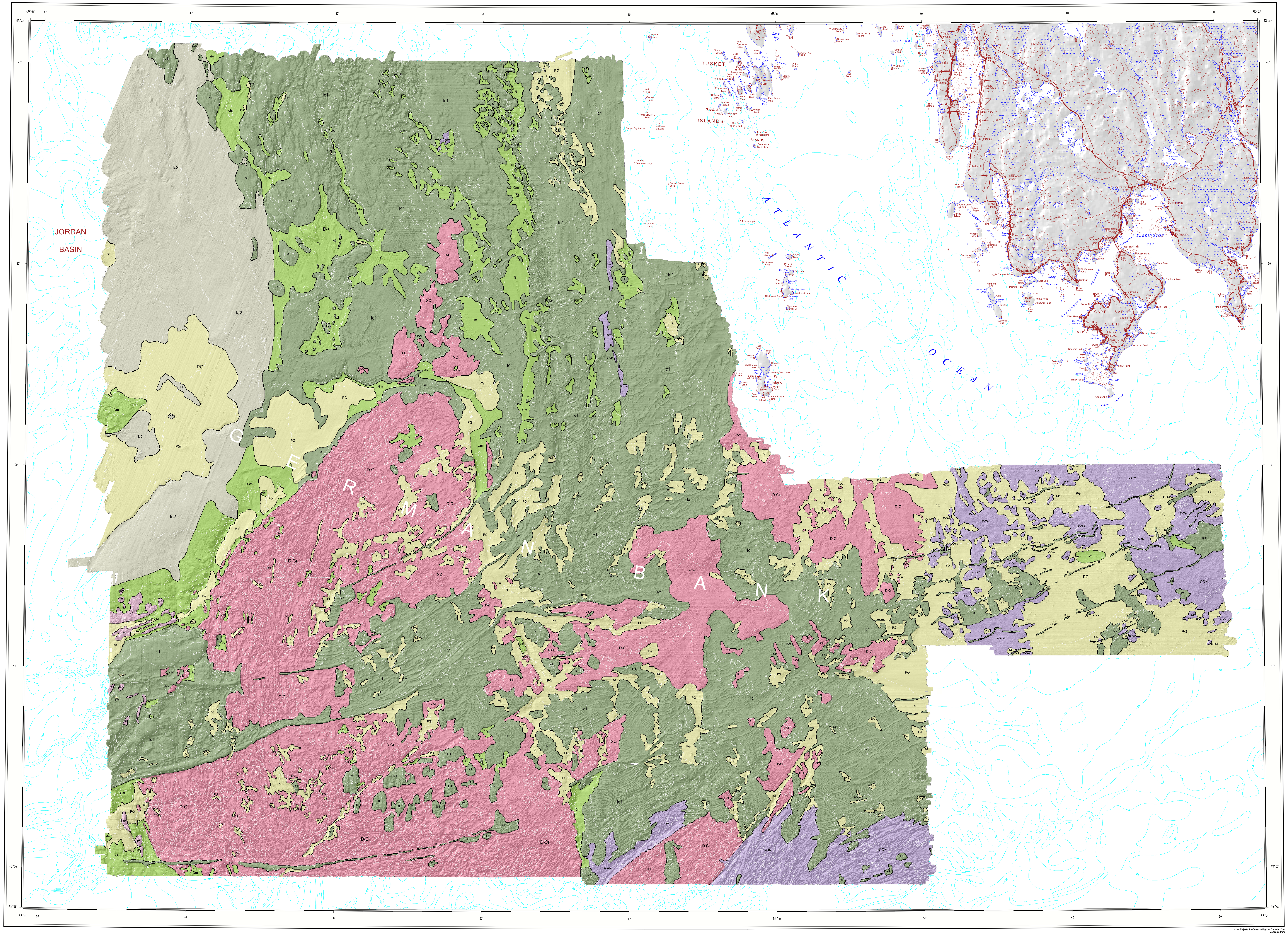
Government of Canada / Gouvernement du Canada

GEOLOGICAL SURVEY OF CANADA / COMMISSION GÉOLOGIQUE DU CANADA



DESCRIPTIVE NOTES

INTRODUCTION

This map is part of a three-map series of German Bank, located on the Scotian Shelf offshore southern Nova Scotia. It is the product of a number of surveys (1997–2003) that used a multibeam-sonar system to map 5321 km² of the seafloor. Other surveys collected geological 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 1:100 000. 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, 1971b, 1972). Sheet 1 shows colour-coded seafloor topography in shaded-relief view. Sheet 2 shows coloured backscatter strength in shaded-relief view.

