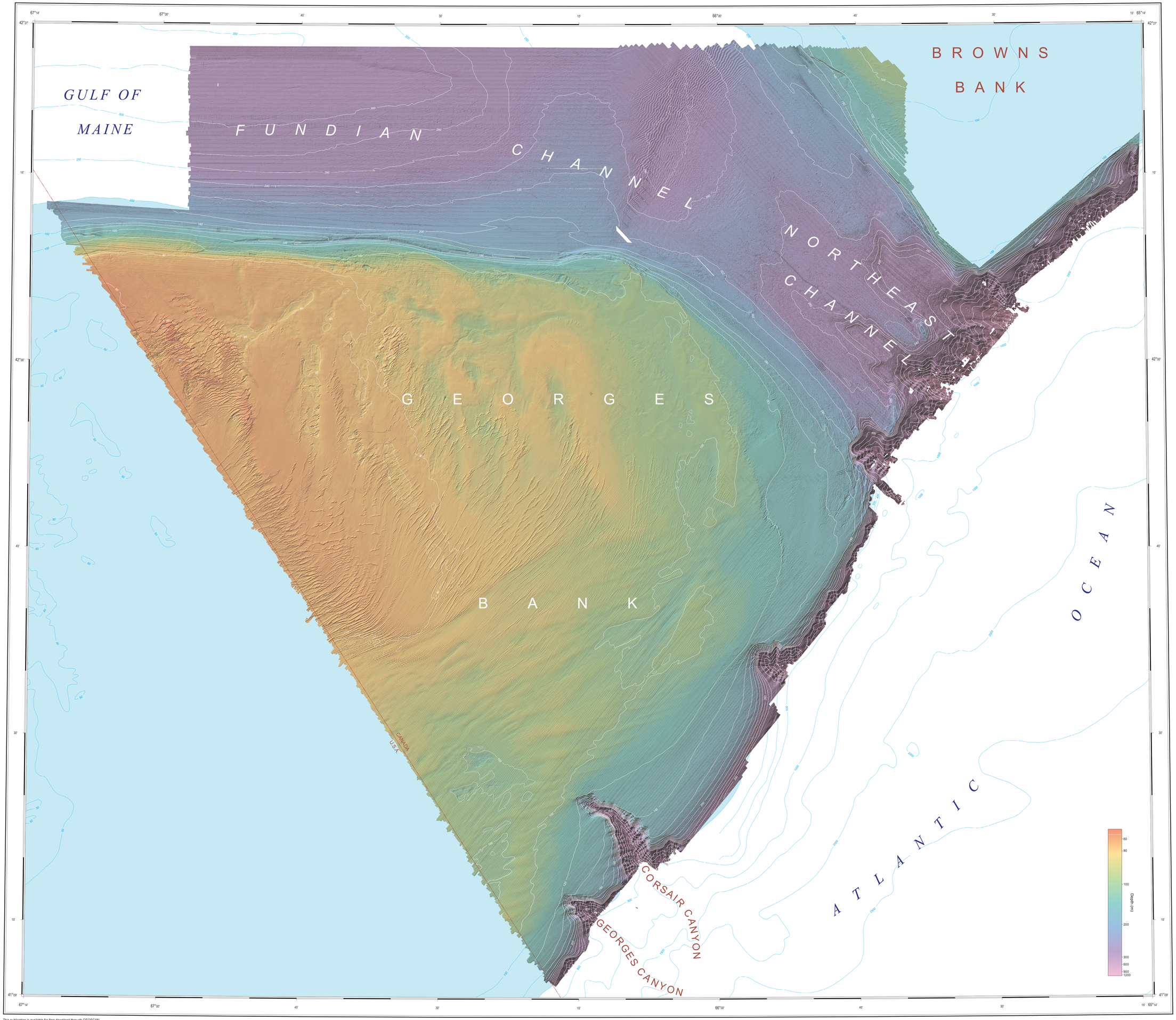

DESCRIPTIVE NOTES

INTRODUCTION

Georges Bank is a large submarine bank in the Gulf of Maine near the edge of the continental shelf south of Nova Scotia and east of Cape Cod. The bank is approximately 290 km long and 150 km wide. The international boundary between Canada and the United States transects the bank with the northeastern third of the bank being Canadian territory.

