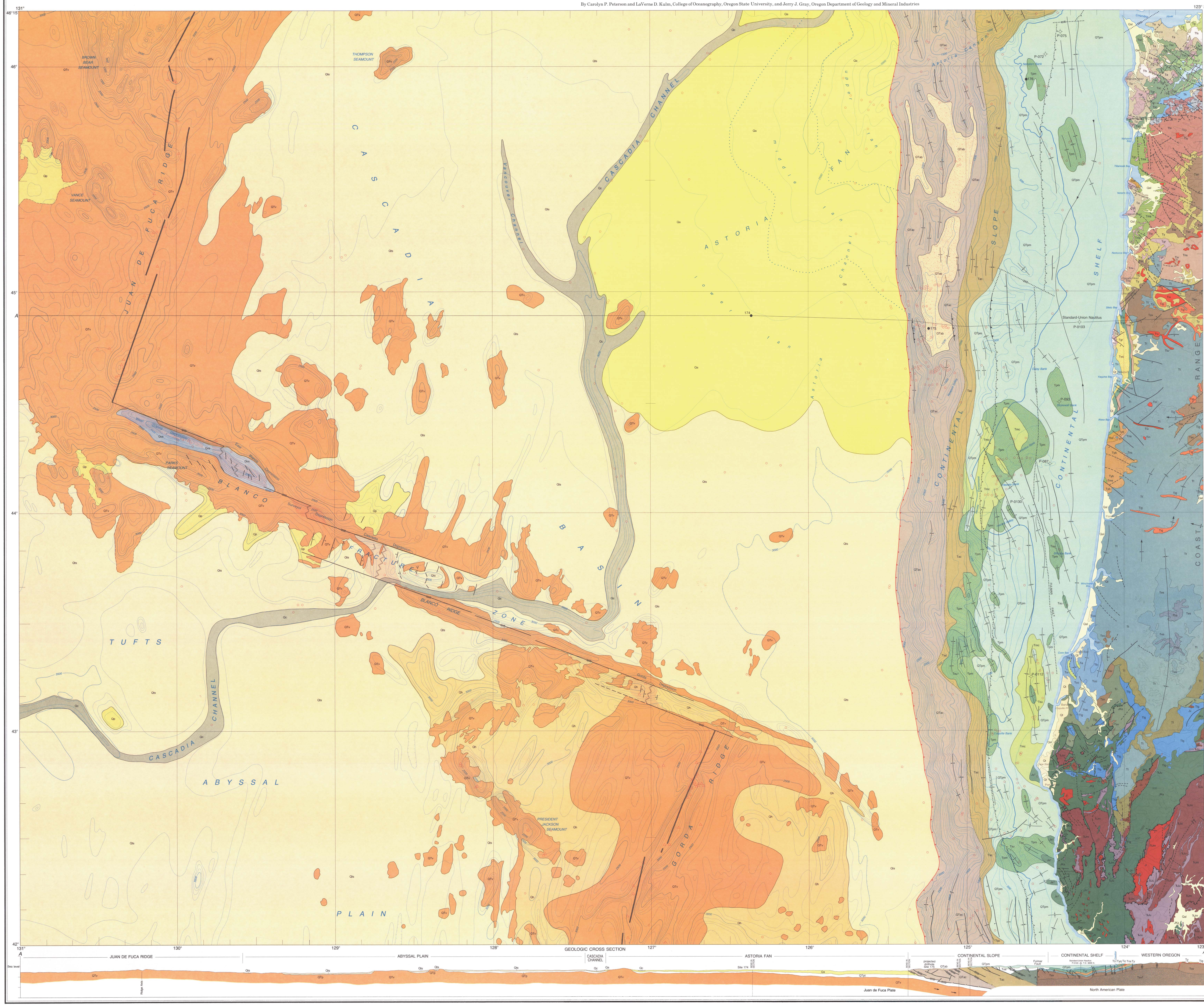
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

GEOLOGIC MAP OF THE OCEAN FLOOR OFF OREGON AND THE ADJACENT CONTINENTAL MARGIN

1986

By Carolyn P. Peterson and LaVerne D. Kulm, College of Oceanography, Oregon State University, and Jerry J. Gray, Oregon Department of Geology and Mineral Industries



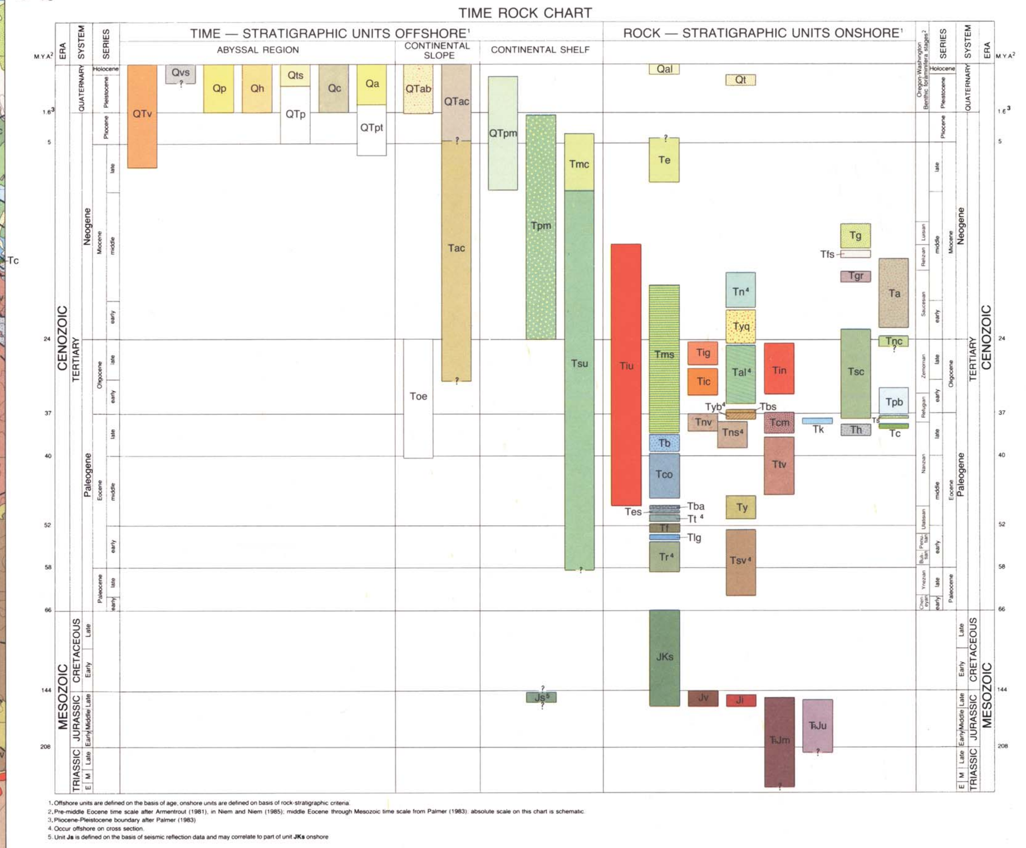
GMS-42

Geologic Map of the Ocean Floor Off Oregon and the Adjacent Continental Margin

By Carolyn P. Peterson, LaVerne D. Kulm, and Jerry J. Gray

Funded by the U.S. Department of the Interior-Minerals Management Service through Cooperative Agreement 14-12-0001-30223

