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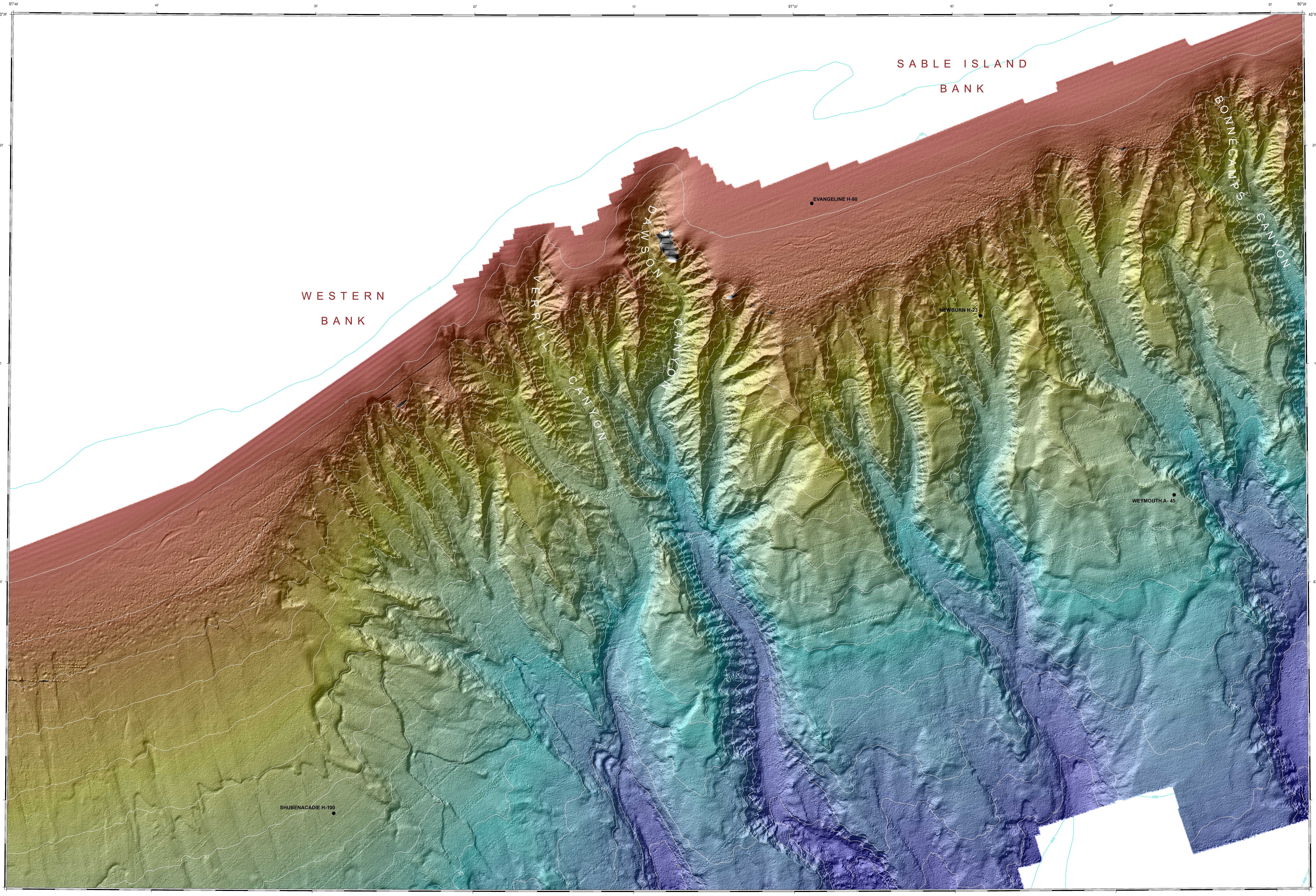
GEOLOGICAL SURVEY OF CANADA | COMMISSION GÉOLOGIQUE DU CANADA



DESCRIPTIVE NOTES

INTRODUCTION

The Verrill Canyon map area is part of the surficial geology map series for the Scotian Slope. This map series comprises three map areas at 1:100 000 scale on the continental slope seaward of Nova Scotia, from Mohican Channel in the west to Logan Canyon in the east. Logan Canyon (Campbell et al., 2008a) and Mohican channel (Campbell et al., 2008b) are available separately. This map displays sun-illuminated seafloor topography that provides a basis for describing the seafloor morphology. The seafloor topography was measured using multibeam sonar, a system that allows for the shipboard collection of several closely spaced depth soundings across a swath up to four times the water depth. The topographic data have been artificially shaded to accentuate physiographic features.

