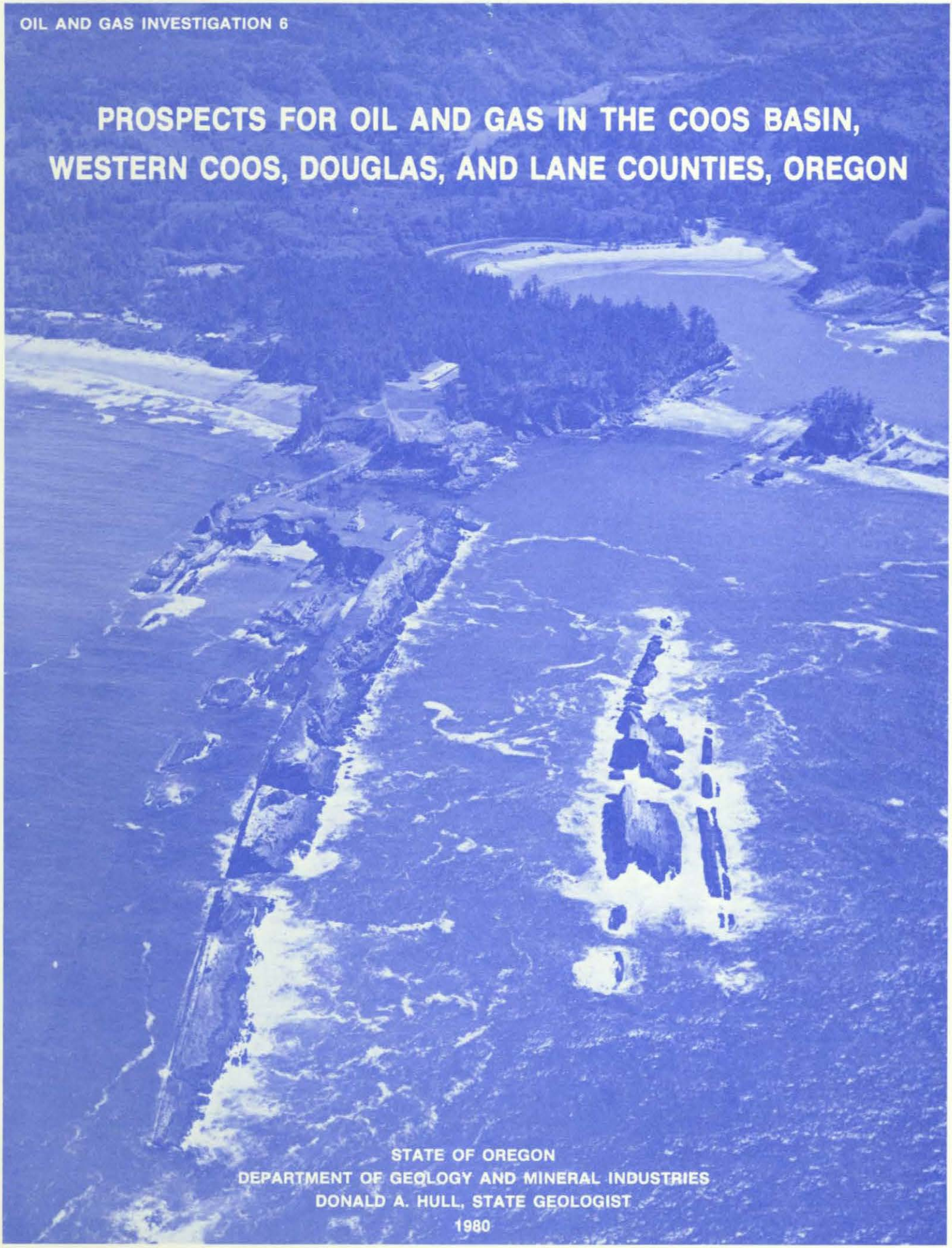
OIL AND GAS INVESTIGATION 6

PROSPECTS FOR OIL AND GAS IN THE COOS BASIN, WESTERN COOS, DOUGLAS, AND LANE COUNTIES, OREGON



STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST
1980

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1005 State Office Building, Portland, Oregon 97201

OIL AND GAS INVESTIGATION 6

PROSPECTS FOR OIL AND GAS IN THE COOS BASIN, WESTERN COOS, DOUGLAS, AND LANE COUNTIES, OREGON

by

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Sections on
Offshore Geology and Geophysics
by
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by
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Consulting Paleontologist

Conducted in conformance with ORS 516.030

1980

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Oil and Gas Investigation 6

Geology and Oil and Gas Prospects of the Coos Basin, Oregon

ERRATA AND SUPPLEMENTARY COMMENTS

Offshore Geology and Gravity Map of the Coos Basin, Oregon

(in envelope)

The legend should be corrected to read: "Pleistocene sediments: Age equivalent of Pleistocene terraces onshore (Qmt)."

Geologic Map of the northern Coos Basin Area, Oregon
and
Geologic Map of the southern Coos Basin Area, Oregon

(both in envelope)

Deposits mapped as Quaternary marine terraces (Qmt) in the northern area may actually be slightly consolidated or weathered late Eocene sediments.

Sacchi Beach beds and their age equivalent, the Lorane shale, are believed to be members of the upper Flournoy Formation (see text).

Some of the probable faults shown on the maps were interpreted from lineations seen on radar imagery.

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Geologic map of the northern Coos Basin area, Oregon
Geologic map of the southern Coos Basin area, Oregon
Offshore geology and gravity map of the Coos Basin, Oregon

GEOLOGY AND OIL AND GAS PROSPECTS OF THE COOS BASIN, OREGON

By Vernon C. Newton, Jr., Geologist/Petroleum Engineer,
Oregon Department of Geology and Mineral Industries

INTRODUCTION

PURPOSE AND SCOPE

The Coos Basin investigation was undertaken to evaluate the possibility of finding commercial amounts of oil and gas in the region. The study was extended to include the continental shelf because that area is believed to contain the best prospects in the State for hydrocarbon accumulations. Although mapping of geologic structures was the main thrust of field work, some basic mapping of sedimentary units was done in the northern part of the project area.

Sandstones appearing to have reservoir qualities were sampled for porosity and permeability tests. Petrography of these sandstones was done by R. O. Van Atta, Portland State University, to see if rock units could be identified by mineral characteristics. Samples of well cuttings and shale outcrops were tested for source rock characteristics to learn if maturation of organic material contained in geologic formations of the Coos Basin had reached a point where oil and gas could have been generated.

Daniel R. McKeel worked samples from five deep wells for micropaleontological determinations. Results of his studies have contributed a great deal to understanding the stratigraphy and structure of the Coos Basin and the adjacent continental shelf. His summaries of all the wells and the species list for a portion of the E. M. Warren Coos County 1-7 well are contained in this report. His other species lists are printed in the Oregon Department of Geology and Mineral Industries Open-File Report O-80-13, which is available from the Portland office of the Department.

Richard W. Couch, David E. Braman, G. Steven Pitts, and LaVerne D. Kulm provided geologic and geophysical data covering the continental shelf. Prior studies by the Geophysics Section of the Oregon State University School of Oceanography have provided a large amount of information on shelf geology. For this study, seismic records of the southwestern coastal area were processed for the first time by Couch's Geophysical Group to give a model of subsurface conditions offshore. These data were tied to gravity, magnetic, and deep well correlations both offshore and onshore.

Lithologic logs from eleven wells drilled in the study area have also been included in Open-File Report O-80-13, which may be obtained from the Portland office of the Oregon Department of Geology and Mineral Industries.

PRIOR GEOLOGIC STUDIES

The Coos Basin has been mapped with a fair amount of detail in past investigations. Geology of the area was first studied by Diller in 1899. A complete list of prior workers was included in the Oregon Department of Geology and Mineral Industries Bulletin 80 (Baldwin and others, 1973) and has been made part of the bibliography of this report, since Bulletin 80 is now out of print.

For this study, mapping in the Coos Bay area was based on work done by Allen and Baldwin (1944) and on revisions to earlier mapping of the Coos Basin by Baldwin (1966). The geologic maps provided with this study are modified from those prepared by Baldwin and Beaulieu (1973). Information from Beaulieu and Hughes (1975) was also incorporated into this report.

ACKNOWLEDGMENTS

In addition to the financial support and information obtained from the contributors and the above authors, we wish to give credit to Paul Tybor and Joseph Haykus of GeoChem Laboratories, Houston, Texas, for analyses related to source rock potential, and to Joseph F. Riccio, Oregon Department of Geology and Mineral Industries, for his lineation interpretation of radar imagery of southwestern Oregon. We are also very grateful to Ewart M. Baldwin for advice on stratigraphic relationships and to John D. Beaulieu for assistance in organizing this report.

