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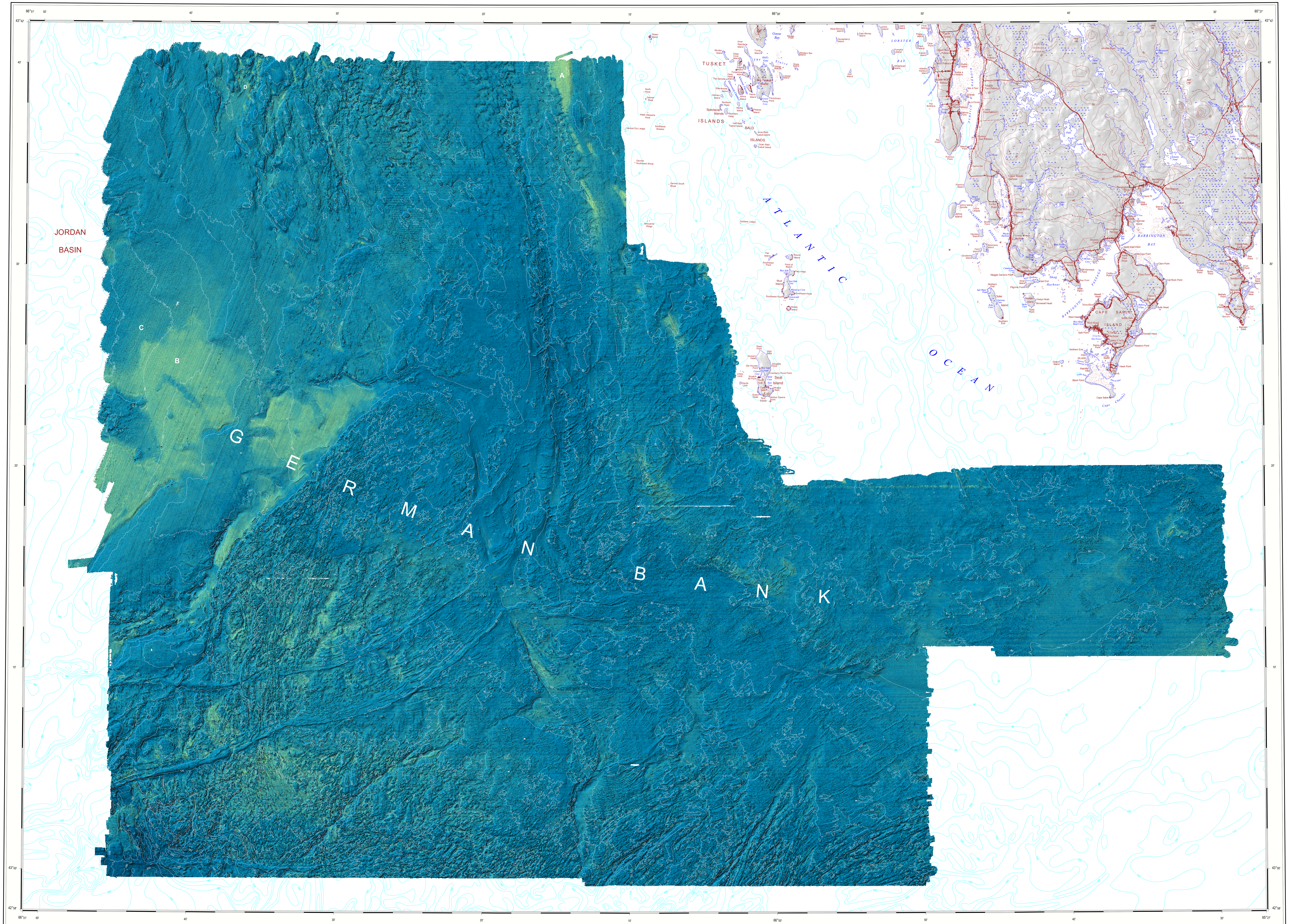
GEOLOGICAL SURVEY OF CANADA   COMMISSION GÉOLOGIQUE DU CANADA



DESCRIPTIVE NOTES

INTRODUCTION

This map is part of a three-map series of German Bank, located on the Scotian Shelf off southern Nova Scotia. This map is the product of a number of surveys (1997–2003) that used a multibeam sonar system to map 5327 km^2 of the seafloor. Other surveys collected geological data for scientific interpretation. This map sheet shows the seafloor topography of German Bank area in shaded-relief view and backscatter strength (coded by colour) at a scale of 1:100 000.