GEOLOGICAL HISTORY

The Scotian Shelf is a formerly glaciated continental margin characterized by a 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 igneous rocks (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 last glacial maximum of the Late Wisconsinan substage of the Quaternary period, 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) 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. 1; 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. In total, 2658 km of geophysical profiles were used in the interpretation of the German Bank surficial geology.

Using an 0.75 m³ Institutt for Kontinentalsokkel-undersøkelser (IKU) grab, 89 seafloor sediment samples were collected at strategic sites interpreted from geophysical profiles and multibeam sonar imagery (see Fig. 1). The sites were chosen to collect seafloor-sediment samples representative of broad areas sharing similar geomorphology and acoustic backscatter response. 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, 94 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 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 speed of drift. About 10 still images were acquired per transect. The still photographic images represent a seafloor area of 0.96 m².

SURFICIAL GEOLOGY

Syvitski (1991) showed that a complete deglacial sequence consists of some or all of the following: 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. The formation names corresponding to the deglacial sequence names are noted here and in the legend. 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).

GLACIAL SEDIMENTS

Ice-contact till

Ice-contact till (units Ic1 and Ic2), equivalent to Scotian Shelf Drift (Drapeau and King, 1972; Fader et al., 1977), is widespread on German Bank. On the eastern flank of Jordan Basin, unit Ic2 is exposed on the seafloor and overlies unit Ic1. Unit Ic2 pinches out to the east. 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 waves, and associated sediment transport and deposition.

Subglacial landforms are accumulations of sediment formed below active ice and are aligned either longitudinal or transverse to ice-flow direction (Menzies and Rose, 1989). Longitudinal forms are streamlined features divided into flutings, megaflutings, and drumlins (prominent on German Bank) and mega-scale glacial lineations (Clark, 1993).

The geomorphology of northern German Bank is characterized by oval mounds with long axes oriented northwest-southeast (e.g., at 43°33.6'N, 66°20'W). The mounds are typically 500–800 m in length and 100–300 m in width with elevations 10–15 m above the surrounding seafloor. Seismic-reflection profiles reveal that the mounds are constructed of acoustically incoherent sediment, interpreted as till, with intermound areas deeply draped by stratified sediment characterized by continuous, coherent reflections, and interpreted as glaciomarine sand and silt. The true height of the partly buried mounds is 20–30 m. The mounds are interpreted to be drumlins with their long axes parallel to the direction of ice flow.

Drumlins on German Bank do not display the typical drumlin morphology of unequivocal stoss (steep, blunt) and lee (gentle, pointed) sides, as defined by Menzies (1979), that would provide further evidence of ice-flow direction; however, the long axis orientation of the drumlins is consistent with an ice-flow direction from northwest to southeast. The drumlins on northern German Bank sometimes have medial ridges, measuring 3–6 m in height and 30–70 m in width, oriented roughly parallel to the drumlin long axis.

In places, megaflutes are interspersed with drumlins (e.g., 43°32.5'N, 66°25'W). The distinction between drumlins and megaflutes is based on length, l; width, w; and elongation ratio, E, of the bedform (Rose, 1987): E = l/w. With an increasing elongation ratio, drumlins grade into megaflutes. The average elongation ratio for drumlins on northern German Bank is about three. In comparison, some markedly elongated features are up to 1200 m in length with widths of approximately 100 m, giving an elongation ratio of twelve. There is no clear spatial segregation of drumlins and megaflutes.