Collection of much of the contained information would not have been possible without the cooperation of AMOCO Production Company, Union Oil Company, and Phillips Petroleum Company. Northwest Natural Gas Company assisted the study by running analyses of gas samples; the State Department of Environmental Quality contributed analyses of formation water samples.

The authors are very grateful for editing, revision, and final preparation of this study by Beverly Vogt, editor; Klaus Neuendorf, editor-librarian; and Loris Killian, Barbara Jacob, and Ruth Pavlat, typists, all of the Oregon Department of Geology and Mineral Industries. We are also indebted to Charles Schumacher and Paul Staub, Department cartographers, for preparation of maps and illustrations.

GEOGRAPHY

The area covered in the Coos Basin study (Figure 1) is contained in the northern portion of the U.S. Geological Survey 1:250,000 series (formerly AMS) map of Coos Bay. The onshore portion of the study area is bounded by latitudes 43° and 44° N. and longitudes 124° and 124°30′ W. The offshore area extends between latitudes 42°45′ and 44° N. and longitudes 124° and 125° W. The Coos Basin mapping covers an area of approximately 1,380 km^2 (530 mi^2).

The basin lies within three geomorphic divisions: a narrow coastal plain, the southwestern portion of the Coast Range, and the northern margin of the Klamath Mountains. The Oregon Coast Range and coastal plain consist of Tertiary marine sedimentary rocks for the most part, and the Klamath Mountains are made up of a complex of Mesozoic rocks.

The region is characterized by low, rugged hills in the western portion and higher mountainous areas to the east and south. River and creek valleys are narrow and steep sided, with narrow ridges between many of them. The drainage pattern is a combination of trellis and dendritic systems. The trellis shape is found where structure controls stream channels, mostly in the southern half of the area.

Four main rivers cross the region, the Siuslaw and Umpqua Rivers in the north half and the Coquille and Coos Rivers in the south. At one time, the course of the Coquille River probably ran north along a major lineation which aligns with South Slough, but recent upwarping changed the direction of the lower reach of the river to its present westward direction.

The coastal margin is a narrow, dune-covered strip bordering a coastal terrace. Many fresh-water lakes occur along the coast in drowned stream channels and downwarped basins. Barrier bars have formed across the mouths of all the major rivers along the coast. The present configuration of the sea coast is believed to be a result of submergence that has occurred since the end of continental glaciation in late Pleistocene time. Wave-cut terraces can be seen along the coast at elevations several hundred feet above present sea level. The presence of both submergent and emergent features in the region relates a history of local crustal warping and later inundation of coastal low areas when continental glaciers melted.

The southwestern coastal area is heavily vegetated because of high rainfall. Annual rainfall in southwestern Oregon varies between 150 and 250 cm (60 and 100 in.), and the temperature is moderate, with the annual mean at approximately 10°C (50°F). The hills and mountains are wooded with native fir, alder, oak, and myrtle. The region is sparsely populated, with no more than 60,000 persons in the entire area. With a combined population of 16,000, the twin cities of Coos Bay—North Bend are the largest communities in southwest Oregon, while Florence, Reedsport, Coquille, Bandon, and Myrtle Point are smaller cities.

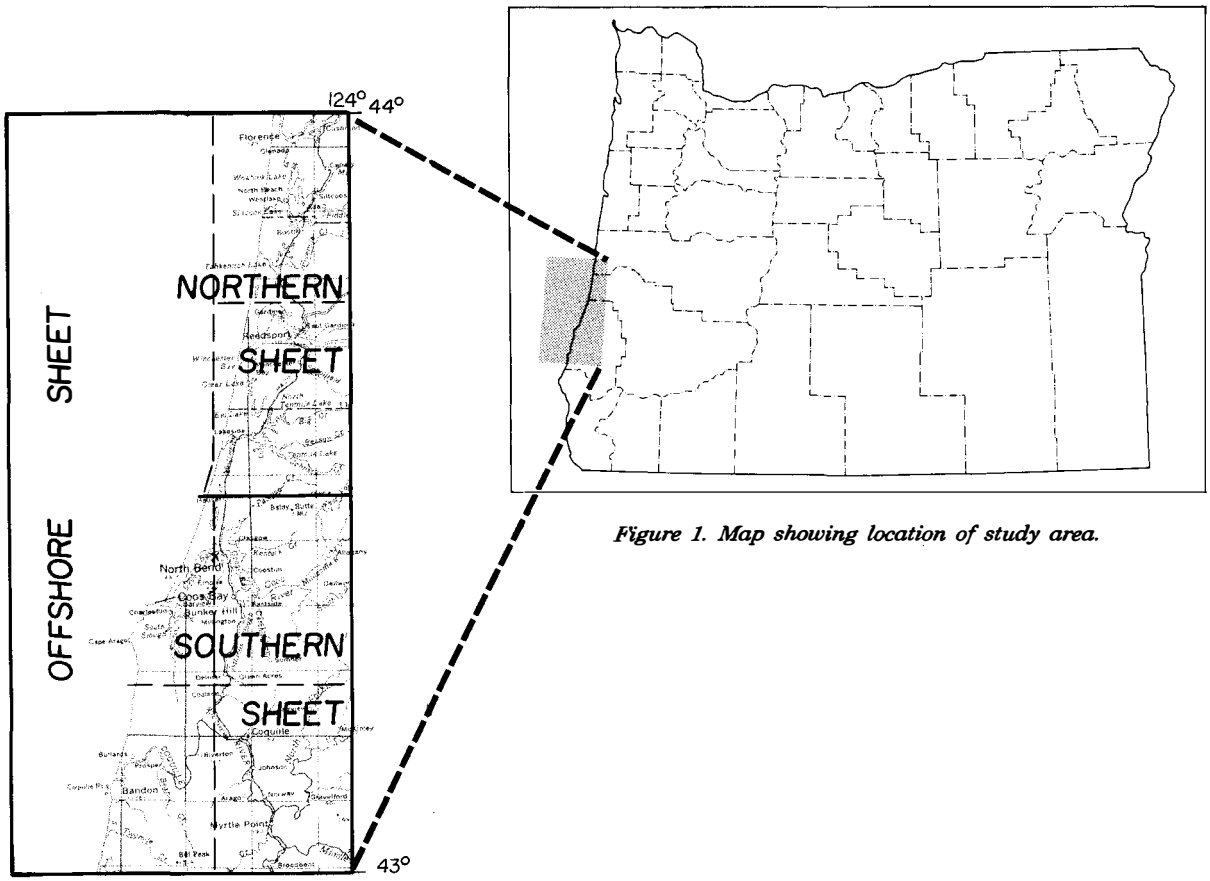


Figure 1. Map showing location of study area.

TECTONICS AND GEOLOGIC HISTORY

The model of the tectonic evolution of southwestern Oregon described here in terms of plate tectonics and sea-floor spreading is based upon current studies of the geology of the Klamath Mountains and the continental shelf.

The plate tectonic model supposes that the earth is covered by several plates all moving relative to each other and that the heavier oceanic basaltic plates underthrust plates containing lighter continental rocks in those places where the two types of plates collide. As the continental plate overrides the oceanic plate, an ocean trench forms at the juncture of the two plates. Heat generated along the underthrust subduction zone causes melting of subducted material, releasing plumes of magma, some of which is extruded at the surface to form a volcanic mountain chain 90 to 150 km (60 to 90 mi) landward of the subduction zone (Dickinson and Seely, 1979). The lowland between the volcanic mountain chain and the subduction trench is known as a forearc basin.

