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Subsurface 3-D geophysical modelling of the Charity Shoal suspected impact structure, Lake Ontario, Canada

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Charity Shoal structure (CSS) is a 1.2 km diameter, 20 m deep bedrock-rimmed depression located in eastern Lake Ontario. The CSS has been previously been proposed as a Late Proterozoic-Ordovician impact structure based on its surface morphology determined by multibeam bathymetric mapping. The subsurface structure was investigated using 1.5 kHz boomer seismic and shipborne total field magnetic and gravity surveys. 2-D and 3-D forward and inversion modelling of potential field data was conducted to determine the depth and geometry of the structure and to compare its geophysical response with the Holleford (Proterozoic-Cambrian age?) simple impact crater. Holleford, located 35 km to the north of Charity Shoal, was identified in the 1960's as a 2.4 km simple impact crater based the crater morphology, gravity anomaly ([U+F07E]2 mgal) and impact breccias recovered by drilling. Geophysical surveys at Charity Shoal revealed a ring-like magnetic anomaly with a central magnetic low (> 1200 nT) and small decrease in Bouguer gravity (< 0.5 mGal) across the structure. The results of 2-D and 3-D magnetic modelling indicate either an impact structure in the Precambrian basement with an estimated depth of [U+F07E]450 m or a volcanic source body (i.e. diatreme) with a remanent magnetization opposing the main field. The Holleford Crater has a ∼2 mGal Bouguer gravity low but newly acquired land-based magnetic surveys show that the structure has little or no magnetic signature. The lack of a magnetic anomaly at Holleford is attributed to the low magnetic susceptibility of the Late Proterozoic target rocks. Forward modelling of the gravity data yielded a crater depth of about 550 m, indicating the structure has likely undergone significant post-impact erosion. The results show that 3-D geophysical models provide a means for evaluating the origin of suspected impact structures and can also be employed to predict changes in geophysical signature of impact structures resulting from post-impact modification by erosion or deep burial.