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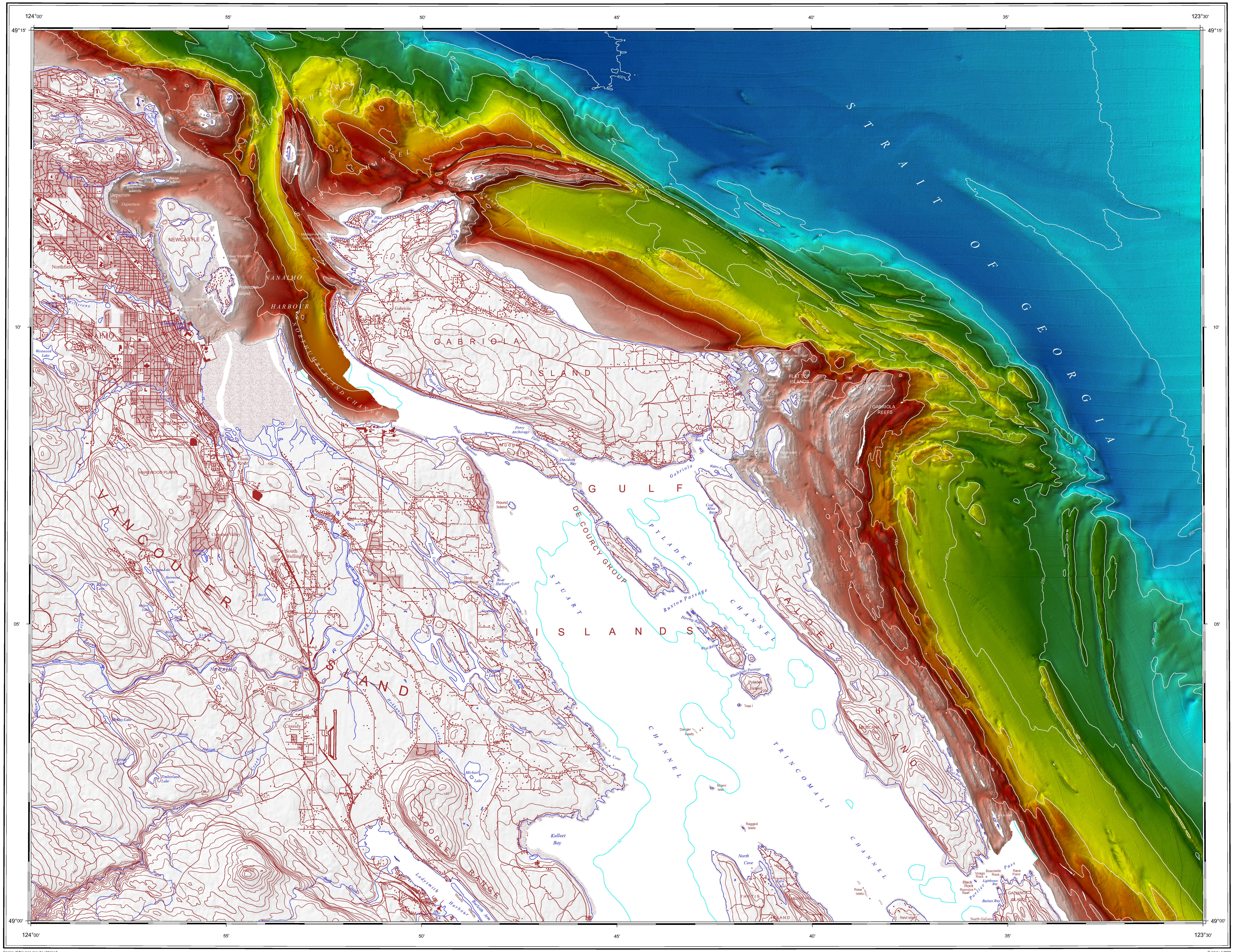

DESCRIPTIVE NOTES

INTRODUCTION

This seafloor topographic map is the first map of a three-map series encompassing the Nanaimo area. The map covers part of the southern Strait of Georgia, east of Nanaimo, Gabriola Island, and Valdez Island. Seafloor topography is presented in colour-coded seafloor depth and shaded relief at a scale of 1:50 000. Topographic contours, generated from multibeam data, are shown in white at an interval of 50 m. For the areas where no multibeam data have been collected, the bathymetric contours were provided by the Canadian Hydrographic Service (CHS) and are shown in light blue at an interval of 50 m. Included in this map series are: Map 2119A (Picard and MacLeod, in press) showing the backscatter strength data derived from multibeam-sonar data and Map 2118A (Picard, in press) showing the interpreted geology derived from seafloor topography, backscatter-strength, sub-bottom profiles, sidescan sonar, grab and core samples, and videos.

