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GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA

DESCRIPTIVE NOTES

INTRODUCTION

This map is part of a four-map series of German Bank, located on the Scotian Shelf offshore southern Nova Scotia. It is the product of a 1997–2003 survey that used a multibeam-sonar system to map 1866 km^2 of the seafloor. Other surveys collected geological and biological data for scientific interpretation. This map shows the seafloor topography of German Bank in shaded-relief view with colour-coded surficial geological units at a scale of 1:50 000. Topographic contours generated from the multibeam data are shown (in white) on the surficial geology at a depth interval of 20 m. Bathymetric contours (in blue) outside the multibeam survey area, presented at a depth interval of 10 m, are from the Natural Resource Map series (Canadian Hydrographic Service, 1967, 1971a, b, 1972). Map 2107A (Todd, 2007b) shows colour-coded seafloor topography in shaded-relief view. Map 2106A (Todd, 2007a) shows coloured backscatter strength in shaded-relief view. Map 2109A (Todd et al., in press) shows seafloor topography in shaded-relief view with colour-coded benthic habitat zonation.

The complete German Bank map suite includes three adjoining map areas at a scale of 1:50 000 that comprise 5321 km^2 of seafloor surveyed with a multibeam-sonar system. In total, twelve maps constitute the German Bank map suite (three map sheets each on four themes: topography, backscatter strength, surficial geology, and benthic habitat).

GEOLOGICAL HISTORY

The Scotian Shelf is a formerly glaciated continental margin characterized bya topographically rugged inner shelf. The inner shelf area constituting German Bank is dominated by outcropping bedrock consisting of Cambro-Ordovician metasedimentary rocks (Meguma Group) intruded by Late Devonian-Carboniferous granitoid plutons (Drapeau and King, 1972; King and MacLean, 1976; Pe-Piper and Loncarevic, 1989; Pe-Piper and Jansa, 1999; McCall, 2002). Bedrock has been modified by glacial erosion and is separated from the discontinuous and thin overlying unconsolidated Quaternary sediments by a rugged erosional surface.

At the glacial maximum of the Late Wisconsinan substage of the Quaternary period, culminating in the Gulf of Maine region at approximately 20 000 BP (radiocarbon years before present, 20 ka), German Bank was covered by a regional ice sheet that terminated to the south on the Scotian Slope (Schnitker et al., 2001; Dyke et al., 2002; Hundert, 2003; Stea, 2004). The glacial maximum was followed by a multiphased retreat of the ice front and the incursion of marine waters into the Gulf of Maine and onto German Bank. Ice-front retreat and glaciomarine deposition began as early as 18 ka with grounded ice absent from the Gulf of Maine by approximately 14 ka (King and Fader, 1986; Schnitker et al., 2001).

The landforms and deposits of the German Bank seafloor provide evidence of the pattern of Late Wisconsinan glacial-dynamic events in the Gulf of Maine offshore southern Nova Scotia. Interpretation of the regional glaciation history of German Bank is primarily based on major glacial landforms (Todd et al., 2007). Glacial landforms occurring in the study area were formed below the ice sheet (drumlins and megaflutes) and at its margins (regional scale moraines >10 km long and De Geer moraines <10 km long).

GEOSCIENTIFIC DATA

In order to provide groundtruth for the multibeam data, and to complement the historical geoscientific information in the area, high-resolution geophysical profiles were collected over German Bank in 2000, 2002, and 2003 (Fig. 2; Todd et al. (2001a, b, 2003, 2004)). The systems deployed included a Huntec Deep Tow Seismic (DTS) boomer, a single-channel sleeve-gun seismic-reflection system, and a Simrad MS992 sidescan sonar (120 kHz and 330 kHz). The geophysical surveys investigated different seafloor types and features identified using the multibeam-bathymetric and backscatter data (Todd, 2007a, b). In total, 502 km of geophysical profiles were used in the interpretation of the German Bank surficial geology.