Former ice-sheet margins on German Bank are demarcated by regional (i.e. >10 km in length) moraines formed by deposition of sediment at the leading edge of the active ice sheet. The regional moraines on German Bank are recessional (Benn and Evans, 1998), formed during overall glacial retreat even though they were deposited during minor readvances or stillstands. The maximum seaward limit of the Late Wisconsinan ice-sheet advance on the southern Scotian Shelf reached the Scotian Shelf edge, 100 km to the southeast (Schnitker et al., 2001; Dyke et al., 2002; Hundert, 2003; Stea, 2004).

Four regional moraines (RM) are identified on southwestern German Bank (Fig. 2). Morphologically, these moraines are composed of 25–40 km long curved segments concave to the northwest. RM 1 is the longest regional moraine and can be traced along segments for approximately 105 km from the southwestern to the eastern part of German Bank. The regional moraines are roughly parallel, have a regional southwest-northeast orientation, and traverse a wide range of water depths. For example, the western end of RM 2 is at a depth of 160 m and rises to 57 m on central German Bank. Sections of some regional moraines rise to 34 m at the eastern edge of the German Bank map area.

Regional moraines display variable heights and widths and both dimensions are consistently larger than De Geer moraine dimensions (discussed below). True moraine heights may be appreciably greater than apparent heights. For example, RM 2 rises 10 m above the surrounding seafloor. However, including the portion of the moraine buried under the flanking glaciomarine sediment, the true height of this moraine is 40 m, four times the apparent height. The exposed moraine width at the seafloor is about 400 m whereas the width at the buried moraine base is approximately 600 m.

At a large scale in plan view, these moraines display a complex geomorphology composed of a suite of curvilinear elements. For example, a continuous, curvilinear, narrow ridge about 50 m wide sharply demarcates the southeastern flank of RM 2 (43°9.9'N, 66°21.5'W). To the northwest of this flank, the moraine is composed of short (tens to hundreds of metres), discontinuous, curvilinear narrow ridges. The orientation of these short ridges, although variable, is southwest-northeast on average. The multitude of curvilinear elements is interpreted to reflect processes occurring at the ice front during moraine 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. 2). Topographic highs on southern German Bank are mantled by swarms of De Geer moraines. Most of these 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 150 m to 200 m. In other areas, sub-parallel 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°6.7'N, 66°17.7'W) are approximately 1.5 m high and 40 m wide. The more prominent De Geer moraines (e.g. 43°5'N, 66°12'W) are approximately 5-8 m high and 100–130 m wide.

Ice-distal silt

Ice-distal glaciomarine sediments result from fallout of sediment from glacial meltwater plumes and ice-rafted debris.

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.

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 (Drapeau and King, 1972; Fader et al., 1977). The morphology and extent of postglacial sediments are interpreted from the topographic map and the backscatter strength map, on which the low backscatter strength areas are interpreted as predominantly 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.

Postglacial deposits adjacent to expanses of outcropping bedrock, for example at 43°24.4'N, 66°20.7'W, display a high backscatter strength resulting from pebbles and cobbles at the seabed surface. Winnowing of finer grained sediment by currents produced this lag deposit, effectively armouring the underlying postglacial material against erosion.

ACKNOWLEDGMENTS

German Bank geoscientific data were collected during four expeditions of the CCGS *Hudson* (1976-016, 2000-047, 2002-026, 2003-054) and during 2000 on the MV *Anne S. Pierce*. O. Longva (Geological Survey of Norway), J. Shaw (Geological Survey of Canada), and C. McCall (St. Mary's University) collaborated at sea and in the elucidation of the deglacial history of German Bank. Multibeam sonar data were collected and processed by the Canadian Hydrographic Service. Geographical Information Systems and cartographic support was provided by S.E. Hayward, W.A. Rainey, S. Hynes, and P. O'Regan. J. Shaw and R.A. Pickrill reviewed the map.