This map of Georges Bank, Fundian Channel, and Northeast Channel is the product of a 1999–2000 bathymetric survey that used multibeam sonar systems to map 11,965 km² of the sea floor. Other oceanographic expeditions to the area collected geological and biological data for scientific interpretation. This map sheet shows the sea floor topography of Georges Bank, Fundian Channel, and Northeast Channel in shaded-relief view and sea floor depth (coded by colour) at a scale of 1:175 000. Topographic contours generated from the multibeam data are shown (in white) on the colour-coded multibeam topography at an interval of 20 m. Bathymetric contours (in blue) outside the multibeam survey area, presented at a depth interval of 25 metres, are from the Natural Resource Map series (Canadian Hydrographic Service, 1966, 1967, 1971, 1972).

A complete series of Georges Bank, Fundian Channel, and Northeast Channel sea floor topographic maps at a scale of 1:50 000 is composed of nine sheets (Todd, 2008a, b, c, d, e, f, g, h, i).

MULTIBEAM BATHYMETRY DATA COLLECTION

Figure 1 shows the three component areas of the Georges Bank and Fundian Channel multibeam sonar bathymetric survey. Data were collected at the mouth of Fundian Channel (in Northeast Channel, area A) in 1999 by the Canadian Hydrographic Service using the Canadian Coast Guard Ship *Frederick G. Creed*, a SWATH (Small Waterplane Area Twin Hull) vessel. The ship was equipped with a Kongsberg EM1000 multibeam bathymetric survey system (95 kHz) with the transducer housed in the starboard pontoon. This system produces 60 beams arrayed over an arc of up to 150°. In 1999–2000, the Canadian Hydrographic Service, in partnership with the Canadian Offshore Scallop Industry Mapping Group, collected multibeam sonar bathymetric data on Georges Bank (area B) using the MV *Anne S. Pierce*. This vessel was equipped with Kongsberg EM1002 multibeam bathymetric survey system (95 kHz) with the transducer mounted on a ram extended beneath the hull. This system produces 111 beams configurable over an arc of up to 150°. Also in 2000, Clearwater Fine Foods Inc. collected multibeam sonar bathymetric data in Fundian Channel (Georges Basin, area C) using the MV *Anne S. Pierce*.

The Kongsberg EM1000 and EM1002 systems operate by ensonifying a narrow strip of sea floor across-track and detecting the sea floor echo. On Georges Bank, the width of sea floor imaged on each survey line was two to five times the water depth; in the deeper water of the Fundian Channel, the ensonification width increased to five to six times the water depth. On the bank and in the channel, line spacing was about three to four times water depth to provide up to 100% ensonification overlap between adjacent lines. The Global Positioning System (with differential corrections) was used for navigation, providing positional accuracy of ±3 m. The vessels surveyed at different speeds. The CCGS *Creed* averaged 14 knots resulting in an average data collection rate of about 48 km² hr⁻¹ in water depths of 250 m and the MV *Anne S. Pierce* averaged 6 knots resulting in an average data collection rate of about 6.6 km² hr⁻¹ in water depths of 80 m. Sound velocity profiles were collected at regular intervals during multibeam data collection and were used to correct the data for refraction due to layering in the water column. The bathymetric data were adjusted for tides using an innovative tidal model that was developed for the project by the Ocean Circulation Group at the Bedford Institute of Oceanography.

MULTIBEAM BATHYMETRIC DATA DISPLAY

The multibeam bathymetric data are presented at 5 m per pixel horizontal resolution on Georges Bank and 10 m per pixel horizontal resolution in Fundian Channel. The shaded relief image was created by vertically exaggerating the topography 10 times and then artifically illuminating the relief by a virtual light source positioned 45° above the horizon at an azimuth of 315°. In the resulting image, topographic features are enhanced by strong illumination on the northwest-facing slopes and by shadows cast on the southeast-facing slopes. Small topographic features are accentuated that could not be effectively shown by contours at this scale. Superimposed on the shaded relief image are colours assigned to water depth, ranging from red (shallow) to violet (deep). In order to apply the widest colour range to the most frequently-occurring water depths, hypsometric analysis was used to calculate the cumulative frequency of water depth. The resulting colour ramp highlights subtle variations in water depth which would otherwise be obscured.