Using an 0.75 m^3 Institutt for Kontinentalsokkel-undersøkelser (IKU) grab, 26 seafloor sediment samples were collected at strategic sites interpreted from geophysical profiles (Fig. 2). The sites were chosen to collect seafloor-sediment samples representative of broad areas sharing similar geomorphology (based on Map 2107A, Todd (2007b)) and acoustic backscatter response (based on Map 2106A, Todd (2007a)). In regions of soft sediment, the grab sampler was able to penetrate the seafloor to a depth of 0.5 m and, when recovered, preserve the integrity of layering within the surficial sediments. Grain-size descriptions based on the samples adhere to the Wentworth size class scheme for clastic sediments (Wentworth, 1922).

With locations chosen from the multibeam-bathymetric data and the geophysical profiles, 30 seafloor photographic sites were occupied using Campod, an instrumented tripod equipped with oblique- and downward-oriented video and still cameras (Gordon et al., 2007). Campod was deployed while the ship slowly drifted across sites of geological (or biological) interest and was repeatedly landed on the seabed to obtain still photographs, thereby collecting transects of high-resolution imagery. Transect duration was 30 minutes with transect lengths ranging up to 1000 m, depending on the current speed. About 10 still images were acquired per transect. The still photographic images represent a seafloor area of 0.96 m^2.

SURFICIAL GEOLOGY

Syvitski (1991) showed that a complete deglacial sequence consists of some or all of thefollowing: ice-contact sediments, ice-proximal sediments, ice-distal sediments, paraglacial coastal sediments, and postglacial sediments. The Quaternary stratigraphy of German Bank described here follows this deglacial sequence scheme. Earlier interpretations of surficial geological formations on German Bank were based on a regional understanding of the Gulf of Maine and Scotian Shelf (Drapeau and King, 1972; Fader et al., 1977, 2004). The formation names corresponding to the deglacial sequencenames are noted here and in the legend.

A regional geological cross-section (Fig. 1) illustrates the stratigraphic relationships of the deglacial sequence discussed below.

GLACIAL SEDIMENTS

Ice-contact till

Ice-contact till (units Ic1 and Ic2), equivalent to Scotian Shelf Drift (Fig. 3; Drapeau and King (1972); Fader et al. (1977)), is widespread on German Bank (note that unit Ic2 does not occur on this map). In places, a gravel lag developed from the till (both units Ic1 and Ic2) which was reworked during transgression of sea level across the Scotian Shelf after about 18 ka (Drapeau and King, 1972; Fader et al. 1977; Fader, 1989). In grab samples, seafloor photographs, and sidescan-sonar records, the gravel lag exhibits a range of grain size from pebbles (2–64 mm) to cobbles (>64–256 mm) to boulders (>256 mm).

Glacial landforms of ice-contact sediment (unit Ic1, till) are widespread on German Bank. These landforms are well preserved and conspicuous despite having been subjected to modification during sea-level transgression and during the modern regime of oceanic currents and associated sediment transport and deposition.

De Geer moraines are small, but numerous, transverse moraines formed at or close to the grounding lines of water-terminating glaciers (Benn and Evans, 1998). De Geer moraines are the most ubiquitous glacial landforms on German Bank (Fig. 4).Topographic highs on southern German Bank are mantled by swarms of De Geer moraines. Most moraines display a simple or curved crest line in planform, but in some areas the crests are complex with bifurcating crest lines and (or) short, en echelon crest segments. The orientation of the moraine crests is generally west-southwest–east-northeast. Individual moraine crests can be traced horizontally from short segments of 2 km up to almost 10 km. The longer moraine crests are formed of multiple curved sections 2–5 km in length with the crests convex toward the southeast. Individual moraines traverse bathymetric ranges of up to 25 m. In the seabed lows between the topographic highs, the De Geer moraines are subdued in relief or are absent, resulting from partial to complete burial by sediment transported from glacial fronts and/or reworked during sea-level transgression of German Bank. The horizontal distance between moraines normal to strike is variable. In some areas, well defined parallel moraines have a roughly regular spacing of approximately 150m to 200 m. In other areas, subparallel ridges are as closely spaced as 30 m to 50 m. The De Geer moraines vary in height and width. Moraines displaying a subtle appearance on the map (e.g. 43°3.4´N, 65°55.8´W) are approximately 1.5 m high and 40 m wide. The more prominent De Geer moraines (e.g. 43°5.9´N, 65°55.0´W) are approximately 5 –8 m high and 100 –130 m wide.