MULTIBEAM BATHYMETRIC DATA COLLECTION

Multibeam bathymetric data were collected from 1997 to 2005 using Kongsberg-Simrad EM-1002 and EM-3000 multibeam echo sounders aboard the Canadian Coast Guard Ships (CCGS) *RB Young* and *Vector*, and the CCGS *Puffin*, *Revisor*, and *Otter Bay*, respectively. The EM-1002 operates at a frequency of 95 kHz producing 111 beams and is generally used for water deeper than 50 m and up to a maximum of 1000 m. The EM-3000 operates at a frequency of 300 kHz utilizing 127 beams and is used for shallow water, up to 100 m. Both systems cover an arc of 120°, and ensonify a narrow strip of seafloor along track. The EM-1002 transducer was mounted on an electrically operated ram. On the CCGS *Puffin*, *Revisor*, and *Otter Bay*, the EM-3000 was mounted in the keel. In order to meet International Hydrographic Organization (IHO) standards for bathymetric data collection, the line spacing was such that a full overlap of the swath was collected. The Differential Global Positioning System was used for navigation, providing positional accuracy of ±5 m. The survey speed averaged 6 knots. The speed of sound in water was measured prior to and during the multibeam sonar data collection and was used to correct for the effect of sonar-beam refraction. Water-depth values were inspected and erroneous values were removed. The data were adjusted for tidal variation using recorded observations or pseudotides calculated from tidal predictions and observations by the CHS. The surveys included in this map are listed in Table 1.

SURVEY	SURVEYORS	REMARKS
1997 Nanaimo Harbour, CCGS *Puffin* 1997 Newcastle Island Passage, CCGS *Puffin* 1997 Departure Bay, CCGS *Puffin* 1997 Duke Point Ferry, CCGS *Puffin*	Peter Milner	All surveys included into one project named 1997 Nanaimo Harbour
1999 Gabriola, CCGS *Revisor*	Ernest Sargent	
2000 Georgia Basin, CCGS *R.B.Young*	Ernest Sargent	
2001 Nanaimo, CCGS *R.B.Young*	Peter Milner	
2002 Gulf Islands, CCGS *Revisor*	Ron Woolley	Includes surveys on east side of Galiano, Gabriola, Mayne, Saturna, and Valdez islands
2005 Nanaimo Approach, CCGS *Otter Bay* and CCGS *Vector*	Kalman Czotter	Includes surveys from both ships

Table 1: List of the multibeam surveys used to create the map.

MULTIBEAM BATHYMETRIC DATA DISPLAY

The multibeam bathymetric data are represented at 5 m/pixel horizontal resolution for the deep waters surveyed using the multibeam EM-1002 and at 2 m/pixel for shallow waters surveyed with the EM-3000. The shaded-relief image was created by vertically exaggerating the topography five times and then sun illuminating the relief with a virtual light source positioned 45° above the horizon at an azimuth of 315°. Superimposed on the shaded-relief image are colours assigned to water depth, ranging from red (shallow) to violet (deep). Some features in the data are artifacts, which mainly result from beam refraction (49°08'30"N, 123°31'W) and dataset merging (49°12'N, 123°47'W along the meridian). The beam-refraction errors create ridging of the seafloor and are more apparent when the survey-lines run normally to the artificial sun-illumination direction. For this map, multiple datasets with different survey line orientations were combined. Therefore, even though the best sun-illumination orientation was chosen to minimize the ridging effect, some beam refraction artifacts are still apparent.

GEOMORPHOLOGY

The Strait of Georgia extends for approximately 220 km in a northwest-southeast direction between Vancouver Island and the British Columbia mainland, with an overall width that varies from 25 km to 55 km. The Strait of Georgia is part of the modern Georgia Basin, which encompasses two additional bodies of water: Juan de Fuca Strait and Puget Sound. The formation of the basin is the result of structural deformation that took place after the Late Jurassic, mainly due to the interaction between the North American lithospheric plate and the Juan de Fuca Plate (Mustard, 1994; England and Bustin, 1998). The latest deformation affecting Georgia Basin and shaping the modern basin is an early Tertiary compression, which resulted in a southwest-directed thrusting that included the Nanaimo Sedimentary Group, and northwest-plunging and trending folds in the Tertiary Chuckanut Formation (Mustard, 1994; Mustard and Rouse, 1994). In the Strait of Georgia, the Chuckanut Formation is mainly found on the eastern side, whereas the Nanaimo Group is found on the western side of the strait and forms the Gulf Islands, here represented by Gabriola, Valdes, and the De Courcy Group islands. The marine portion of the basin is also moderately deformed along a series of mainly northwest-trending faults and folds, visible in the outcropping bedrock (49°08'N, 123°38'W) (Barrie et al., 2005). Some of the marine faults identified by multibeam surveys are marine extensions of faults previously mapped on land. The Porlier Pass Fault is one example (49°04'N, 123°31'W), where faulting is expressed at the seafloor and shows displacement of the modern overlying sediments (Barrie and Hill, 2004).