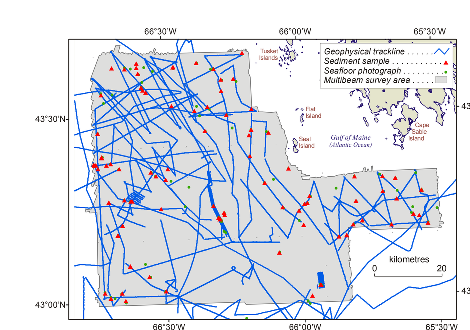


Figure 1. Data source map showing the distribution of geophysical tracklines (seismic-reflection profiles, sidescan-sonar sonograms) and seafloor-sediment samples and photographs.

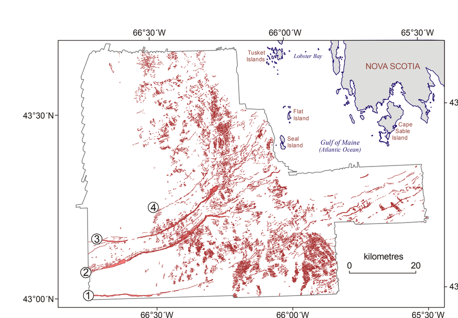


Figure 2. Areas of regional moraines 1–4 (labeled circles) and crest lines of De Geer moraines on German Bank.

REFERENCES

Benn, D.I. and Evans, D.J.A., 1998. Glaciers and Glaciation; Arnold, London, England, 734 p.

Canadian Hydrographic Service, 1967. Natural Resource Chart 15136-A, bathymetry; Department of the Environment, Ottawa, Ontario, scale 1:250 000.

Canadian Hydrographic Service, 1971a. Natural Resource Chart 15124-A, bathymetry; Department of the Environment, Ottawa, Ontario, scale 1:250 000.

Canadian Hydrographic Service, 1971b. Natural Resource Chart 15134-A, bathymetry; Department of the Environment, Ottawa, Ontario, scale 1:250 000.

Canadian Hydrographic Service, 1972. Natural Resource Chart 15126-A, bathymetry; Department of the Environment, Ottawa, Ontario, scale 1:250 000.

Clark, C.D., 1993. Mega-scale glacial lineations and cross-cutting ice-flow landforms; Earth Surface Processes and Landforms, v. 18, p. 1–29.

Drapeau, G. and King, L.H., 1972. Surficial geology of the Yarmouth–German Bank map area; Canadian Hydrographic Service, Marine Sciences Paper 2, Geological Survey of Canada, Paper 72-24, 6 p.

Dyke, A.S., Andrews, J.T., Clark, P.U., England, J.H., Miller, G.H., Shaw, J., and Veillette, J.J., 2002. The Laurentide and Innuitian ice sheets during the Last Glacial Maximum; Quaternary Science Reviews, v. 21, p. 9–31.

Fader, G.B.J., 1989. A Late Pleistocene low sea-level stand of the southeast Canadian offshore; in Late Quaternary Sea-level Correlation and Applications, (ed.) D.B. Scott, P.A. Pirazzoli, and C.A. Honig; Kluwer, Dordrecht, The Netherlands, p. 71–103.

Fader, G.B.J., King, L.H., and MacLean, B., 1977. Surficial geology of the eastern Gulf of Maine and Bay of Fundy; Canadian Hydrographic Service, Marine Science Paper 19, Geological Survey of Canada, Paper 76–17, 23 p.

Fader, G.B.J., Lynds, T., Miller, R.O., Parrott, D.R., Hynes, S., and Sherin, A., 2004. Scotian Shelf regional surficial geology compilation; Geological Survey of Canada, Open File 4671, 1 CD-ROM.

Gordon, D.C., Jr., McKeown, D.L., Steeves, G., Vass, W.P., Bentham, K., and Chin-Yee, M., 2007. Canadian imaging and sampling technology for studying benthic habitat and biological communities; in Mapping the Sea Floor for Habitat Characterization, (ed.) B.J. Todd and H.G. Greene; Geological Association of Canada, Special Paper 47, St. John's, Newfoundland, p. 29–37.