TIME ROCK CHART



1. Offshore units are defined on the basis of age; onshore units are defined on basis of rock-stratigraphic criteria.
2. Pre-middle Eocene time scale after Armentrout (1981), in Niem and Niem (1985); middle Eocene through Mesozoic time scale from Palmer (1983); absolute scale on this chart is schematic.
3. Pliocene-Pleistocene boundary after Palmer (1983)
4. Occur offshore on cross section.
5. Unit **Js** is defined on the basis of seismic reflection data and may correlate to part of unit **JKs** onshore

EXPLANATION

OFFSHORE TIME STRATIGRAPHIC UNITS

Juan de Fuca Ridge — Blanco Fracture Zone — Gorda Ridge — Abyssal Plain

Qvs **Manganese-enriched clayey silts (Holocene-late Pleistocene?)** — Light- and dark-banded brown clayey silts with all layers composed of variable proportions of hydrothermal precipitates, hydrogenous precipitates, volcanic ash, biogenous debris, and minor terrigenous debris. Dark-colored layers indicate increases in manganese-rich hydrothermal activity (Selk, 1978)

Qts **Abyssal plain turbidites (Holocene-late Pleistocene)** — Thin silt and sand turbidites intercalated with hemipelagic muds. Turbidite sequences composed of very fine-grained sand or coarse silt layers that grade upward to hemipelagic clay or silty clay. Silt and sand layers range from a few millimeters to 150 centimeters (cm) thick. Sediments of late Pleistocene age generally have higher percentages of sand and silt turbidites than Holocene abyssal plain sediments (Duncan, 1968; Horn and others, 1971; Kulm and others, 1973a)

Qa **Astoria Fan (Holocene-early Pleistocene)** — Subdivided into three physiographic provinces: upper fan, middle fan, and lower fan. Thick- to thin-bedded, medium- to very fine-grained turbidite sands with thin interbedded olive-gray muds. Sand beds generally range from 50 to 100 cm in thickness. Individual beds grade upward into silts and silty clays and have sharp basal contacts. Thin, graded silt turbidites are also present in minor proportions (Nelson, 1968; Kulm and others, 1973a)

Qh **Hemipelagic mud (Holocene-Pleistocene)** — Homogeneous, poorly sorted, olive-gray and gray clay and silty clay. Radiolarians dominate Holocene strata, while planktonic foraminifers dominate deposits of late Pleistocene age. This unit is restricted to regions topographically isolated from turbidity currents (Duncan, 1968)

Qp **Pelagic ooze and clay (Holocene-Pleistocene)** — Foraminiferal ooze and clay (Duncan, 1968)

Qc **Cascadia Channel fill (Holocene-Pleistocene)** — Rhythmically interbedded thick silt and sand turbidites and thin hemipelagic clays. Sharp basal contacts, commonly with sole marks, are succeeded by laminated and graded sand or silt. The coarse basal zone is overlain by normally graded hemipelagic sediment. Holocene sediments are finer grained, more poorly sorted, and have a higher organic carbon content than their counterparts of late Pleistocene age. Local pebbly claystones and moderately sorted gravels of late Pleistocene age were deposited by ice rafting and turbidity currents caused by catastrophic glacial flooding, respectively (Griggs and Kulm, 1970; Griggs and others, 1970)

QTp **Abyssal plain silt turbidites and interbedded clays (late Pleistocene-Pliocene)** (shown only on cross section) — Pelagic clays and foraminiferal ooze becoming more predominant with increasing depth in section; unit overlies volcanic basement (Kulm and others, 1973a)

QTv **Mid-ocean ridge basalts (Holocene-late Miocene)** — Tholeiitic pillow lavas and sheet and lobate flows erupted along the axes of the Juan de Fuca and Gorda Ridges. Modern Juan de Fuca axial valley is floored predominantly by sheet flows; valley walls are composed chiefly of pillow lavas (Lichtman and others, 1983). On the cross section, unit **QTv** represents oceanic crust (whose upper few hundred meters consist of the volcanic rocks described above) which may grade downward into feeder dike swarms, isotropic gabbros, and layered ultramafic rocks. Ridge basalts increase in age with distance from the ridge axis due to seafloor spreading. Reversals in the earth's magnetic polarity produce the striped pattern of magnetic anomalies in the oceanic crust (see magnetic anomaly map in text accompanying this map).

Several hydrothermal vent sites with associated benthic communities are located in the axial valley of the Juan de Fuca Ridge. Massive sulfide deposits rich in zinc and iron occur at these vent sites (Koski and others, 1982, 1984). Deposits along the northern Gorda Ridge include hydrothermal clay and manganese oxide crusts (Clague and others, 1984)

QTpt **Abyssal plain silt turbidites (early Pleistocene-late Miocene)** (shown only on cross section) — Silty turbidites and interbedded clays. Individual beds generally consist of a thin basal silt interval with a sharp lower contact and grade upward into olive-gray silty clay that in turn grades into calcareous silty clay. Basal silts are planar and micro-cross-laminated. Beds generally range in thickness from 10 to 20 cm. With increasing depth in the section, the basal silt proportion decreases or may be completely absent, while calcareous silty clays of hemipelagic to pelagic origin become more prevalent (Kulm and others, 1973a)

Continental Slope

QTab **Accretionary basin fill (Holocene-Pliocene?)** - Intercalated hemipelagic clays and well-bedded turbidites that consist of well-sorted, fine-grained sand to coarse silt and that have sharp upper and lower contacts. Hemipelagic sediments predominate where topographic barriers prevent turbidite deposition (Kulm and others, 1973b; Kulm and Fowler, 1974; Kulm and Scheidegger, 1979)

QTac **Accretionary complex (Holocene-Pliocene?)** — Abyssal plain and fan sediments that have been accreted to the lower continental slope and subsequently uplifted. Fan and plain sediments include graded sand and silt turbidites and hemipelagic muds. Lower slope accretionary basin sediments are also incorporated into the accretionary prism. The semiconsolidated to indurated strata have been disrupted by folding and faulting as a result of convergence between the Juan de Fuca and North American Plates.

Paleobathymetry, indicated by benthic foraminifers, shows that general uplift of the entire Oregon continental margin has occurred during the late Cenozoic. The uplift rate has been highest on the lower continental slope (1,000 meters per million years [m/my]) and lowest on the outer continental shelf (100 m/my) (Kulm and Fowler, 1974)

Tac **Inferred mélange and broken formation (Miocene?-late Oligocene?)** — May be uplifted, sheared siltstone with large infolds of interbedded sandstone and siltstone; similar to terrain mapped by Rau (1975) in coastal area of the Olympic Peninsula, Washington (Snavely and others, 1980)

Toe **Marine sedimentary rocks, undifferentiated (Oligocene-late Eocene)** (shown only on cross section) — Tuffaceous marine siltstone and mudstone (Snavely and others, 1980)

Continental Shelf

QTpm **Siltstone (Pleistocene-late Miocene)** — Poorly indurated siltstone and minor sandstone. This basinal deposit also blankets upper slope accretionary complex rocks

Tmc **Siliceous claystone (Pliocene-late Miocene)** — Light-gray to olive-gray, well-consolidated, diatomaceous silty claystone. Local unit on Heceta Bank and immediately west of Coos Bay. Correlates to strata onshore south of Coquille Point (Fowler and others, 1971)

Tpm **Mudstone (Pliocene-Miocene)** — Mudstone and siltstone with minor fine-grained sandstone. Miocene rocks have a greater percent sand, while Pliocene rocks have a greater percent clay

Tsu **Mudstones, sandstones, and claystones (pre-late Miocene?)** — Undifferentiated marine sedimentary rocks with some interbedded volcanic and volcaniclastic rocks (Clarke and others, 1985)