Bedrock and structural controls have influenced the morphology of the Strait of Georgia, but Quaternary glaciations, coastal processes, and the modern oceanographic environments are also major factors contributing to the geomorphology of the seafloor. Glaciation affected the Pacific margin of Canada many times and evidence of the youngest glacial episode is found over much of the region (Barrie and Conway, 2002). The distribution of glacial deposits in this area are shown on the surficial geology map (Picard, in press). The latest glaciation, known as the Fraser Glaciation, started around 30 000-25 000 BP (^{14}C). The ice sheet overrode the main portion of the Strait of Georgia around 17 ka and reached its maximum extent in Washington, U.S.A. around 14 000 BP (^{14}C) (Clague and James, 2002). The retreat of the ice sheet was rapid and by 11 300 BP (^{14}C), the strait was ice-free (Barrie and Conway, 2002). Sea level varied throughout the strait due to eustasy and to local glacioisostasic differences. For much of the Strait of Georgia, sea level reached a relative highstand (50 m to 200 m) immediately after deglaciation and fell to near present levels after 10 000 BP (^{14}C) (Barrie and Conway, 2002). South of this map area, Huntley et al. (2001) suggested, based on paleochannel incision elevations, that sea level probably regressed to at least 10 m b.s.l. at about 9000–8000 BP.

The Fraser River discharges a very large volume of fresh water and sediment into the Strait of Georgia. It is a dominant modern control of the oceanographic and geological processes of the central and southern parts of the strait (Barrie et al., 2005). Unconsolidated sediments originating from the river cover most of the seabed of the southern Strait of Georgia.

ACKNOWLEDGMENTS

The master and the crew of the CCGS *R.B.Young*, *Puffin*, *Revisor*, *Otter Bay*, and *Vector* were instrumental in the success of the multibeam bathymetric and groundtruthing surveys. The Canadian Hydrographic Service collected and processed the multibeam data. The authors thank R. Kung, and K. Iwanowska for Geographical Information System (GIS) and cartographic support. The map was reviewed by J.V. Barrie, R. Currie, and B.J. Todd.

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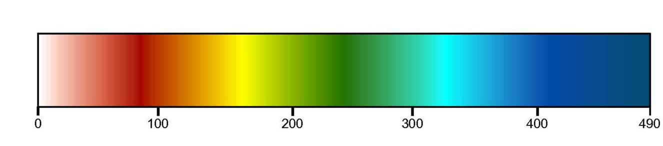
Picard, K.
in press: Surficial geology and sun-illuminated seafloor topography, Nanaimo, British Columbia; Geological Survey of Canada, Map 2118A, scale 1:50 000.



Depth (m)

Published 2008

Copies of this map may be obtained
from the Geological Survey of Canada:
601 Booth Street, Ottawa, Ontario K1A 0E8
3303-33rd Street, N.W., Calgary, Alberta T2L 2A7
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

Canada

Authors: K. Picard and R.F. MacLeod

Multibeam bathymetric data collected by Canadian Hydrographic Service, 1997, 1999–2002, 2005

Multibeam bathymetric data compiled the Geological Survey of Canada, 2007

Co-ordinated through the auspices of the Geoscience for Oceans Management Program

Digital cartography by R.F. MacLeod, GSC (Pacific)

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

MAP 2117A

SUN-ILLUMINATED SEAFLOOR TOPOGRAPHY

NANAIMO

BRITISH COLUMBIA

Scale 1:50 000/Échelle 1/50 000

kilometres 1 0 1 2 3 4 kilomètres

Universal Transverse Mercator Projection
North American Datum 1983

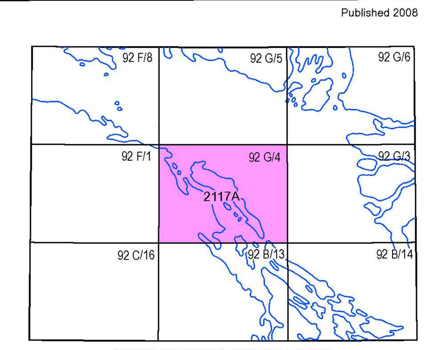
Projection transverse universelle de Mercator
Système de référence géodésique nord-américain 1983

Digital base map from data compiled by Geomatics Canada, modified by GSC (Pacific)

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

Magnetic declination 2008, 18°04'E decreasing 12.0' annually

Depth in metres below mean sea level



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE

Recommended citation:
Picard, K. and MacLeod, R.F.
2008: Sun-illuminated seafloor topography, Nanaimo, British Columbia; Geological Survey of Canada, Map 2117A, scale 1:50 000.