The crustal plate model for western North America as described by Atwater (1970) and other workers is shown in Figures 2 and 11 (see Couch and Braman, this report). It is thought that originally only the Pacific and North American Plates existed in the northeastern part of the Pacific, but as sea-floor spreading progressed, the Pacific Plate became fragmented as it collided with the North American continent, and the Kula and Farallon subplates were formed. Later, the Farallon Plate was further fragmented into the present Explorer, Juan de Fuca, and Gorda Plates. A large portion of the original Farallon Plate is believed to have been subducted under what is now the Pacific Northwest. Atwater (1970) proposed that subduction continued along the plate boundaries south of

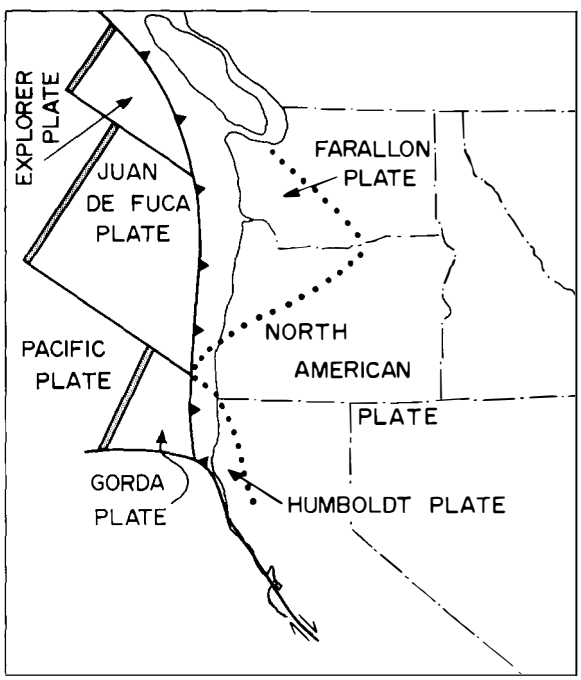


Figure 2. Map of western United States showing conjectural plate fragmentation and subducted portions of plates. (After Silver, 1971; McWilliams, 1978; and Couch, 1979)

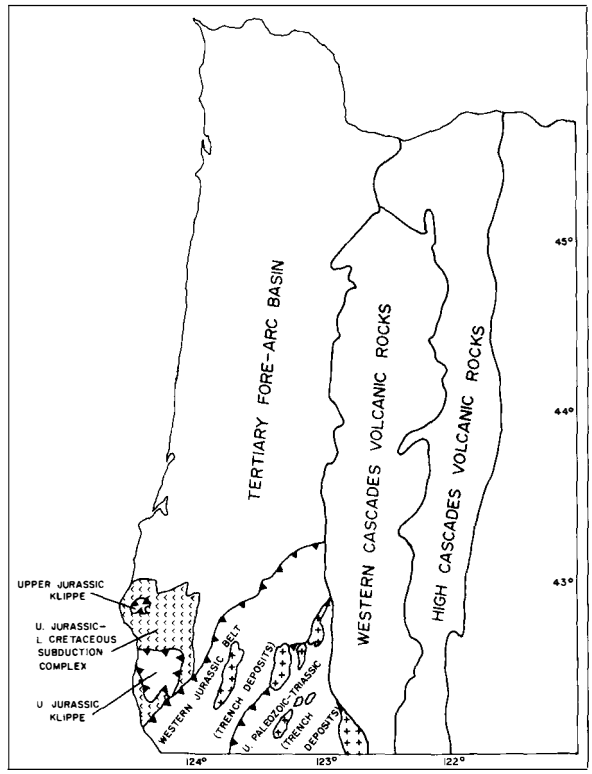


Figure 3. Map showing geologic subdivisions of western Oregon. Map also shows tectonic units of southwestern Oregon.

the Mendocino fracture zone along the California coast until approximately 30 million years ago, when the Farallon spreading center collided with the continent. At that time, motion at the plate boundaries was translated from compressional underthrusting to north-south shear along a nearly vertical San Andreas-type fault zone. This north-south shear motion has continued to the present time. Subduction continued without interruption off the coast north of the Mendocino fracture zone.

Before and during Paleozoic time, the western margin of the North American continent lay somewhere near the present location of the Rocky Mountains. Evidence for this is found in the Belt Series of Proterozoic metasediments within the Rocky Mountains. This series of rocks represents the remains of a continental terrace (Badham, 1978). The continent grew westward by accretion of island arcs and trench, shelf, and slope deposits.

Hotz and others (1977) postulated a northeast-trending subduction zone extending in Mesozoic time from northeastern Oregon to the present site of the Klamath Mountains in southwestern Oregon. Three belts of rocks were recognized in the Klamath Mountains by Irwin (1964) (Figure 3). The westernmost unit consists of a sheared mélange of Late Jurassic rocks representing a subduction complex, the middle group of rocks are Late Jurassic trench deposits, and the easternmost rock unit consists of Paleozoic to Triassic trench deposits (Coleman, 1971a; Spigai, 1971; Ramp and others, 1977).

In Early Cretaceous time, the sea inundated the Klamath Mountains region and the area to the north, depositing sediments of the Myrtle Group and correlative marine units (Baldwin and Beaulieu, 1973). Renewed pulses of underthrusting (subduction) and accompanying compressional tectonism continued through the middle of Cretaceous time in southwestern Oregon. Then, during latest Cretaceous and early Eocene times, uplift ceased, and the sea again encroached upon the northern and eastern portions of the Klamath province. At the close of early Eocene time, another pulse of intense compressional stress in the Klamath Mountains and the margin area to the north caused isoclinal folding and thrust faulting in rocks of the Roseburg Formation and older units.

Crustal stress decreased following early Eocene orogeny so that younger rock units in the Klamath Mountains and the adjoining area were much less deformed. Sediments deposited during early and middle Eocene time north of the Klamath Mountains were laid down on a shelf. Near the border of the Klamath highlands, the Flournoy, Lookingglass, and Tyee Formations were deposited as near-shore deposits in the southern area. To the north, they graded to deeper water turbidite deposits. Paleomagnetism of rocks of the central Oregon Coast Range suggests that the region containing Coast Range rocks was rotated during Cenozoic time, thus lending support to the idea that the continental margin could have been fragmented since Mesozoic time (Simpson and Cox, 1977; McWilliams, 1978; Beck and Burr, 1979).

With renewal of underthrusting, the Coos Basin synclinorium began forming near the close of Eocene time, and warping of basin rocks continued through Pliocene time. Elevated Pleistocene terraces along the southwest coast are evidence that uplift has probably continued up to the present time (Baldwin and Beaulieu, 1973; Dott and Bird, 1979). Following early Eocene subduction, the Coos Basin developed in a forearc location, with later sedimentary units being progressively less severely folded as underthrusting subsided. Coal measures in the Eocene units of the basin indicate that the region was heavily vegetated and that it was at least partially closed off from marine circulation at times, which restricted oxygen supply.

Unconformities ranging in age from late Eocene through Pleistocene were logged from cores obtained by drilling on the Oregon shelf (Von Huene and Kulm, 1973). Work by Byrne, Fowler, and Maloney (1966) indicates that as much as 1,000 m (3,000 ft) of uplift has occurred on the continental shelf off the coast of Oregon since Pliocene time. The horizontal addition to the continent since Miocene time is estimated to be between 5 and 50 km (3 and 30 mi).

Subduction is believed to be continuing off the Oregon-Washington coast at the present time. Silver (1969) gives evidence for continued subduction due to sea-floor spreading of the Gorda rise 160 km (100 mi) west of the present coastline. More recent studies involving heat-flow data, gravity anomalies, and continuing Cascade volcanism yield evidence of active subduction in the Pacific Northwest (Riddihough, 1977). Evidence of transverse segmentation of continental rocks in southwestern Oregon can be seen in the varied elevations of terraces of the same age along the coast. Geophysical data indicate that transverse faults developed in the descending plate during subduction. Cascade volcanoes appear to align with these cross breaks in the crust (Couch, 1977).

In summary, the tectonic model for southwestern Oregon in Mesozoic and Cenozoic times is one of continental growth by accretion of arc-trench systems related to subduction of oceanic crust and to uplift of the slope by compressional stress and/or isostasy.

GEOLOGIC STRUCTURE

ONSHORE COASTAL AREA

Rooth (1974) describes the South Slough (west of the city of Coos Bay) as a north-plunging syncline on the west margin of the Coos synclinorium, which is also north plunging.

Structure in the Coos Basin is genetically related to the Klamath Mountains, which border the basin on the south. Intensity of folding decreases northward away from the Klamath Mountains, with tight folding at the south end of the study area and gentler folds on the north. The Coaledo-Flournoy contact generally outlines the north- to northwesterly-trending Coos Basin. A large salient of the Flournoy Formation extends westward into this trend between Winchester and Reedsport on the coast, thereby suggesting a high or an arch. Two folds were mapped in this area. This large high corresponds to the exposure of Eocene-Oligocene rocks on the adjacent shelf and is reflected by gravity contours. Another large gravity high is located northeast of the city of North Bend (see *Offshore Geology and Gravity Map of the Coos Basin, Oregon,* folded, in envelope). This high is also indicated by outcrops of lower Eocene volcanic rocks.

