an iSALE model of the formation of the Manicouagan impact structure. The simulation will be modified to examine portions of the crater, to study the possibility of different weakening mechanisms operating at various spatial and/or temporal dimensions of the collapse process.

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