Ice-distal silt

Glaciomarine silt (unit Gm) is equivalent to Emerald Silt (Drapeau and King, 1972; Fader et al., 1977) and is exposed at the seabed in small basins across German Bank (Fig. 1).

POSTGLACIAL SEDIMENTS

Postglacial sediments (unit PG) are derived from current and wave reworking of glaciogenic deposits and are equivalent to Sable Island Sand and Gravel (Fig. 3; Drapeau and King, 1972; Fader et al., 1977). The morphology and extent of postglacial sediments are interpreted from the topographic map (Map 2107A, Todd (2007b)) and the backscatter strength map (Map 2106A, Todd (2007a)), on which the low backscatter strength areas are interpreted as prediminantly sand with minor gravel; seafloor sediment samples and sidescan sonograms confirm this interpretation (Todd et al., 2001a, b, 2003, 2004). In the shallow (~50 m), eastern region of German Bank, sand occurs in elongated deposits oriented southeast-northwest with the current flow direction. Although typically a few metres thick, these deposits reach 17 m thick in places. In deeper water (>100 m) on western German Bank, sand is deposited in broad sheets up to 20 m thick.

ACKNOWLEDGMENTS

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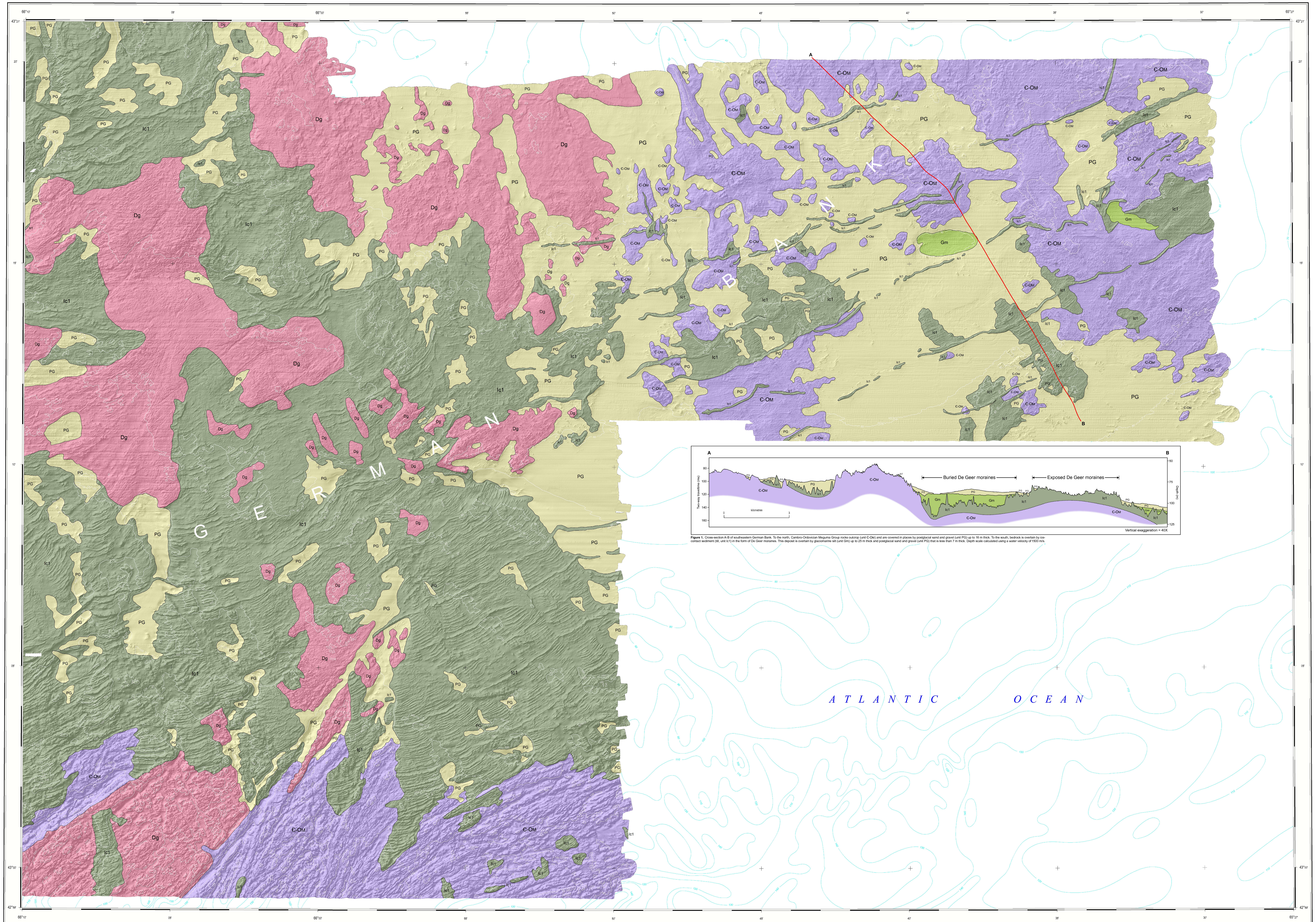