Folds trend northeasterly in the southeast part of the mapped area, changing to a northerly direction farther to the north. The direction of the folds and the narrowing of the southern end of the basin suggest that either compressional stress continued for a longer period near Coos Bay or that the ocean trench was closer to shore there than farther to the north. The folds are believed to be caused by underthrusting of the oceanic plate; axial directions are probably roughly parallel to the plate boundary.

The dominant fault direction is northeast-southwest, and the secondary fault alignment is northwest-southeast. Faults in the coastal region are described as normal type by Rooth (1974). The compressional stress model for southwest Oregon suggests that reverse-type faults would probably occur and that thrust faults could be expected in the south half of the area under investigation. Only one major thrust has been described thus far in the study area, and that is along the west front of Sugarloaf Mountain, 24 km (15 mi) east of the town of Myrtle Point. Northeast-trending faults on the west sides of the Blue Ridge high and the basalt high near the community of Norway in the southeast part of the area may be reverse faults. There appears to be a large fault trending north-south offshore from Cape Arago with a vertical displacement of possibly more than 900 m (3,000 ft), as indicated by steeply dipping beds onshore, relatively flat-lying beds offshore, and tentative correlation of rock units across the fault (see cross section on *Offshore Geology and Gravity Map of the Coos Basin, Oregon,* folded, in envelope).

CONTINENTAL SHELF AND SLOPE

The geologic structure of the continental margin off the southern Oregon coast shows a general north-south trend with parallel to subparallel major fault and fold systems. The shelf and upper slope are characterized by folds, while the lower slope appears to owe its structural character to large-scale faulting. Faults are high-angle, nearly vertical, downthrown on the west, and believed to be mostly normal-type faults. Faults on the lower slope appear to be typical block faults. Maloney (1965) identified faults on the outer shelf as step-type faults. Step faults differ from block faults in that they are formed by compressive stress rather than tension (Spigai, 1971).

Some of the most intensely folded and faulted areas occur as structural highs near submarine banks at the outer edge of the shelf (see sections by Couch and Braman and by Couch and Pitts in this report). The principal shelf high covered in this report occurs at Heceta Bank near latitude 44° N., longitude 124°50′ W. The western limb of the Heceta high may be controlled by major faulting. Coquille Bank, a smaller feature than Heceta Bank, lies 32 km (20 mi) offshore in a southwesterly direction from the coastal town of Bandon and appears to be a doubly plunging anticline. A thick section of Pliocene and younger sediments forms its eastern limb (Kulm and Fowler, 1974).

A large, deep sedimentary basin is indicated on the gravity map southeast of Heceta Bank offshore from the town of Reedsport (see *Offshore Geology and Gravity Map of the Coos Basin, Oregon,* folded, in envelope). The sedimentary fill in this basin must be on the order of 6,000 m (20,000 ft) or more.

Kulm and Fowler (1974) propose an imbricate thrust-fault model for the structural regime on the Oregon shelf (see also Figure 4). They present a large amount of deep-sea core data which support this structural development model.

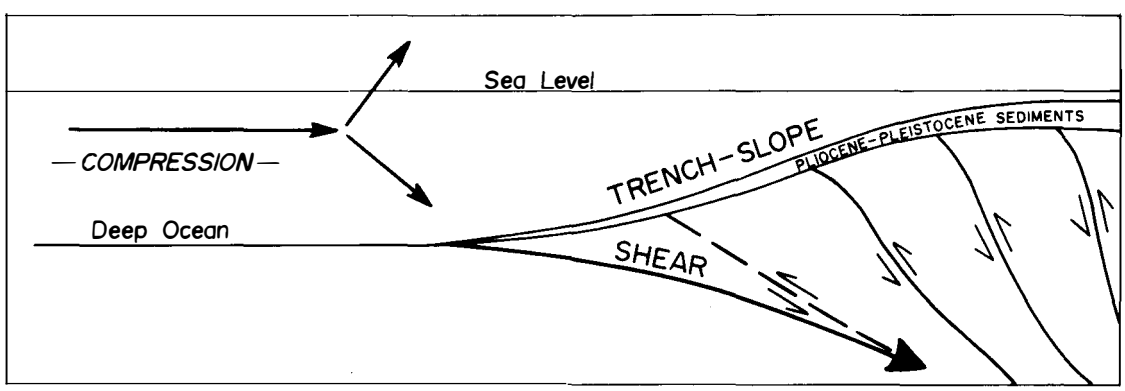
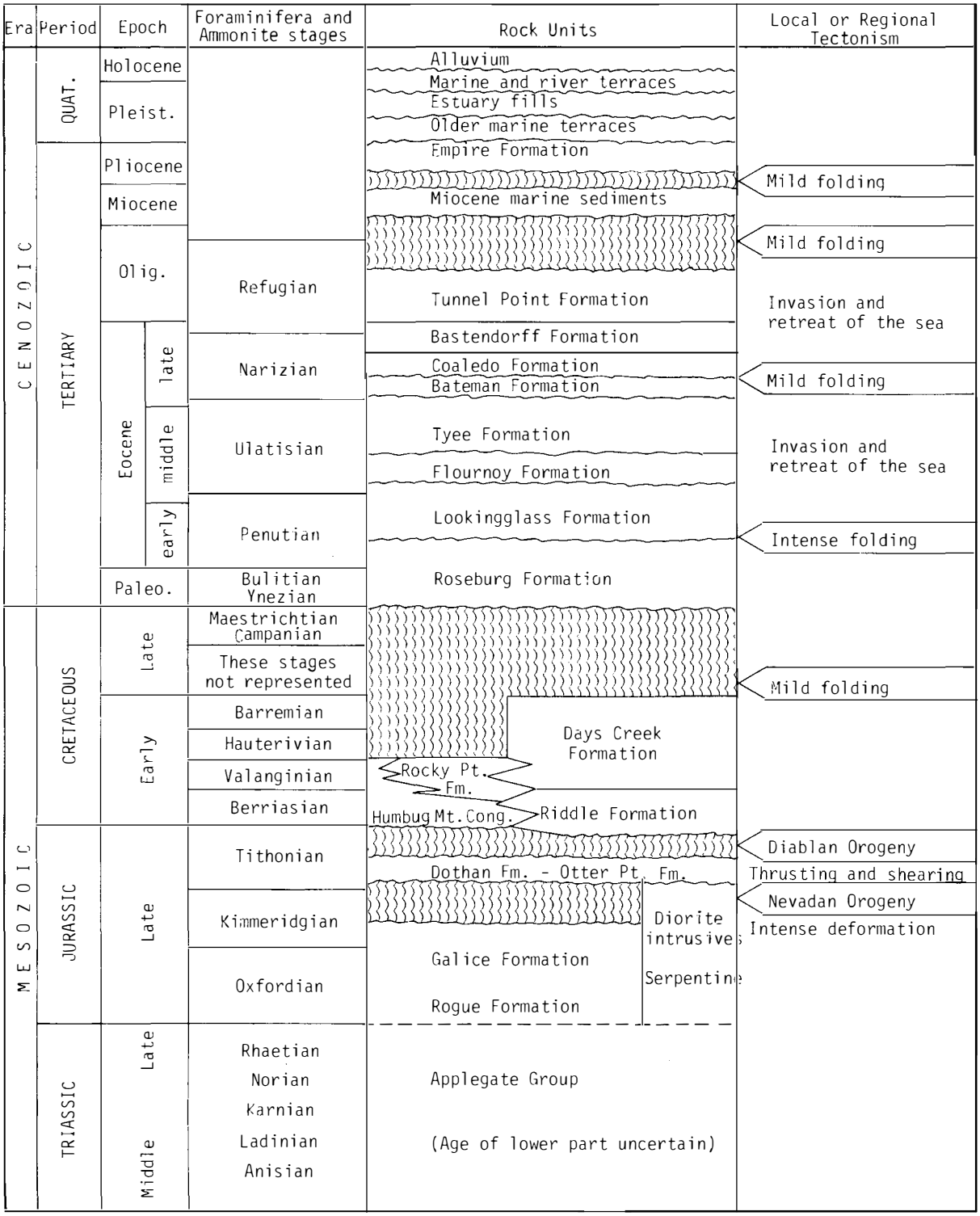


Figure 4. Imbricate thrust model, Oregon shelf. (After Seely, Vail, and Walton, 1974)



Reference: Baldwin, E.M., and Beaulieu, J.D., 1973.

Figure 5. Correlation chart of southwestern Oregon.

