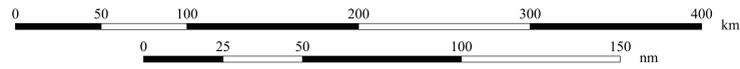


Geologic Map of the Canadian Pacific Exclusive Economic Zone

2024

Scale 1:1,000,000



NAD 1983 BC Environment Albers - D WGS 1984

The background is the 2 arc-second resolution GMRT v4.2 multi-resolution Digital Elevation Model with multidirectional hillshading.

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Map production by A.T. Baxter and C.H.G. Braga (Version 1.0)

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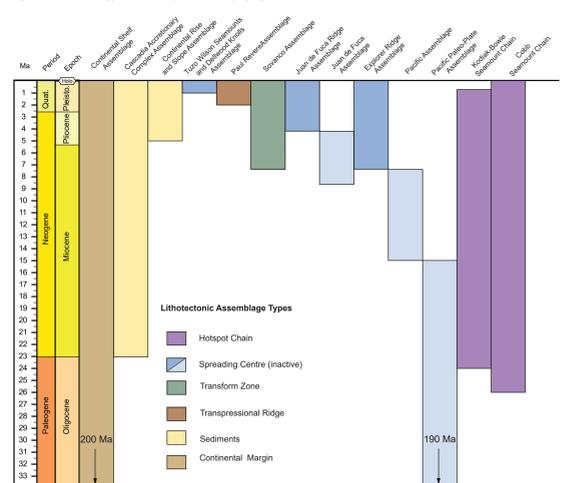
ABSTRACT

The assembled map sheet is a geological compilation of the Canadian northwest Pacific Exclusive Economic Zone (EEZ) at 1:1,000,000 scale. The geologic map shows the distribution of different types of lithological units, geologic structures, and their age relationships. Geologic maps of this type are new tools for the management of marine seabed resources, hazards, environmental and climate impacts, and natural habitats. In this study, geologic formations and lithostratigraphic assemblages are assigned to the entire EEZ. Formation-level geologic units were identified using established remote predictive mapping (RPM) techniques guided by high-resolution multibeam surveys and multiparameter geophysics. The mapped area covers nearly 450,000 km² and includes the continental shelf and slope, the Juan de Fuca and Explorer spreading centers, and oceanic crust accreted to the Juan de Fuca, Explorer and Pacific plates within the EEZ. It also includes two regional-scale tectonic structures: the Cascadia subduction zone in the south, and the Queen Charlotte Fault in the north. The mapped area has been the focus of extensive geologic research since the 1960s (Raff and Mason, 1961; Wilson, 1965; Hey, 1977; Tunniceff et al., 1986; Normark et al., 1987; Carbotte et al., 2008). However, a comprehensive geologic map of the deep marine areas has not been available. Recent advances in the quantity and quality of supporting data and new approaches to modelling these data have significantly improved the recognition and interpretation of geologic features at the seafloor and under thick sediment cover. More than 100,000 km² of the map is covered by high-resolution marine geophysical data (hydroacoustics, seismic surveys, magnetics, and gravity) that have been integrated with the results of sampling, ocean drilling, and seabed observations to classify the geologic formations. These are then correlated across the entire EEZ on one map sheet. The workflow follows closely the techniques used for remote predictive mapping in areas on land where geological information is sparse. The units depicted on the map are formation-level geologic units, following the classification scheme of the International Commission on Stratigraphy, and described in the legend. The map is underlain by a multidirectional hillshade of the regional bathymetry (Figure S1), integrated with GMRT. The data sources, methodology, and preliminary quantitative analysis of the formations are described in the accompanying report. The map, report, and supporting documents are provided in electronic format, including fully-populated attributes tables in ArcGIS Pro® for all mapped features.

