The Corossol Structure: a glaciated crater of possible impact origin in the northwestern Gulf of St Lawrence, eastern Canada

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The majority of confirmed impact craters on Earth have been discovered on land. However, the increased use of high-resolution, full-bottom-coverage seafloor mapping methods such as multibeam bathymetry have enabled the discovery of previously unknown subaqueous impact craters on continental margins and in large lakes. High-resolution bathymetric and sub-bottom profiler data collected south of the city of Sept-Îles in the northwestern Gulf of St Lawrence, eastern Canada (Fig. 1a), revealed a previously unreported circular structure of possible impact origin located 20 km off the mainland in water depths of 40–208 m (Fig. 1b, c) that had been overrun by the Laurentide Ice Sheet (Lajeunesse *et al.* 2013).

Description

The Corossol Structure is exposed on the seafloor of the northwestern Gulf of St Lawrence 20 km offshore of the city of Sept-Îles in eastern Canada (Fig. 1a). The structure has a maximum diameter of 4.1 ($\pm$0.2) km and rises <25 m above the surrounding submarine landscape (Fig. 1b, c). It consists of a 2–2.4 km diameter and <185 m deep annular cavity, surrounded by a shallower brim 45–90 m deep and 90–1300 m wide. Its central uplift is 900–1100 m in diameter and rises to the same elevation as the crater rim at *c.* 75 m water depth (Fig. 1c). Three concentric rings form narrow (<290 m wide) and shallow (<35 m deep) discontinuous depressions around the central cavity. The central cavity is filled with <50 m of Quaternary deposits (Fig. 1d), mostly glacimarine and postglacial sediments. It is interrupted to the north by two diagonal 50 m high bedrock ridges that connect the rim to the central peak (Fig. 1b, c). The crater is delimited to the north by a steep slope (<16°) and a 600 m wide, 248 m deep basin. The sedimentary rocks of the Ordovician St Lawrence Platform surrounding the Corossol Structure show no deformation, but seismic data reveal that they are highly fractured by a series of 10–15 m deep faults (Lajeunesse *et al.* 2013). These faults are included within the concentric rings and form the irregular topography of the structure's brim (Fig. 1b).

The relief surrounding the Corossol Structure is characterized by a cuesta landscape which forms the partially eroded, gently inclined sedimentary rock layers of the St Lawrence Platform that decreases southwards into a flat topography (Fig. 1c). The cuestas consist of steep northward-facing scarps and gentle southward-dipping slopes formed by fluvial erosion during a regional sea-level lowstand that probably predates Quaternary glaciations (Loring & Nota 1973; Lajeunesse 2014). High-resolution seismic data reveal that the bedrock is locally covered with a thin till veneer overlain by 5–10 m of glacimarine and postglacial deposits (Fig. 1d). The discontinuous morphology of the rings results from either their partial burial under these sedimentary units or their erosion. The passage of the Laurentide Ice Sheet formed 200–500 m long and 75–100 m wide streamlined glacial lineations on the southern half of the Corossol structure. Their orientations indicate SE–SSE-directed ice flow.

Interpretation

The impact origin of the Corossol Structure is suggested by its geomorphology, the geological context and a rock fragment recovered from the crater surface that shows, under the microscope, impact melt and shock-induced structures (Lajeunesse *et al.* 2013). The absolute age of this structure remains unknown, but its geological setting suggests that it was formed long after the Middle Ordovician (470 million years ago) but before the Quaternary glaciations (2.7 million years ago), as indicated by streamlined lineations, interpreted as subglacially produced mega-scale glacial lineations (Clark 1993) and till on its surface. The minimum age estimate is based on relics of fluvial erosion observed on the outer walls of the structure, implying it was formed during one of the regional lowstand periods prior to the Quaternary glaciations.

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From: Dowdeswell, J. A., Canals, M., Jakobsson, M., Todd, B. J., Dowdeswell, E. K. & Hogan, K. A. (eds) 2016. *Atlas of Submarine Glacial Landforms: Modern, Quaternary and Ancient*. Geological Society, London, Memoirs, **46**, 127–128, http://doi.org/10.1144/M46.24