LITHOLOGY AND STRATIGRAPHY

PRE-TRIASSIC ROCKS

Because exposures of pre-Triassic-age rocks in the Klamath Mountains south of the Coos Basin are very limited, not much is known about conditions there during the Paleozoic era. Mica schists and chlorite schists of Permian-Pennsylvanian age (Baldwin, 1976) exposed in the upper Applegate River area southwest of Ashland along the northeastern margin of the Klamath Mountains are among the oldest rocks found in Oregon. These schists belong to a group of metamorphosed eugeosynclinal and plutonic rocks which range in age from Ordovician to Late Jurassic (Coleman and Lanphere, 1971). Parent rocks of the eugeosynclinal units are believed to have been marine graywacke and organic shale. Rocks of Permian-Pennsylvanian age are not exposed in the study area but are mentioned here because they may be similar to the basement complex that underlies the Coos Basin. Only rocks of Tertiary age or younger are exposed in the area covered by this report (Figures 5 and 6).

MESOZOIC ROCK UNITS

The Applegate Group consists of metasedimentary and metavolcanic rocks of Triassic age. Metasedimentary units consist of argillite, metagraywacke, chert, quartzite, and marble. This rock unit is included in Irwin's (1964) Paleozoic-Triassic western thrust belt of the Klamaths. The Applegate Group forms a unit that is very thick, probably on the order of a few miles.

The oldest pre-Late Jurassic rocks in southwestern Oregon are flows, agglomerates, and tuffs of the Rogue Formation. These volcanic rocks were metamorphosed to metavolcanic rocks, typically classified as greenstones due to the abundance of the mineral chlorite.

The Galice Formation consists of dark-gray to black, thinly bedded shale and siltstone with some sandstone interbeds. Altered andesite flows, breccias, and tuffs are associated with sedimentary rocks of the Galice Formation. Rocks of this formation were severely deformed during the Nevadan orogeny, and intrusions of diorite were numerous in the Klamath Mountains basin at this time. The Galice Formation is believed to be thrust over the Upper Jurassic Dothan Formation to the west in the Klamath Mountains. Maximum structural thickness of the Galice sediments is estimated to be 4,500 m (15,000 ft). The Galice and Rogue Formations probably constitute a portion of an ophiolite assemblage.

The Colebrooke Schist, believed to be correlative in age to the Galice Formation, was probably emplaced during eastward thrusting of the continental margin in Cretaceous time (Coleman and Lanphere, 1971).

The Dothan Formation of Late Jurassic age is believed to underlie the older Galice Formation in the western half of the Klamaths. The Dothan Formation consists of about 5,400 m (18,000 ft) of dark-gray, well-indurated, rhythmically bedded siltstone and graywacke. It also contains some volcanic rocks, chert, and conglomerate. To the west along the coast, the Otter Point Formation is considered to be a facies equivalent of the Dothan Formation but contains more volcanic rock. The Dothan Formation was probably deposited as a turbidite on the outer shelf, while the Otter Point beds are thought to have been laid down as arc and trench deposits (Coleman, 1971a; Baldwin, 1976).

Earliest Cretaceous to latest Jurassic time is represented in southwestern Oregon by the 300-m (1,000-ft)-thick Riddle Formation (Imlay and others, 1959) and its age equivalent, the Humbug Mountain Conglomerate, which is found on the western edge of the Klamath Mountains. The Humbug Mountain Conglomerate is correlative with the upper portion of the Riddle Formation. The Riddle Formation is composed of chert-pebble conglomerate, dark siltstones, and sandstone. Humbug Mountain beds range in texture from boulder conglomerate to sandstone.

The Days Creek and Rocky Point Formations of Early Cretaceous age overlie the Riddle Formation with slight unconformity southeast of the area mapped in this report. The Days Creek Formation consists of 600 m (2,000 ft) of alternating beds of lithic subgraywacke sandstone and siltstone (Imlay and others, 1959). The Rocky Point Formation is located near the coast in the Port Orford-Gold Beach area and consists of approximately 2,400 m (8,000 ft) of rhythmically bedded sandstone and dark-gray to black siltstone (Koch, 1966).

TERTIARY ROCK UNITS

Early Eocene and Paleocene rocks exposed in southwestern Oregon consist of marine sediments and submarine basalt. These rocks were first described by Diller (1898) and assigned by him to the Umpqua Formation. Characteristically, the rocks are composed of rhythmically bedded sandstone, siltstone, and some shale with basalts in the older portion. Baldwin (1965) subdivided the Umpqua Formation into the Umpqua Group with three unconformity-bounded units: the Roseburg, Lookingglass, and Flournoy Formations.

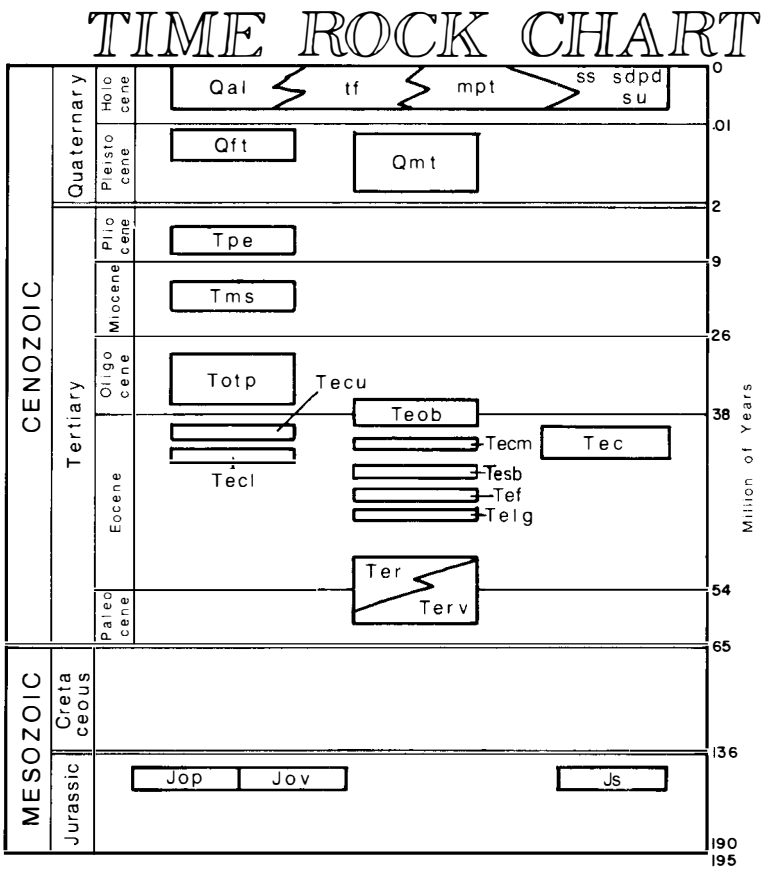
Lower Eocene rocks

Roseburg Formation: The lowest unit of the Umpqua Group is the Roseburg Formation and consists of rhythmites with submarine basalt. The Roseburg Formation is exposed over a 500-km^2 (200 mi^2) area south and east of Coquille. It is not exposed in Coos County very far north of latitude 43°15′ N. Estimated thickness of the Roseburg Formation is between 3,000 and 3,600 m (10,000 and 12,000 ft) (Baldwin, 1974).

Late Cretaceous foraminifers have been found along the North Fork of the Coquille River in sediments assigned to the Roseburg Formation, and Paleocene foraminifers have been found interbedded with Roseburg Formation basalt east of Myrtle Point (Baldwin, 1965). The structural boundaries of these isolated locations are unclear.

Locally, Eocene sedimentary beds which lie below the submarine basalt have been reported (W. Seely, 1978, personal communication). The Roseburg Formation was deposited on the deep ocean floor and has been much more deformed tectonically than the overlying later Eocene units.

Lookingglass Formation: The middle member of the Umpqua Group is the Lookingglass Formation. It consists of a basal conglomerate and overlying rhythmically bedded fine-grained sandstone and siltstone. The Lookingglass Formation overlies the Roseburg Formation with large angular unconformity. It is estimated to have a maximum thickness of 2,100 m (7,000 ft). Coal measures in the lower part of the formation indicate that much of



Description of units

Qal—Quaternary alluvium:
Unconsolidated deposits of sand, silt, clay, and mud in the flood plains of major streams draining sandstone and siltstone terrain, and gravel, sand, and silt along the middle and upper reaches of rivers draining pre-Tertiary or volcanic terrain.

tf—Tidal flat:
Unconsolidated mud, silt, clay and sand in the tidal zone of estuaries and other coastal wetlands; sediments compacted or high in organic material locally.

mpt—Marsh and peat:
Unconsolidated organic soils of silt, clay, and sand in estuarine and fresh-water wetland areas.

ss—Stable sand:
Unconsolidated fine- to medium-grained dune sand; thickness up to 200 ft in large dune fields; much thinner south of Bandon; organic soils and ancient soil horizons; does not include stable sand overlying **Qmt.**

sdpd—Deflation plain and beach sand:
Unconsolidated fine- to medium-grained sand of beaches, flat-lying interdune areas, and transverse dune fields.

su—Unstable dune sand:
Unconsolidated fine- to medium-grained sand of large dunes.