LITHOSTRATIGRAPHIC LEGEND OF GEOLOGICAL FORMATIONS

LABEL	UNIT NAME AND DESCRIPTION	LABEL	UNIT NAME AND DESCRIPTION	LABEL	UNIT NAME AND DESCRIPTION
OCEANIC SEDIMENTS (Osd)					
Osd1	Sedimented Oceanic crust (7.4-15 Ma) (Osd1) Oceanic crust older than 7.4 Ma and younger than 15 Ma completely covered by sediments	Oa0c2	Inner rift valley crust (Oa0c2) Undivided oceanic crust in the inner rift valley of an active spreading center	Dz1d	Transform massif (Dz1d) Uplifted, fault-bound blocks of deformed oceanic crust with an intense secondary fault fabric in a transform zone
Osd2	Sedimented Oceanic crust (>15 Ma) (Osd2) Oceanic crust older than 15 Ma completely covered by sediments	Md0c1	Proximal volcanic ridge (Md0c1) Elongated volcanic edifice or coalesced ridges adjacent to an active magmatic-dominated spreading center, commonly bound by axis-facing normal faults	Dz1e	Transform valley (Dz1e) Deformed oceanic crust, commonly transform valley wall, obscured by thick sediment
VOLCANO FORMATIONS (Ov)					
Ov1	Cone volcano (Ov1) Cone-shaped edifice composed of flows and volcaniclastic material, commonly with a summit crater (0.4-3km diameter), or disrupted by faulting or mass wasting	Mo0c2	Proximal rift valley crust (Mo0c2) Faulted rift valley crust beyond the inner rift valley, commonly cut by normal faults typical of magmatic-tectonic spreading	Dz2	Transpressive ridge (Dz2) Elongated thrust blocks of deformed oceanic crust, with an intense secondary fault fabric, commonly in an active transform fault
Ov2	Shield volcano (Ov2) Mound-shaped edifice composed of massive lava flows and volcaniclastic material extruded onto oceanic crust, commonly with a central caldera (>2km diameter, >200m height)	Lo0a1	Distal volcanic ridge (Lo0a1) Elongate volcanic edifice or coalesced ridges on distal oceanic crust (may include products of off-axis volcanism or earlier seafloor spreading from a distant ridge)	ACTIVE CONTINENTAL MARGIN (Cm)	
Ov3	Dome volcano (Ov3) Dome-shaped edifice with a flat top composed of lava flows and volcaniclastic material (0.4-3km diameter, up to 300m high), may be disrupted by normal faults and mass wasting	Lo0c2	Distal rift valley crust (Lo0c2) Faulted rift valley crust on or beyond the ridge flank of a magmatic-tectonic spreading center, commonly cut by normal faults and obscured by sediment cover	Cm1	Accretionary Wedge (Cm1) Sediments and crust in an accretionary wedge above an active or inactive continental subduction zone
Ov4	Axial volcano (Ov4) Shield volcano at a ridge axis, typically with an axis-parallel cleft or caldera (may also be dissected in two halves on opposite sides of a rift valley or edge axis)	OCEANIC TECTONIZED CRUST (Ot)		Cm2	Accretionary Ridge (Cm2) Trench parallel ridges in an active or inactive continental subduction zone
Ov5	Fissure volcano (Ov5) Elongate volcanic edifice composed mostly of lava flows extruded onto MOR crust, commonly with a central dike (>1 km length, length:width >3)	Ot1	Tectonized crustal block (Ot1) Uplifted block of tectonized oceanic rocks, with complex faulting patterns overprinting the spreading-induced fabric and large-throw high-angle faulting	Cm3	Transpressional Ridge (Cm3) Parallel ridges in an active or inactive continental subduction zone or transition zone to a continental transform zone
Ov6	Volcanic seamount (Ov6) Volcanic edifice of undetermined origin, can be buried under sediment	Oo2	Inside corner massif (Oo2) Tectonized crustal block at an inside corner high adjacent to a ridge axis discontinuity, commonly with grid faulting	SHELF AND SLOPE FORMATIONS (Cs)	
Ovf	Volcanic field (Ovf) A broad area of lava flows and volcaniclastic material surrounding a number of closely-spaced volcanoes	OCEANIC SHEAR-ZONE FORMATIONS (Dz)		Cs1	Continental Shelf (Cs1) Shallow margin of the continent, commonly sedimented
OCEANIC SPREADING CENTER FORMATIONS (Oe)					
Oe0c1	Axial volcanic ridge (Oe0c1) Volcanic ridge marking the active spreading center, commonly with discrete volcanic edifices (cones and domes), dike complexes, or calderas	Dz1a	Transensional shear-zone crust (Dz1a) Deformed and subsided oceanic crust with an intense secondary fault fabric in nodal basins within a ridge discontinuity or its trace, commonly obscured by sediments	Cs2	Continental Rise (Cs2) Base of the continental margin at the transition to oceanic crust
		Dz1b	Overlap basin (Dz1b) Deformed and subsided oceanic crust in an overlapping spreading center or its off-axis trace, commonly bound by volcanic shear-zone crust and overprinted by pillow mounds	Cs3	Continental Rise Blocks (Cs3) Crustal blocks found in the continental slope at the transition to oceanic crust
		Dz1c	Nodal massif (Dz1c) Uplifted, fault-bound blocks of deformed oceanic crust with an intense secondary fault fabric within a ridge discontinuity or its trace	Cs4	Continental Slope (Cs4) Upper part of the continental margin at the transition to oceanic crust
				SEAFLOOR FORMATIONS (Ch)	
				Ch1	Submarine Channel (Ch1) Submarine channel that transports sediments from the shelf to the ocean, can include the canyon system
				Ch2	Submarine Channel flank (Ch2) The flank of a submarine channel that transports sediments from the shelf to the ocean commonly includes a scarp or levee system