Js **Sedimentary rocks (late Jurassic?)** — Sheared assemblage of sedimentary rocks. May correlate to Otter Point Formation **JKs**, as inferred from onshore geology and seismic reflection (Mackay, 1969)

ONSHORE ROCK STRATIGRAPHIC UNITS

Coastal Region — Western Coast Range — Klamath Mountains

Qal **Alluvium (Holocene)** — Unconsolidated stream clay, silt, sand, and gravel; beach sand and gravel; dune sand (Niem and Niem, 1985)

Qt **Terraces (Pleistocene)** — Elevated marine terraces of semiconsolidated silt, sand, and gravel locally; elevated alluvial terraces of semiconsolidated silt, sand, and gravel (Baldwin and others, 1973; Niem and Niem, 1985)

Te **Empire Formation (Pliocene?-upper Miocene)** — Fossiliferous massive sandstone and minor interbeds of siltstone; includes a fossiliferous conglomerate lens (Baldwin and others, 1973)

Tg **Gnat Creek formation (informal) (middle Miocene)** — Marine and nonmarine, thick, cross-bedded to massive feldspathic sandstone and laminated siltstone; minor conglomerate and coal (informal unit of Niem and Niem, 1985)

Columbia River Basalt Group

Tfs **Frenchman Springs Member of the Wanapum Basalt (middle Miocene)** — Subaerial basalts and submarine pillow lavas and breccias and associated dikes and sills of the Columbia River Basalt Group. Equivalent to Cape Foulweather Basalt of Snavely and others (1973) (Niem and Niem, 1985)

Tgr **Grande Ronde Basalt (middle Miocene)** — Subaerial basalts and submarine pillow lavas and breccias and associated dikes and sills of the Columbia River Basalt Group. Equivalent to Depoe Bay Basalt of Snavely and others (1973) (Niem and Niem, 1985)

Ta **Astoria Formation (middle-lower Miocene)** — Thick, laminated to cross-bedded feldspathic and volcanic fine- to coarse-grained sandstone; minor coal; rhythmically bedded turbidite sandstone and siltstone; thick laminated mudstone; massive sandstone; quartzo-feldspathic sandstone and minor tuff in Newport area (Johnson and others, 1984; Niem and Niem, 1985)

Tn **Nye Mudstone (middle-lower Miocene)** — Laminated to massive mudstone and siltstone; locally concretionary (Snavely and others, 1976b)

Tnc **Northrup Creek formation (informal) (lower Miocene-upper Oligocene?)** — Well-bedded laminated micaceous and carbonaceous mudstone and arkosic turbidite sandstone; minor thick-bedded feldspathic sandstone and grit beds (informal unit of Niem and Niem, 1985)

Tyq **Yaquina Formation (lower Miocene-upper Oligocene)** — Tuffaceous and feldspathic sandstone, cross-bedded in part; minor conglomerate and coal (Snavely and others, 1976b)

Tig **Granophyric gabbro (upper Oligocene)** — Inclined sheets, sills, and dikes of massive gabbro (Snavely and others, 1976c)

Tic **Camptonite intrusive rocks (Oligocene)** — Dikes and sills of commonly porphyritic but in part aphyric camptonite (Snavely and others, 1976c)

Tin **Nepheline syenite (Oligocene)** — Sills, dikes, and small stocks of very fine- to fine-grained nepheline syenite or phonolite (Snavely and others, 1976a)

Tal **Alsea Formation (Oligocene)** — Massive tuffaceous siltstone (Snavely and others, 1976a; Johnson and others, 1984)

Tsc **Smuggler Cove formation (informal) (lower Miocene-upper Eocene)** — Thick-bedded bioturbated tuffaceous claystone and siltstone; minor thin-bedded micaceous sandstone and glauconitic sandstone (informal unit of Niem and Niem, 1985)

Ts **Sager Creek formation (informal) (upper Eocene)** — Well-laminated micaceous and carbonaceous mudstone rhythmically interbedded with thin feldspathic sandstone turbidites (informal unit of Niem and Niem, 1985)

Tms **Marine sedimentary rocks, undifferentiated (middle Miocene-upper Eocene)** — Massive tuffaceous mudstone, thin-bedded micaceous sandstone, and tuffaceous mudstone (Johnson and others, 1984)

Tpb **Pittsburg Bluff Formation (lower Oligocene-upper Eocene)** — Fossiliferous, thick-bedded, bioturbated tuffaceous and feldspathic sandstone; glauconitic in lower part (Niem and Niem, 1985)

Tbs **Unnamed basaltic sandstone (lower Oligocene)** — Massive to thick-bedded, fossiliferous, medium- to coarse-grained basaltic sandstone (Snavely and others, 1976a)

Tyb **Yachats Basalt (lower Oligocene-upper Eocene)** — Aphanitic to porphyritic subaerial basalt flows and breccias, with minor pillow lavas, alkalic basalt flows, and related intrusive rocks (Snavely and others, 1976a)

Tns **Nestucca Formation (upper Eocene)** — Thin- to medium-bedded siltstone with minor sandstone and tuff beds (Snavely and others, 1976a)

Tnv **Nestucca volcanic rocks of the Nestucca Formation (upper Eocene)** — Aphanitic to porphyritic subaerial basalt flows, breccias, alkalic basalt flows; minor pillow lavas and related intrusive rocks; flow rocks intertongue with Nestucca Formation sediments (Snavely and others, 1976a; Wells and others, 1983)

Tk **Keasey Formation (upper Eocene)** — Laminated to thin-bedded tuffaceous mudstones and thin-bedded micaceous sandstone and tuff beds (Niem and Niem, 1985)

Tcm **Cole Mountain basalt (informal) (upper Eocene)** — Basalt sills, dikes, and irregular bodies intruded into the Hamlet formation and Cowlitz Formation and along Keasey/Hamlet contact; includes some minor submarine pillow lavas (Niem and Niem, 1985)

Tb **Bastendorff Formation (upper Eocene)** — Massive tuffaceous mudstone and minor thin-bedded micaceous sandstone and tuffaceous mudstone (Baldwin and others, 1973)

Tc **Cowlitz Formation (upper Eocene)** — Micaceous, cross-bedded to thick-bedded arkosic sandstone (Niem and Niem, 1985)

Th **Hamlet formation (informal) (upper Eocene)** — Massive, carbonaceous and mica-bearing mudstone; few thin interbeds of graded, rhythmic, fine-grained, arkosic, micaceous, carbonaceous sandstone and/or medium- to coarse-grained basaltic sandstone (informal unit of Niem and Niem, 1985)

Tiu **Igneous intrusions, undifferentiated (middle Miocene-middle Eocene)** — Gabbro, diabase, and basalt dikes and sills in the Coast Range; diorite, gabbro, and syenite dikes and dacitic and rhyolitic dikes and sills in the Klamath Mountains (Baldwin and others, 1973; Ramp and Peterson, 1979; Johnson and others, 1984)

Tco **Coaledo Formation (upper-middle Eocene)** — Feldspathic, micaceous, cross-bedded to thick-bedded sandstone; minor conglomerate and coal (Johnson and others, 1984)

Ttv **Tillamook Volcanics (upper-middle Eocene)** — Aphanitic to porphyritic subaerial basalt flows, breccias, pillow lavas, alkalic basalt and dacite flows, and related intrusive rocks (Johnson and others, 1984)

Tba **Bateman Formation (middle Eocene)** — Feldspathic, micaceous, cross-bedded to thick-bedded lithic sandstone; minor coal (Baldwin and others, 1973)