Qft—Quaternary fluvial terrace deposits:
Unconsolidated to semiconsolidated flat-lying and elevated deposits of river alluvium overlooking present stream valleys (Quaternary alluvium); includes fine-grained terrace deposits of estuarine origin.

Qmt—Quaternary marine terrace deposits:
Unconsolidated to semiconsolidated flat-lying and elevated marine deposits of sand, silt, clay, and gravel locally; thicknesses vary from 10 to 50 ft but locally are as little as 2 to 3 ft; elevations range from a few feet to several hundred feet near Coos Bay to almost 2,000 ft farther inland.

Tpe—Empire Formation:
Massive marine sandstone with minor interbeds of siltstone; includes a fossiliferous conglomerate lens at Fossil Point.

Tms—Miocene sedimentary rock:
Calcareous, medium-grained gray sandstone exposed at Pigeon Point near Empire; presence of the unit in Coos Bay is inferred from dredgings.

Totp—Tunnel Point Formation:
Coarse- to fine-grained tuffaceous sandstone and minor siltstone exposed only at Tunnel Point near the entrance to Coos Bay.

Teob—Bastendorff Formation:
Thinly bedded gray to buff shale and minor sandstone.

Tecl, Tecm, and Tecu—Coaledo Formation:
Sequence has three members: lower and upper members (**Tecl** and **Tecu**) consist of coal-bearing, cross-bedded, tuffaceous sandstone; middle member (**Tecm**) consists of thin-bedded siltstone with minor sandstone.

Tec—Coaledo Formation:
Undifferentiated.

Tesb—Sacchi Beach beds:
Micaceous siltstone and thinly interbedded arkosic sandstone.

Tef—Flournoy Formation:
Generally well-indurated, rhythmically bedded micaceous sandstone passing upward into thin-bedded sandstone and siltstone.

Telg—Lookingglass Formation:
Rhythmically bedded sandstone and siltstone; well indurated; basal beds are coal bearing and conglomeratic locally near the base of the section.

Ter and Terv—Roseburg Formation:
Thick sequences of sandstone and siltstone; well indurated; rhythmically bedded locally; contains minor conglomerate and massive sandstone; pillowed and brecciated submarine basalts (**Terv**) are abundant locally.

Jop, Jov, and Js—Otter Point Formation:
Tectonically sheared marine sedimentary rocks; includes graywacke, some chert-pebble conglomerate, and radiolarian chert. Also includes altered andesitic and keratophyric breccias and pillows (**Jov**) and isolated blocks of blueschist (**Js**).

Figure 6. Time-rock chart.

Coos County was a near-shore mass of swamp in Looking-glass time.

Middle Eocene rocks

Flournoy Formation: The uppermost member of the Umpqua Group is the Flournoy Formation, which is middle Eocene in age. It is composed chiefly of rhythmically bedded lithic micaceous sandstone and siltstone similar to the overlying Tyee Formation (Figure 7). The Flournoy Formation has an estimated maximum thickness of 1,600 m (5,000 ft) at the north end of the study area, thinning in the south to 300 m (1,000 ft) or less. The Flournoy Formation is exposed in the eastern half of Coos County in a north-northwesterly trending belt and extends to the coast in the north end of the study area. Unconformities separate the Flournoy beds from underlying rock units. Sedimentary rocks mapped in the Siltcoos quadrangle south of the town of Florence and marked "Tec/Tef" on the *Geologic Map of the Northern Coos Basin Area, Oregon* (folded, in envelope) are believed to be uppermost Flournoy Formation or Sacchi Beach equivalent (E. M. Baldwin, 1980, personal communication).

Rock exposures in the drainages of the Threemile and Fivemile Creeks south of Cape Arago were mapped as the Elkton Formation by Baldwin and Beaulieu (1973). It appears now, however, that these exposures are more likely to be the age equivalent of beds at Sacchi Beach which crop out on the coast to the west. The Sacchi Beach deposits consist of approximately 900 m (3,000 ft) of micaceous siltstone and are the age equivalent of the Lorane siltstone which is found near Eugene in the southern Willamette Valley. Both the Sacchi Beach beds and the Lorane siltstone were formerly considered to be members of the upper Tyee Formation but are now believed to be members of the upper Flournoy Formation (E. M. Baldwin, 1980, personal communication).

The Flournoy Formation consists chiefly of massive, rhythmically bedded, micaceous lithic sandstone and siltstone and is similar in lithology to the younger middle Eocene Tyee Formation. Separation of the Flournoy and Tyee Formations is based largely upon stratigraphic relationships (Baldwin and Beaulieu, 1973). The Flournoy Formation is unconformable over the Lookingglass Formation.

Tyee Formation: The Tyee Formation, first described by Diller (1896), occupies the synclinal axis of the south half of the Coast Range province. Exposures of the Tyee Formation are limited to the eastern margin of Coos County and do not crop out in the study area. The Tyee Formation consists of massive, greenish-gray lithic wacke and rhythmically bedded micaceous sandstone and siltstone. Both the Tyee and Flournoy sandstones contain abundant andesitic rock fragments, also metamorphic rock and quartz. Sedimentary beds in the Tyee Formation range from near-shore coaly deposits to turbidites deposited on the outer shelf. The formation is approximately 1,500 m (5,000 ft) thick in Coos County.

Bateman Formation: The Bateman Formation disconformably overlies the Flournoy Formation and is approximately 900 m (1,000 ft) thick where it crops out in eastern Coos County. It is composed of medium-gray micaceous lithic sandstone. Cross bedding and coal seams suggest a deltaic near-shore environment of deposition.

Figure 7. Flournoy rhythmites on Allegany Road, near the town of Allegany, Coos County.

Upper Eocene and younger rock units

Coaledo Formation: In 1899, Diller described the coal-bearing upper Eocene beds in Coos County and named them the Coaledo Formation. The maximum total thickness of the Coaledo beds is roughly 1,800 m (6,000 ft). Turner (1938) divided the Coaledo Formation into three members.

The lower member of the Coaledo Formation is mostly micaceous sandstone containing a number of prominent subbituminous coal seams. Cross-stratification identifies the environment as deltaic with sinuous channel sands. Inland from the coastal area, the Coaledo lies unconformably on the Flournoy Formation. The base of the Coaledo is in unconformable contact with siltstone of the Sacchi Beach member of the uppermost Flournoy Formation. Thickness of the lower member of the Coaledo Formation is from 450 to 540 m (1,800 to 1,800 ft).

The middle member of the Coaledo Formation is mostly tuffaceous siltstone with some sandstone and organic shale. It is 900 m (3,000 ft) thick near Yoakam Point (Figure 8). These fine-grained sediments are believed to represent a transgression of the sea between the deposition of the upper and lower member sandstones. Faunal evidence suggests a shelf environment during deposition of the middle member (Rooth, 1974).

The upper member is approximately 360 m (1,200 ft) thick (Rooth, 1974). Coarsening upward of the sequences from shale to sandstone in the basin sediments suggests that a prograding delta, including distributary channel sands and barrier bar sands, formed during retreat of the rivers which emptied into the south end of the Coos Basin (Ryberg, 1978).

Bastendorff Formation: The Bastendorff Formation of late Eocene-early Oligocene age conformably overlies the Coaledo in the South Slough syncline. It consists of an estimated 870 m (2,900 ft) of thinly laminated dark-gray siltstone and mudstone that weather to a light-tan color. The Bastendorff Formation also contains thin layers of white volcanic ash. Faunal data indicate that the Bastendorff Formation was laid down in a deep marine environment, suggesting another transgressive sequence (Rooth, 1974).

Tunnel Point Formation: Oligocene (Tunnel Point Sandstone) marine sandstone overlies the Bastendorff Formation conformably. It is in turn overlain by Miocene and Pliocene (Empire Formation) marine sandstones separated by unconformities. The lithologic types of sediments and structures show that the South Slough basin was a shallow-water delta from Oligocene time on.