Some features in the multibeam data are artefacts of data collection and environmental conditions during the survey periods. The orientation of the survey track lines can, in some instances, be identified by faint parallel stripes in the image. Because these artefacts are usually regular and geometric in appearance on the map, the human eye can disregard them and distinguish real topographic features.

GEOMORPHOLOGY

The morphology of the Gulf of Maine and Georges Bank is the result of marine sediment deposition during the Mesozoic (65–251 million years ago) and Cenozoic (0–65 million years ago) eras, erosion during the Tertiary period (1.8–65 million years ago), and glacial erosion and deposition during the Pleistocene epoch (11,430–1.8 million years ago). Marine processes reworked and redistributed the glacial sediments during rising sea level in the Holocene epoch (presently to 11,430 years ago) (Twichell et al., 1987; Uchupi and Austin, 1987).

GEORGES BANK

Georges Bank flanks the seaward side of the Gulf of Maine and rises more than 100 m above the Gulf of Maine sea floor. Most of the Canadian portion of Georges Bank has water depths between 60 and 90 m (Canadian Hydrographic Service, 1990, 1997; Valentine et al., 1992). On the shallowest portion of the bank (near 42°N 67°W), depths reach 42 m. Georges Bank forms a seaward-inclined (southeastward) terrace with an average slope of less than 0.05°, or about 0.9 m km⁻¹. The 200 m isobath along southeastern margin of Georges Bank is the continental shelf break. Seaward of the shelf break, water depths increase down the continental slope, which has an average slope of 7°, or about 123 m km⁻¹. The continental slope is incised with a number of canyons; Corsair Canyon is the largest of these.

Seismic reflection profiles show that beneath the surface of Georges Bank there is a prominent unconformity formed on late Cretaceous and Tertiary sedimentary rocks (King and MacLean, 1976; Lewis et al., 1980). The surficial sediment overlying the unconformity forms a veneer of glacial debris transported to Georges Bank during the late Pleistocene from continental areas to the north (Shepard et al., 1934; Knott and Hoskins, 1968; Oldale and Uchupi, 1970; Schlee, 1973; Schlee and Pratt, 1970; Fader, 1964; Fader et al., 1988). During the Holocene, sea level rose from a low stand 120 m below the present sea level (Emery and Garrison, 1967; King and Fader, 1986). The bank was submerged ca. 6000 radiocarbon years BP (Shaw et al., 2002). Georges Bank surficial sediments were reworked by marine processes during sea level transgression and continue to be reworked under the modern oceanic regime (Twichell et al., 1987; Valentine et al., 1993). The most prominent bedforms on Georges Bank are sand waves that are formed through sediment transport by strong tidal and storm currents. The nature and distribution of the Georges Bank sand waves is discussed by Todd and Valentine (2012).

FUNDIAN CHANNEL AND NORTHEAST CHANNEL

Georges Bank is bounded to the north by the Fundian Channel which comprises Georges Basin to the west and Northeast Channel to the east. Georges Basin is the deepest portion of the Gulf of Maine with a maximum depth of 377 m. The steepest slope from Georges Bank to Georges Basin is 1.6°, or about 28 m km⁻¹. The Fundian Channel north of Georges Bank is about 45 km wide and is bounded to the north by Browns Bank on the Scotian Shelf. The Fundian Channel narrows southeastward into Northeast Channel which is about 29 km wide; sill depth in Northeast Channel is 232 m.

Fundian Channel and Northeast Channel were formed by fluvial erosion during Tertiary sea level regression and during cycles of regression and transgression associated with advances and retreats of Pleistocene ice sheets (Uchupi and Austin, 1987). Erosion by ice during the Wisconsinan glaciation also contributed to the present channel topography.

Glacial sediments in the Fundian Channel are incised with an intersecting pattern of linear to curvilinear depressions. In Northeast Channel, glacial sediments exhibit numerous discrete pits. Both the pits and scours are interpreted as evidence of the grounding and dragging, respectively, of iceberg keels during the last deglaciation of the Gulf of Maine.