Figure 1. Cross-section A-B of southeastern German Bank. To the north, Cambro-Ordovician Meguma Group rocks outcrop (unit Є-OM) and are covered in places by postglacial sand and gravel (unit PG) up to 16 m thick. To the south, bedrock is overlain by ice-contact sediment (till, unit Ic1) in the form of De Geer moraines. This deposit is overlain by glaciomarine silt (unit Gm) up to 25 m thick and postglacial sand and gravel (unit PG) that is less than 7 m thick. Depth scale calculated using a water velocity of 1500 m/s.

LEGEND

QUATERNARY

POSTGLACIAL SEDIMENTS

Postglacial sediments result from reworking by ocean processes of earlier glaciogenic sediments — principally till and glaciomarine silt — and from modern sediment transport and deposition. Postglacial sediments are commonly denoted as Sable Island Sand and Gravel.

PG — ***Postglacial sand and gravel:*** *well sorted sand, grading to rounded and subrounded gravel, with characteristic parallel to subparallel, low-amplitude reflections. Sand bodies have a mounded form and reach up to 20 m thick.*

GLACIAL SEDIMENTS

Ice-distal glaciomarine sediments result from fallout of sediment from glacial meltwater plumes and ice-rafted debris. On the Scotian Shelf these fine-grained sediments mainly occur in basins as draped deposits outcropping at the seabed, but occur on some banks as well. Glaciomarine sediments are commonly denoted as Emerald Silt.
Ice-contact sediments were deposited directly by and underneath the ice sheet primarily resulting in till that has an acoustically incoherent signature on seismic-reflection profiles. Ice-contact sediments are ascribed to the Scotian Shelf Drift. This till was deposited directly by ice on bedrock during the Wisconsinan stage of the Pleistocene Epoch.

Gm — ***Ice-distal glaciomarine silt:*** *poorly sorted clayey and sandy silt with some gravel. This unit exhibits a characteristic parallel to subparallel seismic-reflection configuration; the reflectors conformably drape the irregular top of the underlying ice-contact sediment* (unit Ic1) *and bedrock. In places it is interbedded with the underlying ice-contact sediment (unit* Ic1).

Ic1 — ***Ice-contact sediments (till):*** *unsorted, unconsolidated drift with characteristic chaotic seismic-reflection configuration, with evidence of internal reflections suggesting stacked tills, probably consisting of a heterogeneous mixture of clay, sand, gravel, and boulders varying in size and shape. The unit typically displays swarms of De Geer moraines.*

PRE-QUATERNARY

Bedrock is exposed on much of German Bank and mainly consists of Cambro-Ordovician metasedimentary rocks (Meguma Group) intruded by Late Devonian granitoid plutons. Bedrock is separated from overlying unconsolidated Quaternary sediments by a rugged erosional surface.