Ty **Yamhill Formation (middle Eocene)** — Massive to thin-bedded concretionary siltstone with thin interbeds of arkosic, glauconitic, and basaltic sandstone; localized interbedded basalt flows (Wells and others, 1983)

Tt **Tyee Formation (middle Eocene)** — Thick to thin, rhythmically bedded, graded, feldspathic, micaceous sandstone and siltstone (Johnson and others, 1984)

Tes **Elkton Siltstone Member of the Tyee Formation (middle Eocene)** — Thin-bedded sandstone and siltstone; massive concretionary siltstone (Johnson and others, 1984)

Tf **Flournoy Formation (middle-lower Eocene)** — Fine- to medium-grained lithic sandstone, pebbly sandstone, and minor conglomerate and coal; thin-bedded graded sandstone and siltstone (Baldwin and others, 1973)

Tlg **Lookingglass Formation (lower Eocene)** — Alternating thin- to thick-bedded lithic sandstone and mudstone with subordinate massive sandstone, conglomerate, and mudstone (Johnson and others, 1984)

Tr **Roseburg Formation (lower Eocene-upper Paleocene)** — Thin- to thick-bedded lithic sandstone interbedded with mudstone; subordinate massive sandstone, conglomerate, and mudstone (Johnson and others, 1984)

Tsv **Siletz River Volcanics (lower Eocene-upper Paleocene)** — Aphanitic to porphyritic pillow basalt, breccias, tuffs, and related intrusive rocks; minor siltstone interbeds (Johnson and others, 1984). Includes Roseburg volcanic rocks of Baldwin (1974). On cross section, the top of the stipple pattern represents lower limit to which surface geology can be projected

JKs **Sedimentary rocks (Cretaceous-Upper Jurassic)** — Rhythmically interbedded sandstone and mudstone of the Hunters Cove and Rocky Point Formations; massive to thick-bedded, cross-bedded sandstone and minor conglomerate of the Cape Sebastian Sandstone; conglomerate of the Myrtle Group; sheared assemblage of graywacke, siltstone, limestone, and chert of the Otter Point Formation; massive to thick-bedded sandstone and minor intercalated siltstone and shale of the Dothan Formation; rhythmically interbedded sandstone and siltstone of the Galice Formation (Ramp and others, 1977; Ramp and Peterson, 1979)

Jv **Volcanic rocks (Upper Jurassic)** — Basaltic pillow lavas, breccia flows, flows, and pyroclastic rocks of the Otter Point, Dothan, and Galice Formations (Ramp and others, 1977; Ramp and Peterson, 1979)

Ji **Igneous intrusions (Upper Jurassic)** — Diorite and gabbro stocks, dikes, and sills (Ramp and others, 1977; Ramp and Peterson, 1979)

TRJu **Ultramafic rocks (Jurassic-Upper Triassic?)** — Serpentinite and altered peridotites and minor dunites; concordant sheets and tectonically emplaced dikes (Ramp and others, 1977; Ramp and Peterson, 1979)

TRJm **Metamorphic rocks (Jurassic-Triassic?)** — Metasedimentary and metavolcanic rocks of the Galice and Rogue Formations, Colebrook Schist, and Applegate Group; includes amphibolite and metagabbro (Ramp and others, 1977; Ramp and Peterson, 1979)

See accompanying text for the list of references and a discussion of the regional geologic setting.

MAP SYMBOLS

Contact — Approximately located; dashed where inferred offshore

Fault — Approximately located; dashed where probable; dotted where concealed. Ball and bar on downthrown side. Arrows indicate separation. A/T on cross section: A indicates lateral movement along fault away from reader; T indicates movement toward reader

Thrust fault — Saw teeth on upper plate; dashed where approximately located

Base of deformation front of subduction zone — Approximately located; saw teeth on upper plate; bathymetric boundary between continental slope and abyssal plain

Concealed thrust boundary between the accretionary complex to the west and basinal rocks to the east — Saw teeth on upper plate

Approximate time boundary between the Holocene to Pliocene portion of the accretionary complex (QTac) to the west and the accretionary complex of Miocene to late Oligocene age (Tac) to the east — In some localities and in the cross section, this boundary may be a fault

Syncline — Approximately located offshore; arrows show direction of plunge

Anticline — Approximately located offshore; arrows show direction of plunge

Axis of extension within pull-apart depression — Located on the Blanco Fracture Zone

Central portion of pull-apart depression

Location of spreading center on ridge axis

Zone adjacent to shore without sufficient information to map

Physiographic boundaries within the Astoria Fan separating upper, middle, and lower fan

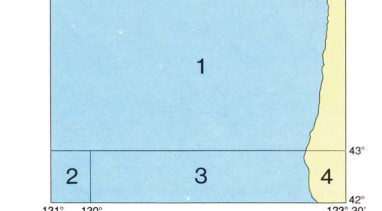
Bathymetric boundary between the continental slope and shelf

Deep Sea Drilling Project drill site, Leg 18

Oil and gas exploration drill hole site on the continental shelf

Gravity, piston, and dart core sample site

Dredge sample site



BASE MAP SOURCES

1. Bathymetry - Topography, 1984: Western North American Continental Margin and Adjacent Ocean Floor Off Oregon and Washington, edited by L.D. Kulm and others. Ocean Margin Drilling Program: Regional Atlas 1.
2. Modified from Juan de Fuca Plate, 1978; Relief compiled by Pacific Geoscience Centre, Surveys and Mapping Branch, Dept. of Energy, Mines and Resources, Ottawa, Canada.
3. Offshore topography of the Western United States between 32° and 49° North Latitude, 1981: U.S. Geological Survey, Open-File Map 81-443.
4. Modified from #3 (above) by the Oregon Dept. of Geology and Mineral Industries, 1984.

This map is not intended for navigational purposes

Map prepared by
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Cartography by Paul E. Staub

Scale 1:500,000 at 46° North Latitude

Mercator Projection

Bathymetric contour interval 100 meters

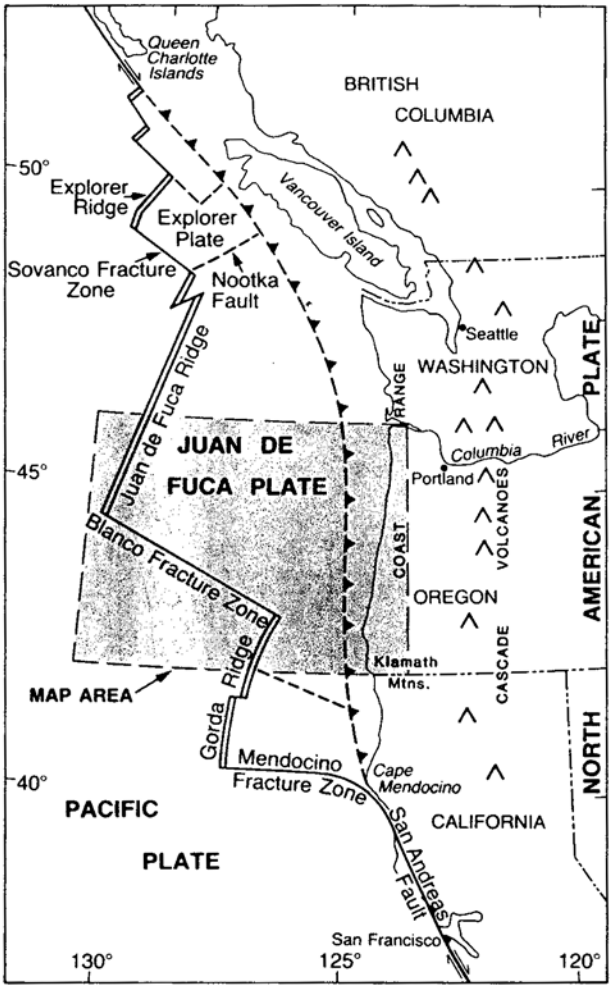
Onshore contour interval 500 meters

The Geology of the Ocean Floor Off Oregon and the Adjacent Continental Margin

By Carolyn P. Peterson and LaVerne D. Kulm, Oregon State University, and
Jerry J. Gray, Oregon Department of Geology and Mineral Industries