Hundert, T., 2003. Western Scotian Slope stratigraphy: insights into late Quaternary deglaciation of the western Scotian Shelf, eastern Canada; M.Sc. thesis, Dalhousie University, Halifax, Nova Scotia, 154 p.

King, L.H. and MacLean, B., 1976. Geology of the Scotian Shelf; Canadian Hydrographic Service, Marine Sciences Paper 7, Geological Survey of Canada, Paper 74-31, 31 p.

King, L.H. and Fader, G.B.J., 1986. Wisconsinan glaciation of the continental shelf-southeast Atlantic Canada; Geological Survey of Canada, Bulletin 363, 72 p.

Menzies, J., 1979. A review of the literature on the formation and location of drumlins; Earth Science Reviews, v. 14, p. 315–359.

Menzies, J. and Rose, J., 1989. Subglacial bedforms: an introduction; Sedimentary Geology, v. 62, p. 117–122.

McCall, C., 2002. Bedrock and surficial sediments of German Bank, offshore southwestern Nova Scotia; B.Sc. thesis, Saint Mary's University, Halifax, Nova Scotia, 87 p.

Pe-Piper, G. and Jansa, L.F., 1999. Pre-Mesozoic basement rocks offshore Nova Scotia, Canada: new constraints on the origin and Paleozoic accretionary history of the Meguma Terrane; Geological Society of America Bulletin, v. 111, p. 1773–1791.

Pe-Piper, G. and Loncarevic, B.D., 1989. Offshore continuation of Meguma terrane, southwestern Nova Scotia; Canadian Journal of Earth Sciences, v. 26, p. 176–191.

Rose, J., 1987. Drumlins as part of a glacier bedform continuum; in Drumlin Symposium, (ed.) J. Menzies and J. Rose; Balkema, Rotterdam, The Netherlands, p. 103–116.

Schnitker, D., Belknap, D.F., Bacchus, T.S., Friez, J.K., Lusardi, B.A., and Popek, D.M., 2001. Deglaciation of the Gulf of Maine; in Deglacial History and Relative Sea-level Changes, Northern New England and Adjacent Canada, (ed.) T.K. Weddle and M.J. Retelle; Boulder, Colorado, Geological Society of America, Special Paper 351, p. 9–34.

Stea, R.R., 2004. The Appalachian Glacier Complex in Maritime Canada; Quaternary glaciations – extent and chronology, 2, part II: North America, (ed.) J. Ehlers and P.L. Gibbard; Elsevier Science, Amsterdam, The Netherlands, p. 213–232.

Syvitski, J.P.M., 1991. Towards an understanding of sediment deposition on glaciated continental shelves; Continental Shelf Research, v. 11, p. 897–937.

Todd, B.J., Asprey, K.W., Atkinson, A.S., Blasco, R., Fromm, S., Girouard, P.R., Kostylev, V.E., Longva, O., Lynds, T., Rainey, W.A., Spencer, P.L., Uyesugi, M.S., and Valentine, P.C., 2003. Expedition report CCGS Hudson 2002-026: Gulf of Maine; Geological Survey of Canada, Open File 1468, 143 p.

Todd, B.J., Atkinson, A., Beaver, D.E., Rainey, W., Strang, J., MacCabe, S.S., Murphy, R., Pledge, P.E., and Uyesugi, M.S., 2001a, Expedition report: MV Anne S. Pierce, 2000: German Bank, Scotian Shelf; Geological Survey of Canada, Open File 4187, 34 p.

Todd, B.J., Boyce, A.A., Chapman, C.B., Kostylev, V.E., Rainey, W.A., Spencer, P.L., and Uyesugi, M.S., 2001b. Expedition report CCGS Hudson 2000-047: Gulf of Maine; Geological Survey of Canada, Open File 3931, 93 p.

Todd, B.J., Rainey, W.A., Girouard, P.R., Valentine, P.C., Chapman, C.B., Middleton, G.D., Boyce, A.A., Uyesugi, M.S., Kostylev, V.E., Rumbolt, S.T., Fromm, S.A., Hynes, S.E., and Spencer, P.L., 2004. Expedition report CCGS Hudson 2003-054: German Bank, Gulf of Maine; Geological Survey of Canada, Open File 4728, 126 p.