Terraces: Pliocene-Pleistocene terraces formed later along the southwest coast as a result of uplift and sea-level rise during melting of polar ice. Terraces are found up to an elevation of 450 m (1,500 ft) in the Coos County coastal area. Some of the terraces mapped in the Siltcoos quadrangle south of the town of Florence (marked "Qmt" on the *Geologic Map of the Northern Coos Basin Area, Oregon*, folded, in envelope) may actually be remnants of late Eocene sandstone made up of rounded quartz and feldspar grains with no mica.

Pleistocene sediments: The age of unit "Qp" on the *Offshore Geology and Gravity Map of the Coos Basin, Oregon* (folded, in envelope) is unclear because of the limited data currently available. Both Pleistocene and Pliocene rocks probably occur in this unit.

UNCONFORMITIES

Onshore in western Oregon, major unconformities have been defined as occurring in the Late Jurassic, at the close of the Jurassic (Diablo and Nevadan orogeny), the middle of the Cretaceous, and between the early Eocene and middle Eocene at the close of Roseburg Formation deposition (Baldwin and Beaulieu, 1973).

Reflection profiles run on the Oregon continental shelf and slope display at least two major angular unconformities in the Tertiary rocks. They occur between Pliocene and Pleistocene sediments and between middle and late Miocene sediments (Kulm and Fowler, 1974).

Figure 8. Yoakam Point, just south of the entrance to Coos Bay. This promontory is formed from upper Eocene coal-bearing siltstone.

SOURCE ROCK INVESTIGATIONS

GENERAL DISCUSSION

Knowledge of the way petroleum forms and accumulates has expanded rapidly over the past 10 years. Scientists have known for some time that oil is generated from organic material and have demonstrated this in laboratory experiments. However, the natural processes that create oil and petroleum gas are quite complex and thus far not completely understood. There is now little doubt that oil and petroleum gas are generated from transformation of organic debris which was buried in sedimentary deposits. Compilation worldwide of geological and geochemical data from producing formations shows that oil and gas are generated under certain environmental conditions.

Three main phases of organic transformation in sedimentary deposits have been recognized (Tissot and Welte, 1978):

1. Diagenesis—the transformation of organic material by bacterial and chemical reactions at shallow depths. The completion of diagenesis results in changing much of the original organic debris into kerogen. Some methane gas is generated in this process.
2. Catagenesis—the degradation of kerogen into hydrocarbons as a result of heat and pressure. This is the main oil-formation stage.
3. Metagenesis—the last stage of transformation of organic material, resulting in the structural reorganization of kerogen. This alteration usually occurs at burial depths in excess of 3,100 m (10,000 ft). Under these conditions, only methane is generated in significant amounts.

Generally speaking, oil is formed from fossil aquatic plants, while methane gas forms from transformation of fossil terrestrial plants. Depth of burial and paleotemperature are other factors that determine whether oil or gas will be formed. Coal forms from buried terrestrial plant material, depending on the type of organic substances present. The conversion of significant amounts of plant material to oil, gas, or coal requires a reducing environment. Methane, carbon dioxide, and nitrogen can be generated from any organic material, but oil is formed primarily from the remains of aquatic life.

The level of organic maturation or potential for rocks to produce hydrocarbons can be ascertained by determining the rank of coal associated with those rocks. Maturation of organic debris in sedimentary rocks depends primarily upon the depth of burial (Figure 9) and secondarily upon paleotemperature and the amount of time temperature and pressure act on the buried material. Certain organic compounds found in sedimentary rocks are indicators of the depth of burial and the temperatures which have acted on the rock constituents over long periods of time.

Coal rank, vitrinite reflectance, coloration of spores, and type of hydrocarbons indicate the pressure-temperature history of petroleum source rocks. Data collected thus far by researchers show that biogenic methane (swamp gas) forms at temperatures between 68° and 126° C (154° and 259° F); oil forms at temperatures between 115° and 150° C (239° and 302° F); and thermal methane (petroleum gas) forms at temperatures between 106° and 177° C (223° and 351° F). Data on burial depth collected from known source rocks show that for oil the burial depth required is between 2 and 4 km (6,600 and 13,200 ft) and for thermal gas between 3 and 7 km (10,000 and 23,000 ft) (Dow, 1978). These depths, however, could have varied for many of the petroleum occurrences because the paleotemperature could have been abnormally high or the time at sufficient burial depth could have continued for 100 million years rather than 20 or 30 million years. Burial depth, temperature, and time are variables in the maturation process, and they differ for each occurrence of oil and gas.

In some instances, oil is known to have been generated within a few million years; in others, it has taken as long as several hundred million years to form. Where basin subsidence occurs at a rapid rate, maturation is shortened; conversely, in regions where subsidence occurs over a long time, maturation takes longer. Worldwide data show that most of the known oil was generated within the last 100 million years (since Early Cretaceous time). A small percentage of the world's oil is believed to have formed over a span of 100 to 300 million years. Some of the younger oil very likely represents recycled organic debris and petroliferous deposits from older rocks which have been uplifted and eroded.

Figures 9 and 10 show graphically two versions of maturation indices. The charts relate the maturation factors of burial depth, temperature, and time. From these illustrations it can be seen that no appreciable quantity of hydrocarbons formed if coal rank was below bituminous or the paleotemperature did not exceed 115° C (239° F).

COOS BASIN

Few indices have been published for potential source rocks in Oregon, and probably very little information has been acquired to date by private companies. However, it is important to examine the potential source rocks in Coos County in order to estimate the probability of finding commercial deposits of oil and gas. As part of this study, a

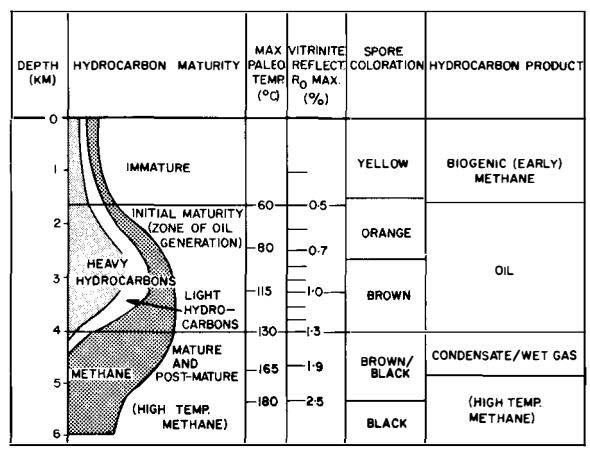


Figure 9. Organic maturation indices (Tertiary oils and coals). (After Tissot and others, 1974; Vassayevich and others, 1974; Cooper and others, 1975; Hood and others, 1975; Kanstler and Smith, 1978; and Oil and Gas Journal, *November 1978)*

total of 15 shale and three coal outcrop samples were submitted to GeoChem Laboratories for source rock tests (Appendixes F and G). The samples were sent in two batches. Complete source rock indices were run on the first set of samples; only visual kerogen analyses were run on the second set of shale samples, and the coal samples were tested for vitrinite reflectance.

Nearly all the tests indicated that rocks from Coos Basin are immature to moderately immature petroleum source rocks and are thus a very poor source for generating oil. Figure 28 in Appendix F shows a chromatograph of a typical crude oil. Chromatographs of hydrocarbons contained in Coos Basin shale samples are characteristic of immature source rocks. These rocks have reached only the initial stage for oil generation; therefore, only biogenic methane can be expected from them, according to the tests.

These results appear discouraging, but the sampling thus far is very limited. Also, tests on these outcrop specimens may be somewhat misleading because of deep weathering due to the moist climate in southwestern Oregon. Poor results on outcrop samples have been noted by others (James Edwards, Tenneco Oil, 1978, and George Sharp, formerly with Shell Oil, 1978, personal communications). Furthermore, no one geological, geophysical, or geochemical criterion should be relied upon to evaluate prospects, since occurrences of oil and gas depend on a complex natural system.

One sample of coal from the upper Coaledo Formation is characterized as a very good source for methane gas, while underlying shales test as immature. One sample of Roseburg Formation shale and one of Flournoy Formation shale contained reworked organic material which had reached the oil-generating stage of maturation. Coal from the Libbey Mine was determined to be meta-anthracite, which is surprising, since most of the coal in the Coaledo Formation is of subbituminous rank. Finally, according to work done by Deroo and others (1977), rocks having indices of some of the samples tested could generate some oil and gas, although the oil would be of low gravity.