Regional Lithostratigraphic Correlation Diagram of the Canadian Pacific EEZ. The diagram shows the temporal relationships between major episodes of crustal growth represented by the geologic assemblages. Age relations of tectonic events and assemblages are guided by published geochronology of volcanic units, magnetic chrons, depositional ages of sedimentary units, and relative ages of assemblages inferred from mapped relationships. See accompanying text for details.



SYMBOLS	
	Caldera rim
	Formation boundary
	Major fault zone
	Spreading center
	Active subduction (inferred)
	Spot Height (msl)
	Isochron boundary
ABBREVIATIONS	
COSC	Cobb Overlapping Spreading Centre
EOCSC	Endeavour Overlapping Spreading Centre
ET	Explorer Transform
ESD	Explorer Deep
HR	Haida Ridge
MER	Middle Explorer Rift
NER	Northern Explorer Rift
RDF	Revere-Dellwood Fault
SER	Southern Explorer Ridge
WR	Winona Ridge

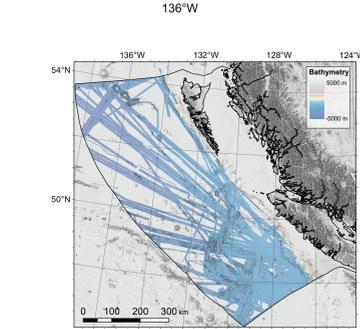
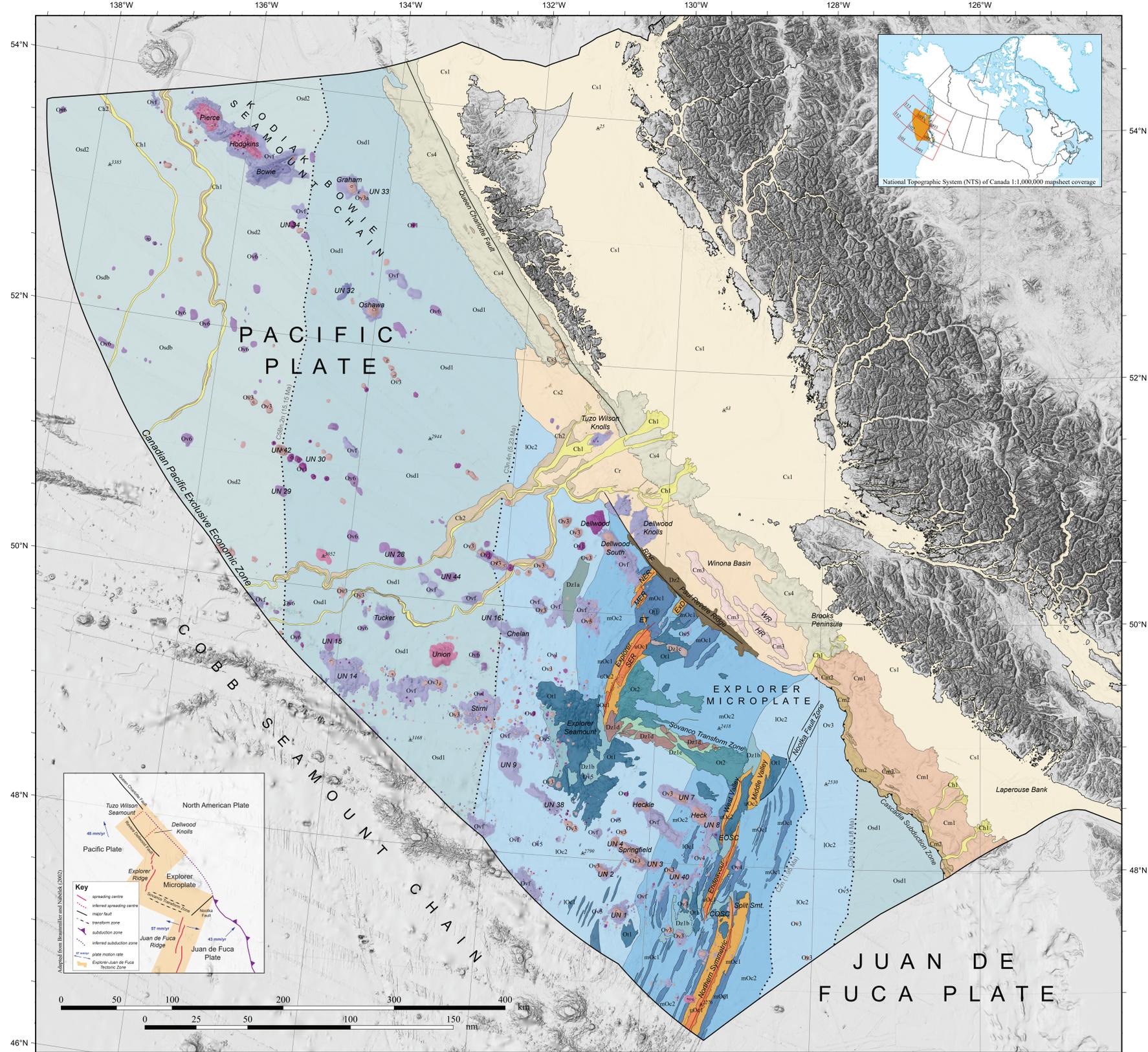