DEVONIAN

SOUTH MOUNTAIN BATHOLITH AND MEGUMA TERRANE PLUTONS

Dg — *Acoustic basement: undifferentiated Late Devonian granitoid suites cutting the Cambro-Ordovician Meguma Group.*

CAMBRO-ORDOVICIAN

MEGUMA GROUP

Є-OM — *Acoustic basement: metasedimentary rocks, Cambrian quartzite, greywacke, and slate.*

Geological contact (map unit boundaries are interpreted from multibeam sonar bathymetry and geophysical seismic-profile data and are inferred contacts that may be gradational or conceptual in nature) . . . .

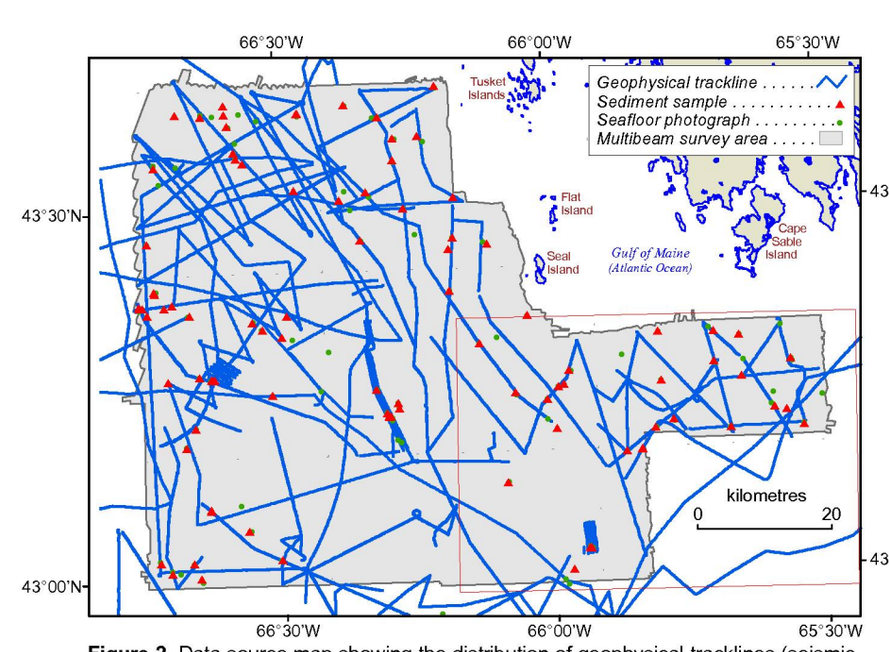


Figure 2. Data source map showing the distribution of geophysical tracklines (seismic-reflection profiles, sidescan-sonar sonograms) and seafloor-sediment samples and photographs. Extent of map sheet outlined in red.