Low backscatter values are white to light green and high backscatter values are blue. Topographic contours generated from the multibeam data are shown (in white) on the colour-coded backscatter strength 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 3 shows seafloor topography in shaded-relief view with colour-coded surficial geological units.

BACKSCATTER STRENGTH

Multibeam bathymetric data were collected 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 Simrad Subsea EM1000 multibeam bathymetric survey system (95 kHz) with the transducer mounted in the starboard pontoon. This system produces 60 beams arrayed over an arc of 150° and operates by ensonifying a narrow strip of seafloor across track and detecting the seafloor echo. The width of seafloor imaged on each survey line was five to six times the water depth. Line spacing was about three to four times water depth to provide ensonification overlap between adjacent lines. The Differential Global Positioning System was used for navigation, providing positional accuracy of ±3 m. Survey speeds averaged 14 knots, resulting in an average data collection rate of about 5.0 km^2/h in water depths of 35–70 m. The sound velocity in the ocean was measured during multibeam data collection and used to correct the effect of sonar beam refraction. During the survey, water-depth values were inspected and erroneous values were removed. The data were adjusted for tidal variation using tidal predictions from the Canadian Hydrographic Service.

Backscatter strengths ranging from 0 to -128 dB were logged by the Simrad Subsea EM1000 system simultaneously with the bathymetric data. To reduce the dynamic range of the recorded data, the system applied a partial correction to the backscatter strength values for the varying angle of incidence by using Lambert's law for the variation with angle and assuming a flat seafloor. Backscatter strengths were computed using calibration values for the electronics and transducers at the time of instrument manufacture.

Some features in the backscatter data are artifacts of data collection, environmental conditions during the survey periods, and data processing. The orientation of the survey track lines can, in some instances, be identified by faint parallel stripes in the image. These stripes are particularly evident on areas of the seafloor having high backscatter strength (blue), for example near 43°39.5'N, 66°11.5'W. Because these artifacts are usually regular and geometric in appearance on the map, the human eye can disregard them and distinguish real patterns of backscatter strength distribution.

Courtney and Shaw (2000) summarized the relationship of backscatter strength to seafloor sediment. Multibeam systems record the mean backscattered signal strength, or mean amplitude, in each returned beam. The amount of acoustic energy returned in each beam depends upon the interaction of the incident energy in the downgoing ray with the physical characteristics of the seabed and the shallow subsurface, and is strongly dependent on the angle of incidence of the beam to the seabed. Multibeam sonar systems project sound from an angle of 0° for beams pointing directly down from the survey vessel to angles as high as 75° for the outermost beams. For angles of incidence less than approximately 20°, the signal returned from the seabed is within the specular zone where a reflection from the seabed is recorded from objects larger than the acoustic wavelength (~1.6 cm). The amount of energy returned from a specular reflection increases with the acoustic impedance contrast across the water-seabed boundary (acoustic impedance is the product of density and acoustic velocity). At wide beam angles, the signal returned from the seabed arises from constructive interference with roughness on the seabed and this scattered energy increases with increasing surface roughness. At these angles, there can also be an added contribution to the backscatter energy from volume heterogeneity within the subsurface material. For example, acoustic energy penetrates deeper below the seabed into soft, fine-grained material (silt and sand) than it does into hard, coarse-grained material (gravel). Subsurface coarse-grained material will contribute to backscattered energy.

No simple relationship exists between backscatter strength and surficial sediment type; however, for incidence angles beyond the specular range, there is a correspondence between backscatter strength and surficial sediment roughness. This correspondence can be utilized for preliminary sediment identification and rudimentary mapping (Mitchell and Hughes Clark, 1994; Shaw et al., 1997; Todd et al., 1999). Cobbles and boulders (>64 mm) constitute a locally rough seabed, return high-amplitude backscatter signals (typically -10 to -30 dB), and are shown as blue on this map. Silt and sand (< 2 mm) constitute a locally smooth seabed, return low-amplitude backscatter signals (typically -30 to -60 dB), and are shown as light green to white on this map. Because backscatter is a function of a suite of acoustical variables, it is prudent to interpret backscatter images in conjunction with other geophysical data (seismic-reflection profiles and sidescan-sonar sonograms), geological samples of seafloor materials, and seafloor photographs. This groundtruth surveying and accompanying interpretation is an essential component in the production of the German Bank surficial geology (Sheet 3) and benthic habitat (Sheet 4) maps.