Figure S1 Ship-tracks showing where high-resolution multibeam bathymetry data are available in the map area. The multibeam datasets have maximum resolutions of 61 m and 67 m (GMRT and NOAA NCEI datasets, respectively), and cover approximately 50% of the EEZ. The background is the 2 arc-second resolution GMRT v4.2 multi-resolution digital elevation model with multidirectional hillshading.

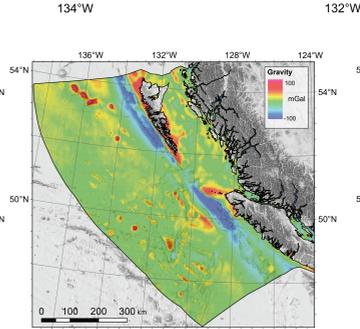


Figure S2 Free-air gravity anomaly map derived from satellite altimetry. Gravity anomalies (v.32.1) are calculated variations that reflect features on the seafloor, such as volcanoes, or changes in the density or thickness of the crust (Sandwell et al., 2014). The data were downloaded from <https://topex.ucsd.edu/pub/>. The background is the 2 arc-second resolution GMRT v4.2 multi-resolution digital elevation model with multidirectional hillshading.

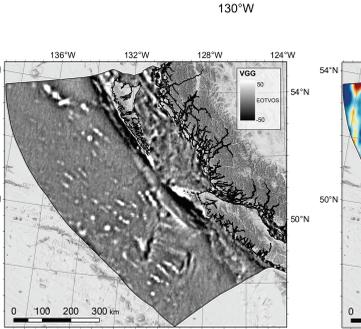


Figure S3 Vertical gravity gradient (VGG) map of the EEZ derived from the global gravity model of Sandwell and Smith (1997). VGG (v.32.1) is the first vertical derivative of the global free-air gravity data (Figure S2). Near surface features are enhanced in the VGG, which shows major structures at the seafloor and beneath the cover of sediment. The data were downloaded from <https://topex.ucsd.edu/pub/>. The background is the 2 arc-second resolution GMRT v4.2 multi-resolution digital elevation model with multidirectional hillshading.

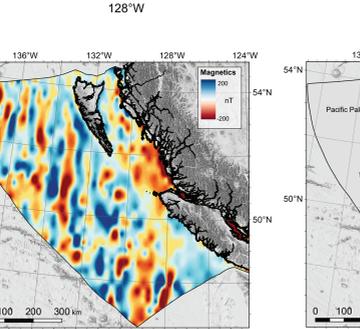


Figure S4 Magnetic anomalies from the 2-arc-minute compilations, EMAG2v3 (Earth Magnetic Anomaly Grid; Maus et al., 2009) which is a global compilation of magnetic data from airborne, ship-based and satellite magnetic measurements. Positive and negative anomalies corresponding to magnetic polarity reversals and compositional variations of the crust. The data were downloaded from <https://www.ngs.noaa.gov/products/>. The background is the 2 arc-second resolution GMRT v4.2 multi-resolution digital elevation model with multidirectional hillshading.

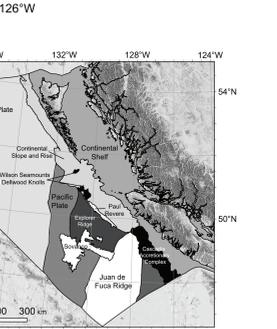


Figure S5 Lithotectonic assemblage map of the Pacific EEZ, showing the distribution of 12 different assemblages defined by groups of formations of similar age and origin, integrated with regional structures. The labeled assemblages are those in the Lithostratigraphic Correlation Diagram.

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