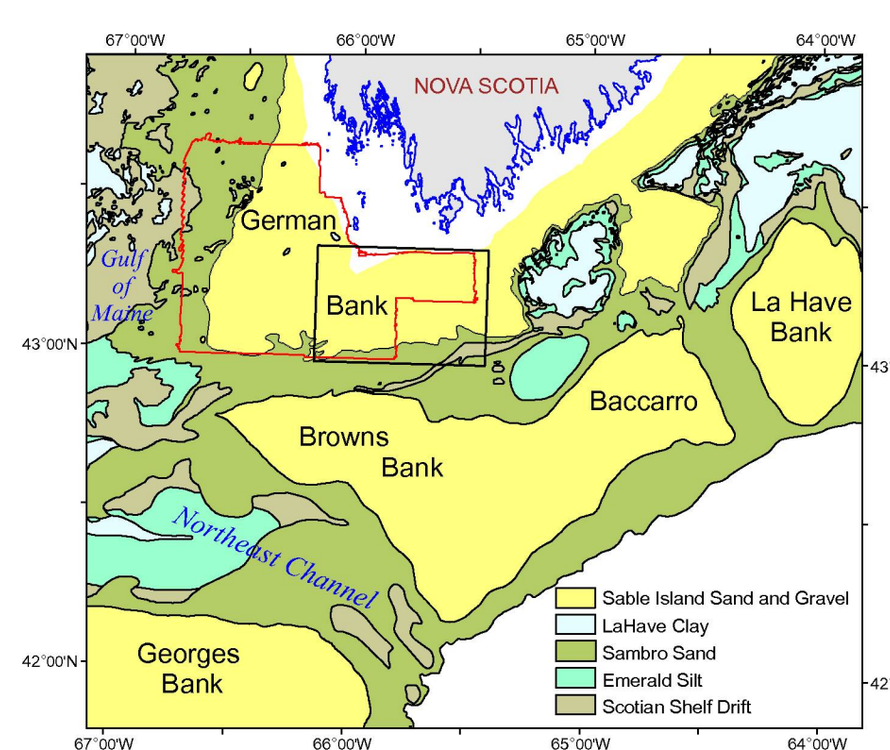


Figure 3. Stratigraphic map showing an earlier interpretation of the distribution of surficial geological formations on the Scotian Shelf and in the Gulf of Maine based on premultibeam sonar survey data (Drapeau and King, 1972; Fader et al., 1977, 2004). Red line shows outline of area mapped using multibeam sonar. Black line outlines extent of map sheet.

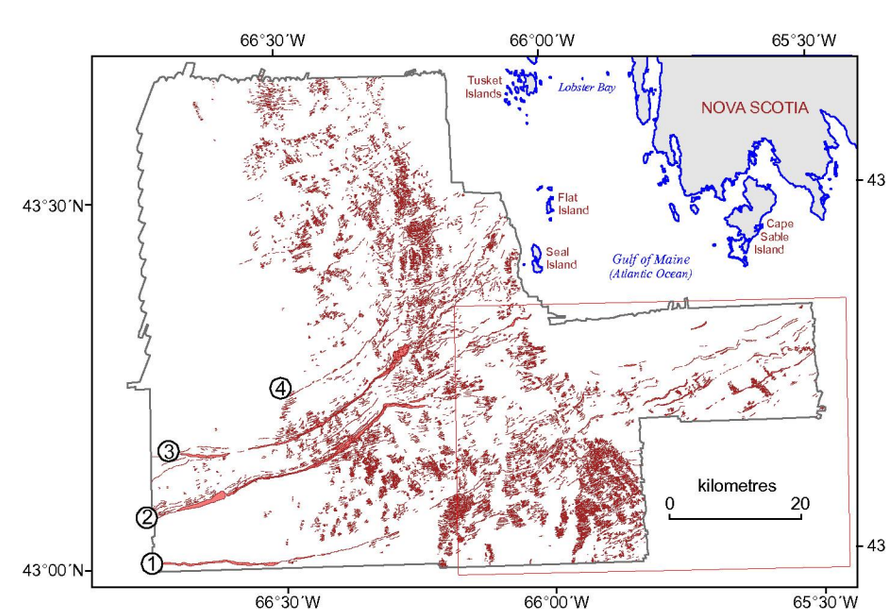


Figure 4. Areas of regional moraines 1–4 (labelled circles) and crest lines of De Geer moraines on German Bank. Extent of map sheet is outlined in red.