Introduction

The geologic map was constructed from a large number of published sources, including the papers, maps, charts, and side-scan sonar mosaics cited in the *Geologic Bibliography and Index Maps of the Ocean Floor Off Oregon and the Adjacent Continental Margin* (Peterson and others, 1985), which is a companion publication to this one; the atlas of the *Western North American Continental Margin and Adjacent Ocean Floor Off Oregon and Washington* (Kulm and others, 1984b); and *Atlas of the Exclusive Economic Zone, Western Conterminous United States* (EEZ Scan 84 Scientific Staff, 1986). The major sources of published and unpublished data used in this map are identified in the sections entitled "Acknowledgments" and "References." A substantial amount of data resides in the College of Oceanography archives at Oregon State University (OSU) and in the Office of Pacific Marine Geology, U.S. Geological Survey (USGS), Menlo Park, California. The base map, which includes the offshore bathymetry and onshore topography, was modified from the map published by Connard and others (1984) for western Oregon and the adjacent seafloor. Although more accurate bathymetric maps have been made through SeaBeam swath mapping of portions of the continental slope and the spreading Gorda and Juan de Fuca Ridges, they have not yet been published for the Oregon region. Nevertheless, selected structural information and trends of tectonic features derived from unpublished SeaBeam data were incorporated into this geologic map. These include the major faults and pull-apart basins (e.g., Cascadia Depression) of the Blanco Fracture Zone and the trends of axial zones of the spreading ridges (Embley and others, 1986). Discrepancies between the two bathymetric data sets have been resolved to achieve a best fit of these data.

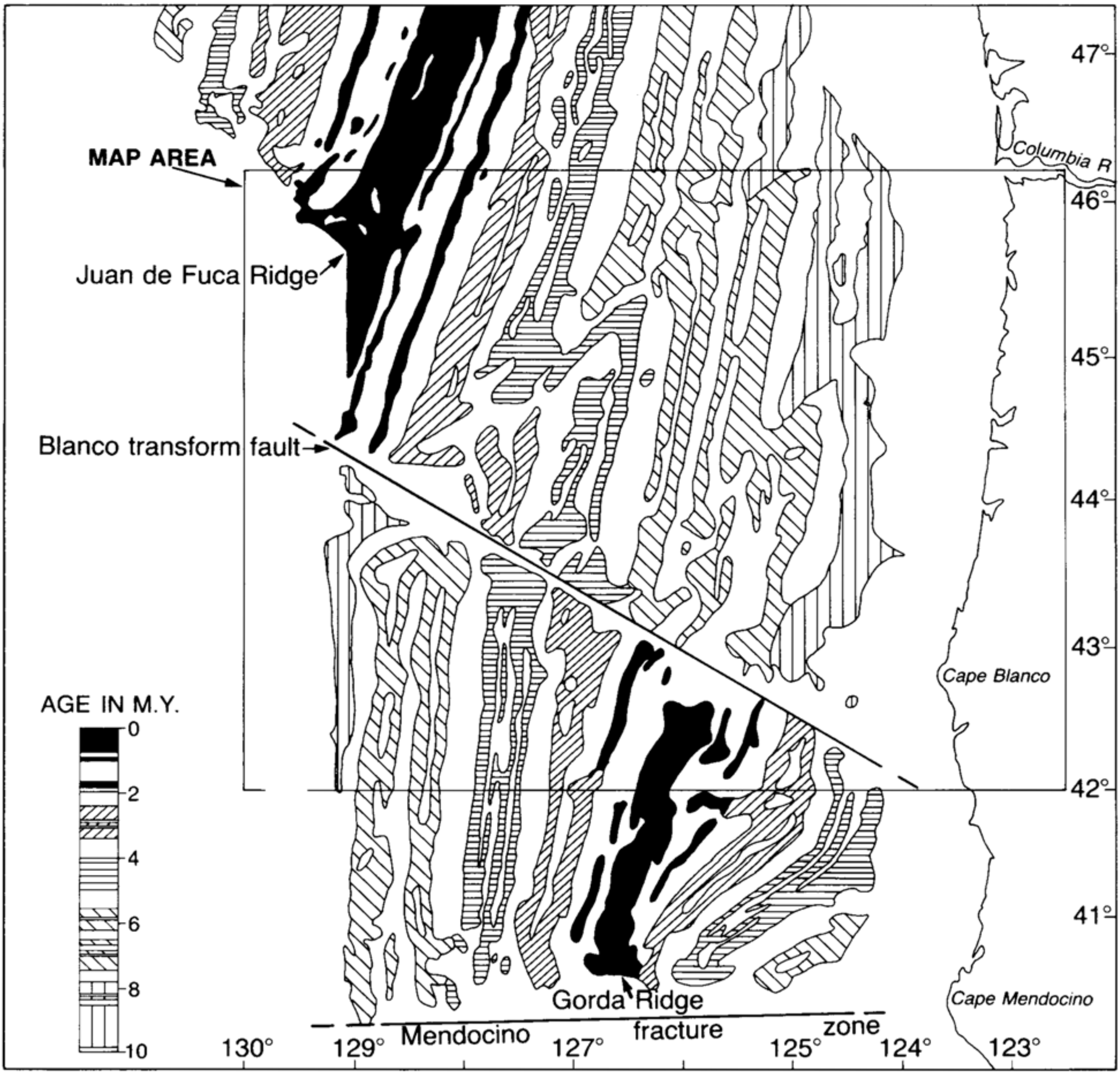


Location map of the Juan de Fuca plate and the Oregon continental margin (from Riddihough, 1984).