MULTIBEAM BATHYMETRY DATA COLLECTION

Data were collected during two surveys; a deep-water survey using a Simrad EM300 system and a shallow-water survey using a Simrad EM1002 system that together covered an area of about 22 000 km^2 on the Scotian Slope, from 100 m to 3900 m water depth.

Deep-water survey (700 m to 3900 m water depth)

The deep-water multibeam survey was conducted by C&C Technologies Inc. during May 18 to June 20, 2000. The survey was co-ordinated by the Geological Survey of Canada in collaboration with several industry partners (Pickrill et al., 2001). It utilized a Simrad EM300 multibeam sonar system installed on the M/V *Ocean Alert*, a former Coast Guard vessel that at the time was owned by Alert Shipping of St. John's, Newfoundland. The EM300 is a 30 kHz multibeam sonar system with operational depths from 10 m to 4500 m. The system produces 135 beams over a maximum arc of 150°. During this survey the swath coverage was approximately three times the water depth up to a maximum swath width of approximately 4000 m. Ship's position and attitude were provided by an Applanix POS/MV system that provided differential GPS accuracy of about 3 m and attitude accuracy of about 0.05°. Survey speed was 10–12 knots. The final two days of the survey were within The Gully Marine Protected Area and were funded by the Geological Survey of Canada and the Department of Fisheries and Oceans.

Shallow-water survey (100 m to 700 m water depth)

The shallow-water multibeam survey was conducted by the Geological Survey of Canada in partnership with Clearwater Fine Foods Inc. during July 18 to August 4, 2000. The survey utilized a Simrad EM1002 installed on the M/V *Anne S. Pierce*, a vessel operated by Clearwater Fine Foods Inc. The EM1002 is a 93–98 kHz multibeam sonar system with operational depths from 10 m to 800 m. The system produces 111 beams over a maximum arc of 150°. During the survey the swath coverage was approximately four times the water depth. Ship's position and attitude were provided by an Applanix POS/MV system that provided differential GPS accuracy of about 3 m and attitude accuracy of about 0.05°. Survey speed was 10 knots.

For both surveys, sound-velocity profiles were collected daily and more often if necessary. Corrections for sound velocity were applied in real time in order to ensure accurate water-depth calculations and remove water-velocity artifacts.

MULTIBEAM BATHYMETRIC DATA DISPLAY

The imagery displayed on the maps was produced by gridding the processed deep-water data at 20 m and the shallow-water data at 10 m. The images were then merged to make a single digital elevation model of the slope from which sun-illuminated images and slope gradients could be derived (Mosher et al., 2004). Bathymetric values are colour coded from cool colours (blues and violets) for deeper depths and warm colours (reds and oranges) for shallower depths. Artificial sun illumination is directed from 315° at 45° above the horizon with a vertical exaggeration of five. Two data artifacts are common in the imagery. Parallel ridges oriented along the survey direction are present and are due to refraction errors from line to line. Also, a linear seam is visible through most of the data near 700 m water depth where the two surveys have been merged. It should also be noted that horizontal resolution decreases substantially with increased water depth due to the increased area of seabed or footprint covered by each beam (Table 1) (Mosher et al., 2005) and, to a lesser extent, the increase in beam spacing. Overall, this results in a smoothing effect in the data with an underestimation of locally steep slopes and an inability to resolve small features.

Water depth (m)	Area of ensonification (m^2) (normal incidence)	Area of ensonification (m^2) (45° beam)
200	19	43
400	77	213
800	308	871
1500	1077	3041
2000	1914	5421

Table 1. Footprint of individual beams over various water depths (*modified from* Mosher et al., 2005)

GEOMORPHOLOGY

The modern Scotian Slope extends approximately 1000 km from Northeast Channel to Laurentian Channel. The central Scotian Slope is informally defined as the area between Mohican channel to the west and The Gully to the east. This region of the slope can be divided into two distinct morphological provinces (Mosher et al., 2004). West of Verrill Canyon the regional gradient is 1.5° to 3° and the seabed is relatively flat. East of Verrill Canyon the regional gradient is steeper, 2.5° to 4°, and the seabed is deeply incised by submarine canyons, several of which cut back tens of kilometres into the outer continental shelf. Regional controls on evolution of the morphology are discussed by Piper (1988).

The Verrill Canyon map area is bounded to the west by Verrill Canyon and to the east by Bonnécamps Canyon. The canyon systems in this area have a dendritic pattern and form individual catchments. The major submarine canyons cut back into the continental shelf and comprise several branches that coalesce on the mid- and lower slope and are divided by broad intercanyon areas. The canyon walls range from incised with well developed ridge-and-gully relief to planar or scalloped.