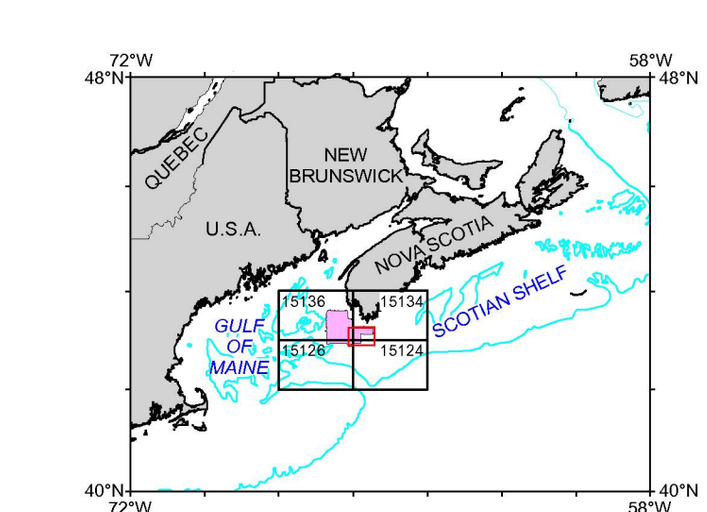
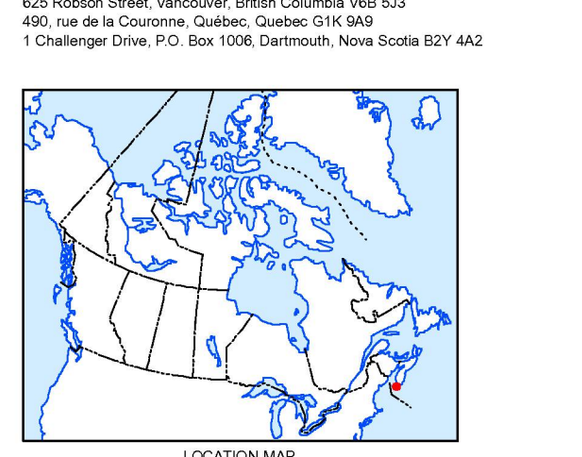


Figure 5. Location map shows extent of map sheet in red. The pink shadowing shows the extent of the multibeam sonar coverage. Five-digit numbers refer to Marsden Square System used for Natural Resource Map series at 1:250 000 scale. Blue line shows 200 m isobath.



LOCATION MAP

Author: B.J. Todd

This map was produced by Natural Resources Canada in co-operation with Fisheries and Oceans Canada

Geology by B.J. Todd, 2006–2008

Geological compilation by B.J. Todd, S.E. Hayward, W.A. Rainey, and R.O. Miller, 2001–2008

Digital cartography by P. O'Regan, Data Dissemination Division (DDD) and S. Hayward, GSC (Atlantic)

MAP 2148A

SURFICIAL GEOLOGY AND SUN-ILLUMINATED SEAFLOOR TOPOGRAPHY

GERMAN BANK

SCOTIAN SHELF
OFFSHORE NOVA SCOTIA

Scale 1:50 000/Échelle 1/50 000

kilometres 1 0 1 2 3 4 kilomètres

Universal Transverse Mercator Projection / Projection transverse universelle de Mercator
North American Datum 1983 / Système de référence géodésique nord-américain, 1983

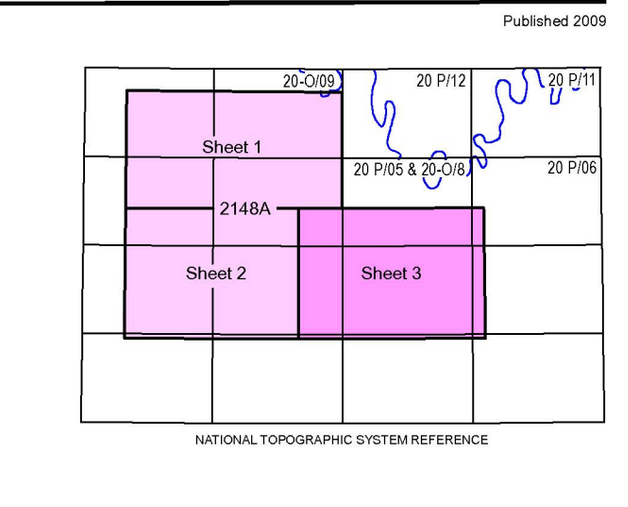
This map is not to be used for navigational purposes / Cette carte ne doit pas être utilisée aux fins de navigation

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

Digital bathymetric contours in metres supplied by the Canadian Hydrographic Service and GSC (Atlantic)

Magnetic declination 2009, 17°28'W, decreasing 6.1' annually

Depth in metres below mean sea level



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Sheet 3 of 3, surficial geology and sun-illuminated seafloor topography (southeast area)

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