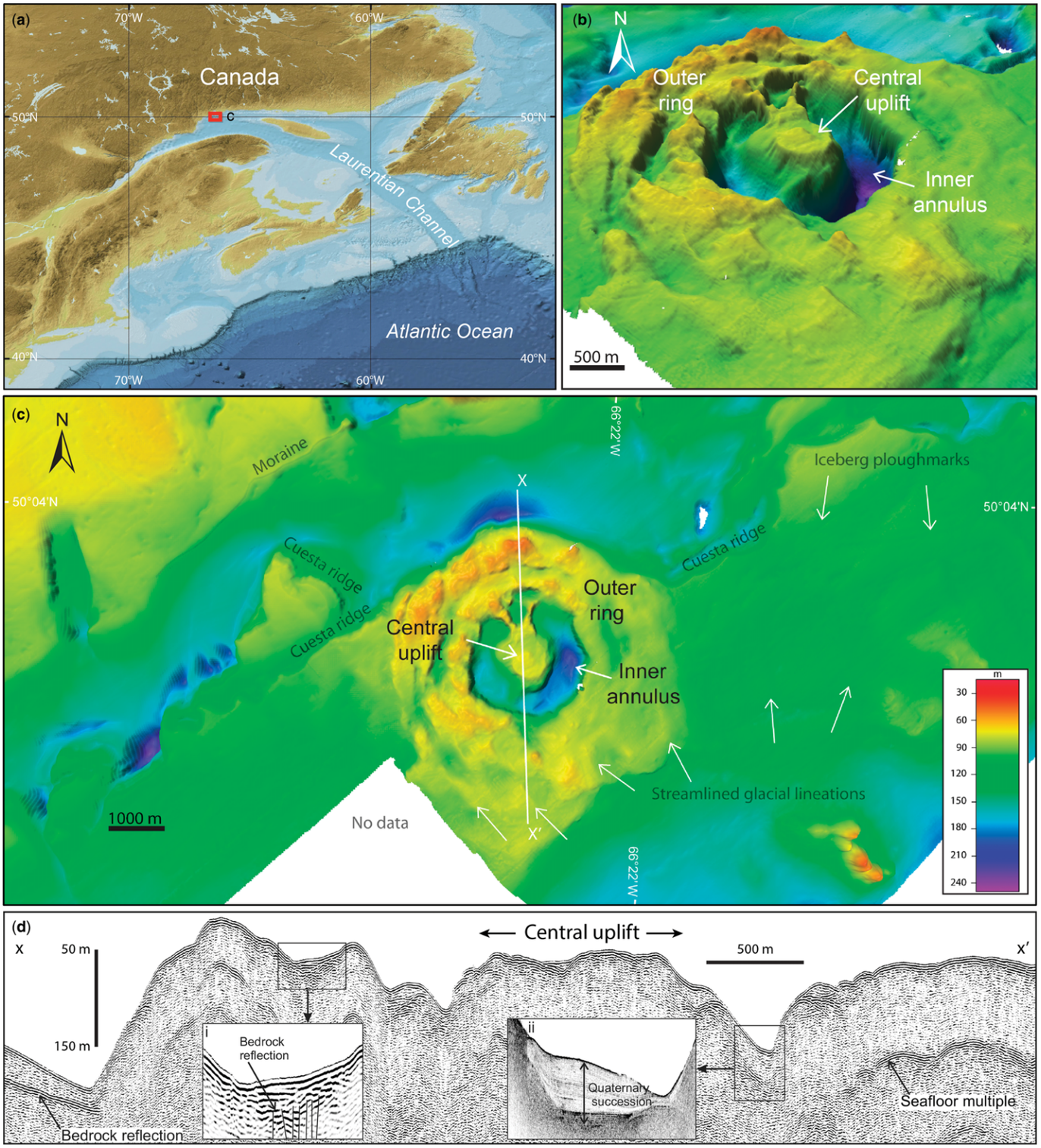

Fig. 1. The Corossol Structure, northwestern Gulf of St Lawrence, eastern Canada. (**a**) Location of study area (red box; map from GEBCO_08). (**b**) The Corossol Structure from an oblique view. (**c**) The structure is delimited to the north by series of cuesta ridges. Streamlined glacial lineations and till on its surface indicate that it was covered by the Laurentide Ice Sheet during the last glacial episode. Depth values (214, 43 and 208 m) illustrate the highest and lowest points inside and outside the structures, respectively. Acquisition system Kongsberg EM-1000. Frequency 95 kHz. Grid-cell size 10 m. Data acquired by the Canadian Hydrographic Service. (**d**) North–south sparker profile x–x′ showing the sedimentary infill in one of the structure's outer rings (inset i) and in the inner annular depression. The Chirp profile (inset ii) shows a 50 m thick sequence of Quaternary sediments. The location of seismic profile x–x′ is shown by a white line in (c). Acquisition systems Applied Acoustics Squid 2000 Sparker and Edgetech X-Star 2.1 Chirp. Frequency 2–20 kHz.