Offshore Geology

Gravity, piston, and dart core samples (sample locations shown on the map as open circles), dredge samples (open triangles), data from Deep Sea Drilling Project (DSDP) Site 174, seismic reflection records, and observations made from the submersible *Alvin* were used to define the abyssal plain stratigraphic units and boundaries. The geologic units of the abyssal regions are (1) basalt (**QTv**) comprising the young spreading ridges and seamounts and underlying the Cascadia Basin; (2) manganese-enriched volcanic silts of the East and West Blanco Depressions (**Qvs**); (3) abyssal plain sand-silt turbidites and hemipelagic mudstones (**Qts**); (4) sand turbidites of the Astoria Fan (**Qa**), which are prograding seaward over the abyssal plain deposits (**QTpt** on the cross section); and (5) relatively thin hemipelagic (**Qh**) and pelagic (**Qp**) deposits draped over the volcanic topography (seamounts) of the Cascadia Basin and portions of the mountainous spreading ridges. These volcanic terrains are covered by either hemipelagic deposits (i.e., **Qh** on the Gorda Ridge) or pelagic deposits (i.e., **Qp** on the Juan de Fuca Ridge) shortly after their formation, depending upon their proximity to the continent. Hemipelagic deposits consist largely of terrigenous silts and clays. With increasing distance from the continent, the hemipelagic deposits grade into pelagic sediments comprised mainly of foraminiferal and radiolarian ooze with minor clay (Duncan, 1968; Phipps, 1974). When the warm buoyant oceanic crust cools and subsides on either side of the spreading centers, these hemipelagic/pelagic deposits are covered by terrigenous turbidites. Core lithologies, depositional patterns, and concepts of turbidity current deposition for the Cascadia Basin/Tufts Abyssal Plain, Cascadia Channel, and Blanco Fracture Zone, as described by Duncan (1968), Griggs and Kulm (1970), and Ibach (1981), respectively, were used to define and extrapolate the boundaries of the silt and sand turbidites of late Pleistocene age (**Qts**) on the geologic map. Terrigenous turbidites may directly overlie volcanic rocks where the tectonic setting allows turbidity currents access to the newly formed oceanic crust of the pull-apart basins (i.e., unit **Qts** in the Cascadia Depression; Embley and others, 1986). The sandy turbidites (**Qc**) of the Cascadia Channel indicate that the channel has served as a conduit for turbidity currents reaching the Blanco Fracture Zone and Tufts Abyssal Plain (Griggs and Kulm, 1970, 1973; Duncan and Kulm, 1970). Portions of the volcanic terrain of the Blanco Ridge were uplifted during late Pleistocene time, isolating terrigenous turbidites on these topographic highs (Duncan, 1968; Duncan and Kulm, 1970; Ibach, 1981).

A variety of geological and geophysical data were used to define the stratigraphic units and the structures of the continental shelf and slope. Data from six oil and gas exploration drill holes (Snavely and others, 1982; Kulm and others, 1984a; Peterson and others, 1984), DSDP Sites 175 and 176 (Kulm and others, 1973b,c), and approximately 250 dredge and core samples, concentrated largely in the vicinity of submarine banks (Maloney, 1965; Carlson, 1968; Fowler and others, 1971; Kulm and Fowler, 1974; Kulm and others, 1984a) were used to define the stratigraphic units on the continental shelf. Single-channel seismic-reflection records (e.g., Mackay, 1969; Muehlberg, 1971; Spigai, 1971; Kulm and Fowler, 1974; Clarke and others, 1985) and multichannel records (Snavely and others, 1977, 1980, 1985, 1986; Mann and Snavely, 1984) were used to extrapolate the geologic units to areas of the shelf where no samples were available and to delineate the major structures. A major right-lateral strike-slip fault (Fulmar Fault) is inferred from oil and gas exploration drill holes and seismic and magnetic data on the continental shelf. The major movement on the Fulmar Fault occurred prior to the deposition of strata of late Eocene to Oligocene age (**Toe**) that overlap



Magnetic anomaly map (modified from Silver, 1971).

the fault (Snavely and others, 1977, 1980, 1982; Snavely, 1986). The fold pattern in the sediments of the continental shelf (**QTpm**) and slope (**QTac, Tac**) trends in a north-south direction, whereas structures in the older strata (**Tpm**) have a more northwesterly trend. Interconnecting shallow synclines occurring between the shore and the submarine banks near the outer edge of the shelf contain largely siltstones and sandstones of Pleistocene to late Miocene age (**QTpm**). Some of the most striking folded and faulted areas occur beneath the submarine banks (e.g., Nehalem, Heceta, and Coquille Banks), which have been uplifted as much as 1 kilometer (km) since late Miocene time (Kulm and Fowler, 1974). The most structurally complex area of the inner shelf lies between Coos Bay and the Rogue River. Pre-Quaternary sediments (**Tmc**) tentatively correlated with onshore sediments (**Te**; Fowler and others, 1971) crop out on the seafloor or are covered by a thin veneer of Quaternary sediment. Pre-Tertiary strata (**Js**) form an irregular acoustic basement that shallows near the shore in the vicinity of Cape Blanco and in isolated outcrops southward to the California border.

Lithologic and tectonic data derived from DSDP Site 175 (Kulm and others, 1973b), the structural and stratigraphic data from a 1984 study using the submersible *Alvin* (Kulm and others, 1986), deep-towed camera surveys, and dated punch cores and dredges were used to identify the Holocene to Pliocene portion of the accretionary complex (i.e., unit **QTac**, accreted strata comprised largely of a seaward-verging thrust sequence of mudstones and sandstones), which is exposed in canyons and slump scars on the lower and middle continental slope. On the geologic map, the accretionary complex has been divided into a younger unit of Holocene to Pliocene age (**QTac**) and an older unit of Miocene to late Oligocene age (**Tac**). Older rocks of the accretionary complex of Miocene to late Oligocene age (unit **Tac** on cross section) are most likely situated landward of unit **QTac** on the upper continental slope (Snavely and others, 1980). Overlying Holocene to Pleistocene basinal deposits (**QTab**) are recognized in Site 175 and in seismic-reflection records made over the continental slope. In the areas of the continental slope that were not surveyed or sampled, multichannel seismic-reflection records were used to define the accretionary complex; these relatively thin basin deposits are clearly outlined in seismic-reflection records. The older and more landward subsurface portions of the inferred accretionary complex (**Tac**) are unsampled. The boundary between the accreted strata (**Tac**) of Miocene to late Oligocene age and the Eocene rocks occurring within units **Toe, Tsv,** and **Tr** on the cross section, as shown on the geologic map, was inferred from the noticeable seaward disruption of strata shown in multichannel seismic records made across the outermost continental shelf.

Observations from the submersible *Alvin* and *Alvin*-towed seismic-reflection records made off central Oregon show that the most recent thrust boundary between the subducting Juan de Fuca Plate and the North American Plate (lowermost continental slope) is a deformation front characterized by a series of low-lying benches consisting generally of seaward-verging strata (Kulm and others, 1986). While landward-verging strata are observed in some submersible-towed and surface-towed multichannel seismic records, they appear to be confined to the shallower portions of the overall underthrusting sedimentary sequences.

The generalized geologic cross section (A-A′) was derived and simplified from several data sources: abyssal plain from Griggs and Kulm (1973), Kulm and others (1973a), and OSU data files; continental slope from Kulm and others (1973a), von Huene and Kulm (1973), Snavely and others (1980, 1986), and Kulm and others (1986); continental shelf from Snavely and others (1980); and western Oregon from Snavely and others (1976b, 1980) and Johnson and others (1984).

Onshore Geology

The geologic map of western Oregon is simplified from several published sources. Compilation of published and unpublished maps by Wells and others (1983), Johnson and others (1984), and Niem and Niem (1985) are the primary sources of the map north of 43° N. latitude to the Columbia River. County geologic maps (Ramp, 1972; Baldwin and others, 1973; Ramp and others, 1977; Ramp and Peterson, 1979) were used for the compilation south of 43° N. latitude to the Oregon-California border. Tertiary map units are shown on the geologic map as they are given in the source maps. The Mesozoic rock units have been simplified and combined into five units: sedimentary, volcanic, igneous intrusive, ultramafic, and metamorphic rocks.