ACKNOWLEDGMENTS

K. Paul of the Canadian Hydrographic Service (CHS) organized the multibeam bathymetric survey of the mouth of Fundian Channel (Northeast Channel). M. Lamplugh and G. Costello (CHS) organized the multibeam bathymetric survey of Georges Bank in cooperation with the Canadian Offshore Scallop Association Industry Mapping Group. D. Beaver of the Geological Survey of Canada (GSC) participated in the Fundian Channel survey undertaken by Clearwater Fine Foods Inc. The Georges Bank and Fundian Channel maps are based on multibeam sonar data used in agreement with the Canadian Offshore Scallop Association Industry Mapping Group and Clearwater Fine Foods Inc. Multibeam sonar data were processed by CHS and GSC. We thank the master and crew of the CCGS *Frederick G. Creed* and of the MV *Anne S. Pierce* for their efforts at sea. Geographical Information Systems and cartographic support was provided by S. Hayward, P. O'Regan, E. Patton, W.A. Rainey and S. Hynes. John Shaw undertook scientific review of the map.

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2008e: Shaded seafloor relief of Georges Bank and Fundian Channel, Gulf of Maine, Sheet 5; Geological Survey of Canada, Map 2195A, scale 1:50 000. doi:10.4095/282052

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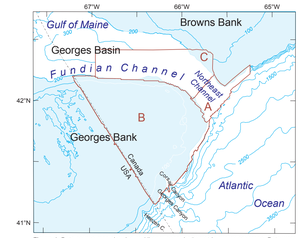

Figure 1. Data source map showing multibeam sonar bathymetric survey coverage. Data were collected in area A in 1999 by the Canadian Hydrographic Service on the CCGS *Creed* using a Kongsberg EM1000 system, in area B in 1999–2000 by the Canadian Hydrographic Service and the Canadian Offshore Scallop Industry Mapping Group on the MV *Anne S. Pierce* using a Kongsberg EM1002 system, and in area C in 2000 by Clearwater Fine Foods Inc. on the MV *Anne S. Pierce* using a Kongsberg EM1002 system. This colour-coded, shaded relief view of Georges Bank and the Fundian Channel is available as "Georges Bank, Gulf of Maine, Scotian Shelf, offshore eastern Canada" at http://gdr.nrcan.gc.ca/multibath/index_e.php.

This publication is available for free download through GEOSCAN (http://geoscan.ess.nrcan.gc.ca/).
doi:10.4095/293172

LOCATION MAP

Canada

Author: B.J. Todd

This map was produced by Natural Resources Canada in co-operation with Fisheries and Oceans Canada, the Canadian Offshore Scallop Industry Mapping Group and Clearwater Fine Foods Inc.

Multibeam bathymetric data collected by Canadian Hydrographic Service, Canadian Offshore Scallop Industry Mapping Group, and Clearwater Fine Foods Inc., 1999–2000

Multibeam bathymetric data compiled by Canadian Hydrographic Service and Geological Survey of Canada, 1999–2007

Cartography by P. O'Regan, Data Dissemination Division (DDD) and Scott Hayward, GSC (Atlantic)

OPEN FILE 5896

SHADED SEAFLOOR RELIEF

GEORGES BANK, FUNDIAN CHANNEL, AND NORTHEAST CHANNEL

GULF OF MAINE

Scale 1:175 000/Échelle 1/175 000

kilometres 3 0 3 6 9 12 kilometres

Universal Transverse Mercator Projection
North American Datum 1983

Projection transverse universelle de Mercator
Système de référence géodésique nord-américain, 1983

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This map is not to be used for navigational purposes

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Cette carte ne doit pas être utilisée aux fins de navigation

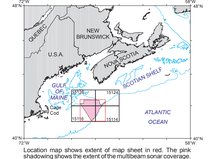
Any revisions or additional bathymetric information known to the user would be welcomed by the Geological Survey of Canada

Digital bathymetric contours, in metres, supplied by the Geological Survey of Canada and the Canadian Hydrographic Service

Mean magnetic declination 2013, 16°31'W, decreasing 5.6'annually. Readings vary from 16°03'W in the SW corner to 16°57'W in the NE corner of the map.

Some geographical names subject to revision

Depth in metres below mean sea level



Location map shows extent of map sheet in red. The pink shadowing shows the extent of the multibeam sonar coverage. Five-digit numbers refer to Marsden Square System used for Natural Resource Map series at 1:250 000 scale. Blue line shows 200 m isobath.

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