BACKSCATTER DISTRIBUTION

The distribution of backscatter strength on German Bank provides insight into ocean circulation and related modern seafloor sediment transport processes not apparent in the bathymetric image. Ocean circulation in the region of German Bank has been studied using moored current meters, drifting buoys, and finite-element modelling (Smith, 1983; Page and Smith, 1989; Lynch and Naimie, 1993; Hannah et al., 2000). Seasonal circulation is tidally dominated with a persistent westward and northwestward flow toward the Gulf of Maine. The winnowing and transport of fine-grained sediment under the influence of currents results in remnant coarse-grained deposits with moderate to high backscatter strength over much of German Bank. In shallow water (~50 m), sand is deposited in linear bodies oriented southeast-northwest with the current flow direction, for example at 43°33'N, 66°13'W. These sand deposits are characterized by low backscatter strength (**A**). In deeper water (>100 m) on western German Bank, sand is deposited in broad sheets with backscatter strengths ranging from moderate to low (**B**). In water depths from 120 m to 165 m, sand has infilled paleoiceberg scours (**C**). In basins on northwest German Bank, sand has a moderate backscatter strength (**D**).

ACKNOWLEDGMENTS

G. Costello of the Canadian Hydrographic Service (CHS) organized the multibeam bathymetric survey of German Bank and oversaw data processing. Canadian Hydrographic Service provided the data to the Geological Survey of Canada (GSC) for further processing and interpretation. K. DesRoches processed the backscatter strength using software developed by R.C. Courtney (GSC). The authors thank the master and crew of the CCGS Frederick G. Creed for their efforts at sea. R.A. Pickrill (GSC), G. Costello, and M. Lamplugh (CHS) supported the development of the German Bank maps. Geographical Information Systems and cartographic support was provided by S. Hayward, W.A. Rainey, S. Hynes, and P. O'Regan. V. Barrie, A. Bolduc, and R.A. Pickrill reviewed the map.

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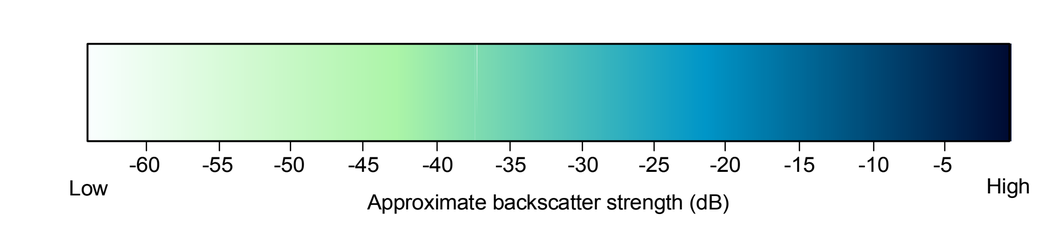


LOCATION MAP

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.

Multibeam bathymetric data collected by Canadian Hydrographic Service, 1997, 1998, 2000, 2002, and 2003

Multibeam backscatter data compiled by Geological Survey of Canada, 2004

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

This map is not to be used for navigational purposes

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

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

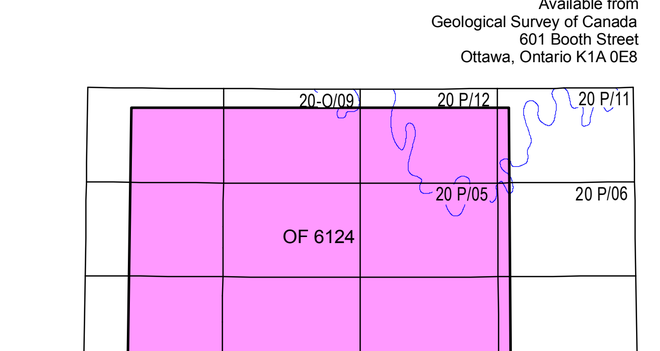
Digital base map (land area) from data compiled by Geomatics Canada, modified by GSC (Atlantic)

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

Available from
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8



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GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
2010
SHEET 2 OF 3
FEUILLET 2 ET 3

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Sheet 2 of 3, backscatter strength

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.

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