Acknowledgments

Several individuals kindly contributed diagrams and data of both unpublished and published information for the compilation of the geologic map. The locations of the axes of the spreading Gorda and Juan de Fuca Ridges and the structure of the pull-apart basins of the Blanco Fracture Zone were provided by Robert Embley and Steven Hammond, National Oceanic and Atmospheric Administration (NOAA), from the SeaBeam bathymetry of these features. Sam Clarke and Parke D. Snavely, Jr., USGS, contributed information and valuable discussion on the structure and stratigraphy of the continental shelf and slope off Oregon. Discussions with Alan R. Niem and Wendy A. Niem, OSU; Parke D. Snavely, Jr., USGS; and John D. Beaulieu and Beverly F. Vogt, Oregon Department of Geology and Mineral Industries (DOGAMI), about the onshore structure and stratigraphy were very helpful in compiling the map. The descriptions and locations of recently acquired dredge samples from the Gorda Ridge were kindly supplied by Martin Fisk, OSU. Elizabeth Asbury, OSU, produced the computer output of the cores and dredges displayed on the map. Margaret Stribling, OSU, assisted in compiling both onshore and offshore geology. The authors gratefully acknowledge review by Wendy A. Niem and Alan R. Niem, OSU; Parke D. Snavely, Jr., and Sam Clarke, USGS; Robert Embley, NOAA; and Donald A. Hull and Len Ramp, DOGAMI. The authors bear the ultimate responsibility for this map. This study was funded by the U.S. Department of the Interior-Minerals Management Service through Cooperative Agreement 14-12-0001-30223.

REFERENCES

Armentrout, J.M., 1981, Correlation and ages of Cenozoic chronostratigraphic units in Oregon and Washington, *in* Armentrout, J.M., ed., Pacific Northwest Cenozoic biostratigraphy: Boulder, Colo., Geological Society of America Special Paper 184, p. 137-148.

Baldwin, E.M., 1974, Eocene stratigraphy of southwestern Oregon: Oregon Department of Geology and Mineral Industries Bulletin 83, 40 p.

Baldwin, E.M., Beaulieu, J.D., Ramp, L., Gray, J.J., Newton, V.C., Jr., and Mason, R.S., 1973, Geology and mineral resources of Coos County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 80, 82 p., scale 1:62,500.

Carlson, P.R., 1968, Marine geology of the Astoria submarine canyon: Corvallis, Oreg., Oregon State University doctoral dissertation, 273 p.

Clague, D., Friesen, W., Quinterno, P., Morgenson, L., Holmes, M., Morton, J., Bouse, R., and Davis, A., 1984, Preliminary geological, geophysical, and biological data from the Gorda Ridge: U.S. Geological Survey Open-File Report 84-364, 49 p.

Clarke, S.H., Field, M.E., and Hirozawa, C.A., 1985, Reconnaissance geology and geologic hazards of the offshore Coos Bay Basin, Oregon: U.S. Geological Survey Bulletin 1645, 41 p.

Connard, G., Couch, R., Pitts, G.S., and Troseth, S., 1984, Bathymetry and topography, *in* Kulm, L.D., and others, eds., Western North American continental margin and adjacent ocean floor off Oregon and Washington: Atlas 1, Ocean Margin Drilling Program, Regional Atlas Series, Woods Hole, Mass., Marine Science International, Sheet 1.

Duncan, J.R., Jr., 1968, Late Pleistocene and postglacial sedimentation and stratigraphy of deep-sea environments off Oregon: Corvallis, Oreg., Oregon State University doctoral dissertation, 222 p.

Duncan, J.R., Jr., and Kulm, L.D., 1970, Mineralogy, provenance, and dispersal history of late Quaternary deep-sea sands in Cascadia Basin and Blanco Fracture Zone off Oregon: Journal of Sedimentary Petrology, v. 40, no. 3, p. 874-887.

EEZ Scan 84 Scientific Staff, 1986, Atlas of the Exclusive Economic Zone, Western Conterminous United States: U.S. Geological Survey Miscellaneous Investigations Series I-1792, 152 p.

Embley, R.W., Kulm, L.D., Massoth, G., Abbott, D., and Holmes, M., 1986, Morphology, structure, and resource potential of the Blanco transform fault, *in* Scholl, D.W., Grantz, A., and Vedder, J.G., eds., Geology and resource potential of the continental margin of western North America and adjacent ocean basins—Beaufort Sea to Baja California: American Association of Petroleum Geologists Memoir Series, in press.

Fowler, G.A., Orr, W.N., and Kulm, L.D., 1971, An upper Miocene diatomaceous rock unit on the Oregon continental shelf: Journal of Geology, v. 79, no. 5, p. 603-608.

Griggs, G.B., and Kulm, L.D., 1970, Sedimentation in Cascadia deep-sea channel: Geological Society of America Bulletin, v. 81, no. 5, p. 1361-1384.

———1973, Origin and development of Cascadia deep-sea channel: Journal of Geophysical Research, v. 78B, p. 6325-6339.

Griggs, G.B., Kulm, L.D., Waters, A.C., and Fowler, G.A., 1970, Deep-sea gravel from Cascadia Channel: Journal of Geology, v. 78, no. 5, p. 611-619.

Horn, D.R., Ewing, M., Delach, M.N., and Horn, B.M., 1971, Turbidites of the northeast Pacific: Sedimentology, v. 16, p. 55-69.

Ibach, D.H., 1981, The structure and tectonics of the Blanco Fracture Zone: Corvallis, Oreg., Oregon State University master's thesis, 60 p.

Johnson, S.Y., Niem, W.A., Niem, A.R., Brandon, M.T., and Stewart, R.J., 1984, Geology, western Oregon and Washington, *in* Kulm, L.D., and others, eds., Western North American continental margin and adjacent ocean floor off Oregon and Washington: Atlas 1, Ocean Margin Drilling Program, Regional Atlas Series, Woods Hole, Mass., Marine Science International, Sheet 14, scale 1:900,000.

Koski, R.A., Clague, D.A., and Oudin, E., 1984, Mineralogy and chemistry of massive sulfide deposits from the Juan de Fuca Ridge: Geological Society of America Bulletin, v. 95, no. 8, p. 930-945.

Koski, R.A., Goodfellow, R., and Bouse, R.M., 1982, Preliminary description of massive sulfide samples from the southern Juan de Fuca Ridge: U.S. Geological Survey Open-File Report 82-200B, 21 p.

Kulm, L.D., and Fowler, G.A., 1974, Oregon continental margin structure and stratigraphy: A test of the imbricate thrust model, *in* Burk, C.A., and Drake, C.L., eds., The geology of continental margins: New York, Springer-Verlag, p. 261-283.

Kulm, L.D., Loubere, P.W., and Peper, J.S., 1984a, Geology of continental margin and Cascadia Basin, *in* Kulm, L.D., and others, eds., Western North American continental margin and adjacent ocean floor off Oregon and Washington: Atlas 1, Ocean Margin Drilling Program, Regional Atlas Series, Woods Hole, Mass., Marine Science International, Sheet 29, scale 1:2,000,000.

Kulm, L.D., and Scheidegger, K.F., 1979, Quaternary sedimentation on the tectonically active Oregon continental slope, *in* Doyle, L.J., and Pilkey, O.H., eds., Geology of the continental slopes: Society of Economic Paleontologists and Mineralogists Special Publication 27, p. 247-263.

Kulm, L.D., Suess, E., Moore, J.C., Carson, B., Lewis, B.T., Ritger, S.D., Kadko, D.C., Thornburg, T.M., Embley, R.W., Rugh, W.D., Massoth, G.J., Lanseth, M.G., Cochrane, G.R., and Scamman, R.L., 1986, Oregon subduction zone: Venting, fauna, and carbonates: Science, v. 231, p. 561-573.

Kulm, L.D., and others, 1973a, Site 174, *in* Kulm, L.D., von Huene, R., and others, eds., Initial reports of the Deep Sea Drilling Project, v. 18: Washington, D.C., U.S. Government Printing Office, p. 97-168.