Todd, B.J., Valentine, P.C., Longva, O., and Shaw, J., 2007. Glacial landforms on German Bank, Scotian Shelf: evidence for Late Wisconsinan ice-sheet dynamics and implications for the formation of De Geer moraines; Boreas, v. 36, p. 148–169.

Wentworth, C.K., 1922. A scale of grade and class terms for clastic sediments; Journal of Geology, v. 30, p. 377–393.

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 interbedded with the underlying ice-contact sediment (unit Ic1).*

Ic2 — ***Ice-contact sediments (till):*** *unsorted, unstratified and unconsolidated drift, with characteristic transparent seismic-reflection configuration, consisting of a heterogeneous mixture of clay, sand, gravel, and boulders varying in size and shape. The till occurs on the eastern flank of Jordan Basin, reaching 60 m in thickness. The till is absent from the eastern portion of the map area. A surficial gravel lag commonly overlies these sediments.*

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 till occurs across the map region and is thickest on the eastern flank of Jordan Basin where it is commonly 20 m to 40 m thick, buried beneath unstratified ice-contact sediment (unit Ic2). Elsewhere, the outcropping till typically displays an array of glacial landforms including moraines, drumlins, and megaflutes.*

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–CARBONIFEROUS

MEGUMA TERRANE PLUTONS

D-Ci — *Acoustic basement: undifferentiated Late Devonian–Carboniferous igneous rocks cutting the Cambro–Ordovician Meguma Group.*

CAMBRO–ORDOVICIAN

MEGUMA GROUP

C-OM — *Acoustic basement: metasedimentary rock, Cambrian quartzite, greywacke and slates.*

PRECAMBRIAN TO MISSISSIPPIAN

UNDIFFERENTIATED

pP — *Undifferentiated: acoustic basement; comprises instrusive, volcanic, and metasedimentary rocks.*

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)

Authors: B.J. Todd and P.C. Valentine

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

Geological compilation by B.J. Todd, Geological Survey of Canada and P.C. Valentine, U.S. Geological Survey.

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)

OPEN FILE 6124

SHADED SEAFLOOR RELIEF, BACKSCATTER STRENGTH, AND SURFICIAL GEOLOGY

GERMAN BANK

SCOTIAN SHELF
OFFSHORE NOVA SCOTIA

Scale 1:100 000/Échelle 1/100 000

kilometres 2 0 2 4 6 8 kilomètres

Universal Transverse Mercator Projection
North American Datum 1983

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

© Her Majesty the Queen in Right of Canada 2010
This map is not to be used for navigational purposes

© Sa Majesté la Reine du chef du Canada 2010
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

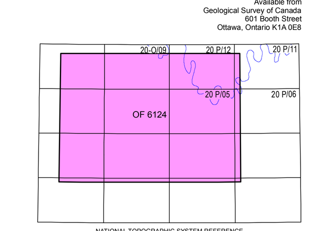
Digital base map (land area) from data compiled by Geomatics Canada, modified by GSC (Atlantic)

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

Mean magnetic declination 2010, 17°18'W, decreasing 6.0' annually. Readings vary from 16°59'W in the SW corner to 17°37'W in the NE corner of the map

Depth in metres below mean sea level

©Her Majesty the Queen in Right of Canada 2010
Available from
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE

OPEN FILE
DOSSIER PUBLIC
6124
GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
2010
SHEET 3 OF 3
FEUILLET 3 ET 3

Open files are products that have not gone through the GSC formal publication process.

Les dossiers publics sont des produits qui n'ont pas été soumis au processus officiel de publication de la CGC.

Sheet 3 of 3, surficial geology

Recommended citation:
Todd, B.J. and Valentine, P.C., 2010. Shaded seafloor relief, backscatter strength, and surficial geology; German Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Open File 6124, scale 1:100 000.

Canada