The canyons within the Verrill Canyon map area are morphologically similar to many other canyons on the eastern continental margin of Canada. They were excavated over the past million years as continental glaciation lowered sea level so that the shelf was emergent and river sediments were discharged near the top of the continental slope. At times, glacial ice reached the edge of the continental shelf and subglacial meltwater may have flowed directly via hyperpycnal processes into submarine canyons. Canyon erosion was the result of turbidity currents that flowed down the canyons at times of glacial maxima. Some canyons are located on the sites of older Cenozoic canyons on the continental margin (Piper et al., 1987). Tidal flow within the upper parts of canyons reduces sedimentation there at the present time (Piper and Campbell, 2002).

The western part of Verrill Canyon appears different than the canyons to the east. The tributaries in this part of the canyon probably have an origin principally from retrogressive sediment failure. Long linear escarpments, in places over 50 m high, are commonly located along deep-seated faults related to salt tectonics (Newton, 2003; Shimeld, 2004). The escarpments are buried headscarps of old submarine landslides, most of which completely evacuated the seabed downslope of the scarp (Campbell et al., 2004). From 300 m to 500 m water depth on the upper slope, much of the seabed is scoured and pitted, evidence of past seafloor impacts by icebergs (Pickrill et al., 2001). Shallower than 300 m, these features have been mantled by a layer of sand and gravel and the seabed appears smooth (Piper and Campbell, 2002).

ACKNOWLEDGMENTS

R.A. Pickrill was instrumental in co-ordinating the multibeam surveys. C&C Technologies Inc. acquired the deep-water multibeam data and D. Beaver oversaw data collection during the shallow-water survey. Data processing was performed by staff of GSC Atlantic. S. Hynes and M. Furlong provided GIS support and P. O'Regan provided cartographic support. This map was reviewed by P. Hill and A. Bolduc. This work was part of GSC Project X36 (D. Mosher, leader) in the Geoscience for Ocean Management Program.

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Exploration wells . . . . ●

200 600 1000 1400 1800 2200 2600 3000

Depth (m)

Copies of this map may be obtained
from the Geological Survey of Canada:
601 Booth Street, Ottawa, Ontario K1A 0E8
625 Robson Street, Vancouver, B.C. V6B 5J3
490, rue de la Couronne, Québec, Quebec G1K 9A9
1 Challenger Drive, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2

LOCATION MAP

Authors: D.C. Campbell, D.J.W. Piper, D.C. Mosher, and K.A. Jenner

Multibeam bathymetric data collected by C&C Technologies Inc. and the Geological Survey of Canada in partnership with Clearwater Fine Foods Inc., 2000

Multibeam bathymetric data compiled by C&C Technologies Inc. and Geological Survey of Canada, 2000

Digital cartography by P. O'Regan, Data Dissemination Division (DDD)

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

MAP 2125A

SUN-ILLUMINATED SEAFLOOR TOPOGRAPHY

VERRILL CANYON

SCOTIAN SLOPE

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

This map is not to be used for navigational purposes

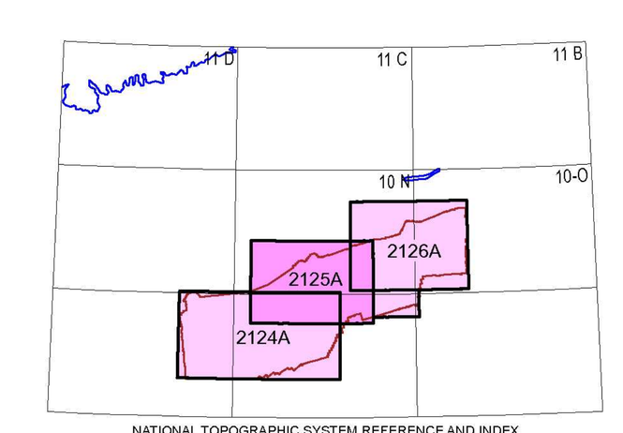
Cette carte ne doit pas être utilisée aux fins de navigation

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

Mean magnetic declination 2008, 18°35'W, decreasing 8.1' annually. Readings vary from 18°43'W in the NE corner to 18°24'W in the SW corner of the map

Depth in metres below sea level

Published 2008



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

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2008: Sun-illuminated seafloor topography, Verrill Canyon, Scotian Slope, offshore Nova Scotia; Geological Survey of Canada, Map 2125A, scale 1:100 000.