———1973b, Site 175, *in* Kulm, L.D., von Huene, R., and others, eds., Initial reports of the Deep Sea Drilling Project, v. 18: Washington, D.C., U.S. Government Printing Office, p. 169-212.

———1973c, Site 176, *in* Kulm, L.D., von Huene, R., and others, eds., Initial reports of the Deep Sea Drilling Project, v. 18: Washington, D.C., U.S. Government Printing Office, p. 213-232.

———1984b, Western North American continental margin and adjacent ocean floor off Oregon and Washington: Atlas 1, Ocean Margin Drilling Program, Regional Atlas Series, Woods Hole, Mass., Marine Science International, 32 sheets.

Lichtman, G.S., Normark, W.R., Delaney, J.R., Morton, J.L., Johnson, H.P., and Karsten, J.L., 1983, Photogeology and evolution of the Juan de Fuca Ridge: U.S. Geological Survey Open-File Report 83-464, 15 p., 1 sheet.

Mackay, A.J., 1969, Continuous seismic profiling investigation of the southern Oregon continental shelf between Cape Blanco and Coos Bay: Corvallis, Oreg., Oregon State University master's thesis, 118 p. [Also U.S. Geological Survey Open-File Report 69-156].

Maloney, N.J., 1965, Geology of the continental terrace off the central coast of Oregon: Corvallis, Oreg., Oregon State University doctoral dissertation, 233 p.

Mann, D.M., and Snavely, P.D., Jr., 1984, Multichannel seismic-reflection profiles collected in 1978 off of the Washington/Oregon coast: U.S. Geological Survey Open-File Report 84-5, 3 p., 1 sheet.

Muehlberg, G.E., 1971, Structure and stratigraphy of Tertiary and Quaternary strata, Heceta Bank, central Oregon shelf: Corvallis, Oreg., Oregon State University master's thesis, 88 p.

Nelson, C.H., 1968, Marine geology of the Astoria deep-sea fan: Corvallis, Oreg., Oregon State University doctoral dissertation, 287 p.

Niem, A.R., and Niem, W.A., 1985, Oil and gas investigation of the Astoria basin, Clatsop and northernmost Tillamook Counties, northwest Oregon: Oregon Department of Geology and Mineral Industries Oil and Gas Investigation 14, 8 p., 2 pl. incl. map, scale 1:100,000.

Palmer, A.R., 1983, The Decade of North American Geology 1983 geologic time scale: Geology, v. 11, no. 9, p. 503-504.

Peterson, C.P., Kulm, L.D., and Gray, J.J., 1985, Geologic bibliography and index maps of the ocean floor off Oregon and the adjacent continental margin: Oregon Department of Geology and Mineral Industries Geologic Map Series Map GMS-39.

Peterson, C.P., Loubere, P.W., and Kulm, L.D., 1984, Stratigraphy of continental shelf and coastal region, *in* Kulm, L.D., and others, eds., Western North American continental margin and adjacent ocean floor off Oregon and Washington: Atlas 1, Ocean Margin Drilling Program, Regional Atlas Series, Woods Hole, Mass., Marine Science International, Sheet 30.

Phipps, J.B., 1974, Sediments and tectonics of the Gorda-Juan de Fuca Plate: Corvallis, Oreg., Oregon State University doctoral dissertation, 118 p.

Ramp, L., 1972, Geology and mineral resources of Douglas County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 75, 106 p.

Ramp, L., and Peterson, N.V., 1979, Geology and mineral resources of Josephine County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 100, 45 p.

Ramp, L., Schlicker, H.G., and Gray, J.J., 1977, Geology, mineral resources, and rock material of Curry County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 93, 79 p.

Riddihough, R., 1984, Recent movements of the Juan de Fuca Plate System: Journal of Geophysical Research, v. 89, p. 6980-6994.

Selk, B.W., 1978, The manganese-enriched sediments of the Blanco Trough: Evidence for hydrothermal activity in a fracture zone: Corvallis, Oreg., Oregon State University master's thesis, 214 p.

Silver, E.A., 1971, Small plate tectonics in the northeastern Pacific: Geological Society of America Bulletin, v. 82, no. 12, p. 3491-3496

Snavely, P.D., Jr., 1986, Tertiary geologic framework, neotectonics, and petroleum potential of the Oregon-Washington continental margin, *in* Scholl, D.W., Grantz, A., and Vedder, J.G., eds., Geology and resource potential of the continental margin of western North America and adjacent ocean basins—Beaufort Sea to Baja California: American Association of Petroleum Geologists Memoir Series, in press.

Snavely, P.D., Jr., Miller, J., von Huene, R., and Mann, D., 1986, Central Oregon margin, Line W076-5, *in* von Huene, R., ed., Seismic images of modern convergent margin tectonic structure: American Association of Petroleum Geologists Memoir Series, in press.

Snavely, P.D., Jr., Pearl, J.E., and Lander, D.L., 1977, Interim report on petroleum resources potential and geologic hazards in the outer continental shelf—Oregon and Washington Tertiary Province: U.S. Geological Survey Open-File Report 77-282, 64 p.

Snavely, P.D., Jr., MacLeod, N.S., and Wagner, H.C., 1973, Miocene tholeiitic basalts of coastal Oregon and Washington and their relations to coeval basalts of the Columbia Plateau: Geological Society of America Bulletin, v. 84, no. 2, p. 387-424.

Snavely, P.D., Jr., MacLeod, N.S., Wagner, H.C., and Rau, W.W., 1976a, Geologic map of the Waldport and Tidewater quadrangles, Lincoln, Lane, and Benton Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Series Map I-866, scale 1:62,500.

———1976b, Geologic map of the Yaquina and Toledo quadrangles, Lincoln County, Oregon: U.S. Geological Survey Miscellaneous Investigations Series Map I-867, scale 1:62,500.

———1976c, Geologic map of the Cape Foulweather and Euchre Mountain quadrangles, Lincoln County, Oregon: U.S. Geological Survey Miscellaneous Investigations Series Map I-868, scale 1:62,500.

Snavely, P.D., Jr., Wagner, H.C., and Lander, D.L., 1980, Geologic cross section of the central Oregon continental margin: Geological Society of America Map and Chart Series MC-28J, 8 p., 1 sheet.

———1985, Land-sea geologic cross section of the southern Oregon continental margin: U.S. Geological Survey Miscellaneous Investigations Series Map I-1463, scale 1:125,000.

Snavely, P.D., Jr., Wagner, H.C., and Rau, W.W., 1982, Sections showing biostratigraphy and correlation of Tertiary rocks penetrated in wells drilled on the southern Oregon continental margin: U.S. Geological Survey Miscellaneous Field Studies Map MF-1482.

Spigai, J.J., 1971, Marine geology of the continental margin off southern Oregon: Corvallis, Oreg., Oregon State University doctoral dissertation, 229 p.

von Huene, R., and Kulm, L.D., 1973, Tectonic summary of Leg 18, *in* Kulm, L.D., von Huene, R., and others, eds., Initial reports of the Deep Sea Drilling Project, v. 18: Washington, D.C., U.S. Government Printing Office, p. 961-976.

Wells, R.E., Niem, A.R., MacLeod, N.S., Snavely, P.D., Jr., and Niem, W.A., 1983, Preliminary geologic map of the west half of the Vancouver (Wa.-Ore.) 1°x2° quadrangle, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-83-6, scale 1:250,000 [Also U.S. Geological Survey Open-File Report 83-591].