Onshore reservoir prospects in Coos Basin are limited to sedimentary units older than Oligocene, since Oligocene and younger deposits are not thick enough and have been deeply eroded. Also, burial depth was insufficient. Maturation indices of organic material in rocks of the Coos Basin give some estimate of maximum subsidence in past geologic time. Subsidence can also be deduced from the total thickness of sedimentary sections now existing in the Coos Basin. There is an estimated 3,000 m (10,000 ft) of Tertiary marine deposits within the central portion of the Coos Basin area. If a subsidence of 900 m (3,000 ft) took place in Bastendorff time (Rooth, 1977), maximum downwarp of this portion of the continent may be in excess of 4,500 m (15,000 ft). Based upon these estimates, only units of lower Coaledo age and older could produce commercial amounts of petroleum. However, Colin Barker reported that about half the world's oil supply is found at depths less than 1,800 m (6,000 ft)

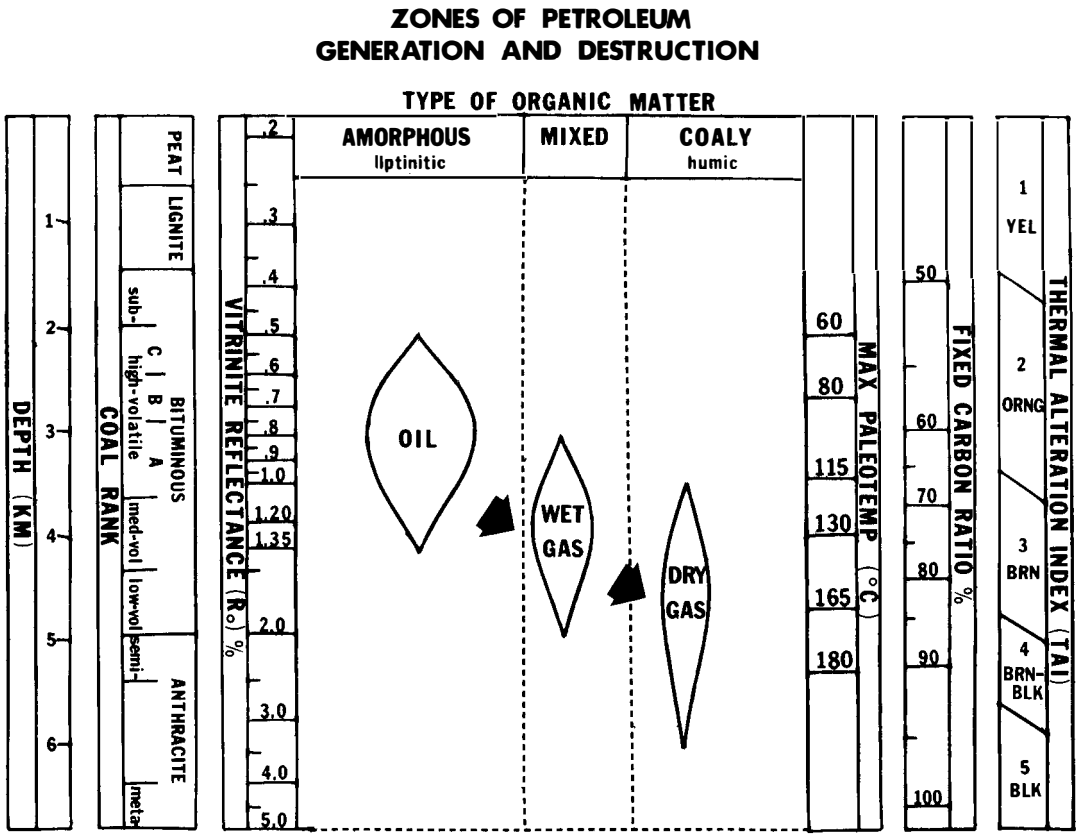


Figure 10. Correlation of maturation indices (Dow, 1977).

(Geotimes, 1976), even though maturation models say that significant amounts of oil cannot be generated at burial depths less than that. These occurrences must be explained by migration from source areas.

Some favorable evidence for oil and gas accumulation in the Coos Basin can be seen in the composition of gas from two or three shallow wells drilled in Coos County and one well drilled in Tertiary rocks inland to the east (see Table 9). These gases contain fractions of petroleum, indicating that diagenesis of organic matter had reached the oil-generating stage. Source rock tests by GeoChem Laboratory show that the coal sample from the upper Coaledo Member has very good characteristics for being a source of methane gas. Burial depth and paleotemperature apparently were sufficient for the upper member of the Coaledo Formation; therefore, it is reasonable to assume that these conditions were at least as good or better for older rock units. Furthermore, organic content of stratigraphic units may vary considerably laterally. More sampling of organic shales is needed in the Coos Basin to focus on the oil and gas potential. Preferably, samples should be obtained from core holes at a depth of at least 30 m (100 ft). Evidence of reworked mature organic material in samples of Roseburg and Flournoy age suggest there may be oil and gas objectives in rocks of Paleocene and older age.

Samples collected from surface exposures are likely to have been taken from the margins of basins, where the formation was uplifted and never deeply buried. Downdip from the sampled locations, the same rock units are usually inaccessible, except by deep drilling. Therefore, a rock formation could be an immature source rock at one location and yet be a mature petroleum source elsewhere. Therefore, more data must be collected before conclusions can be drawn about petroleum potential based on maturation of organic material.

Source rock potential of offshore deposits was not tested in this study because no samples were available. The continental shelf consists of at least 13,000 km^2 (5,000 mi^2) of marine sedimentary rocks. Thickness of these sedimentary units is much greater offshore than onshore, as indicated by eight deep exploration holes drilled during the 1960's and by geophysical surveys compiled in this report. This means that organically rich sedimentary layers on the shelf have been deeply buried through much of the Tertiary period. Thus, one would expect organic maturation to have reached the optimum oil-generating stage. This is confirmed by shows of petroleum gas in three of the offshore holes (see cross sections included with the *Offshore Geology and Gravity Map of the Coos Basin, Oregon,* folded, in envelope). One of the holes, the Union Oil OCS P-0130 (Fulmar 1) also had good shows of oil in the bottom 600 to 900 m (2,000 to 3,000 ft).

PETROLEUM POTENTIAL

ONSHORE COOS BASIN

The present onshore basin consists of forearc sediments and older slope and trench deposits that accumulated as a result of westward building of the continent. The Coaledo Formation and younger rock units also contain sequences of delta deposits, but because of the compressional stress regime, these probably do not cover a large part of the basin area.

The potential for reservoir rock in the Coos Basin is good, since sediment sources in the Klamath highlands have contributed huge quantities of debris derived from erosion of metamorphic and intrusive rock. Good to fair reservoir rocks were obtained from field sampling of Tertiary sedimentary units of all ages (see Appendix H).

Organic maturation tests on shale and coal samples from the study area show that the upper Coaledo Formation coal has good methane potential, while most of the shale samples appear to be poor source rock material (see Appendixes F and G). Thus, it appears that depth of burial or paleotemperature of upper Eocene rocks in the Coos Basin was not sufficient to generate large quantities of hydrocarbons. While this contradicts somewhat the results obtained from the upper Coaledo Formation coal sample, sampling is too limited to draw conclusions on petroleum potential. As stated earlier in this report, although maturation models require a burial depth of at least 1,800 m (6,000 ft), half of the world's oil reservoirs are found at depths less than this. Some of the shallow-depth accumulations can be accounted for by subsequent uplift and removal of overlying rocks by erosion after the oil formed, and other shallow accumulations can be attributed to migration of hydrocarbons. Studies over the past few decades have shown that hydrocarbons migrate with other formation fluids in the sediments fairly soon after deposition. Geochemical studies show that much of the oil found in shallow fields was not generated in the enclosing rocks.

Favorable attributes of various fold structures occurring in the study area are discussed below in order of their potential to produce oil or gas.

FAT ELK ANTICLINE

This fold is located in secs. 4, 8, 9, 17, 19, and 20, T. 28 S., R. 13 W., and appears to be a doubly plunging northeast-trending anticline. Rocks of the upper Coaledo Formation are exposed at the surface. Targets at this location are believed to be in the lower Coaledo and Flournoy Formations and can probably be reached by drilling to approximately 1,520 m (5,000 ft). There is some prospect of finding hydrocarbons in sands of the Roseburg Formation by drilling another 300 m (1,000 ft); however, the Roseburg Formation is well indurated and generally has low permeability and porosity. The Coast Oil 1 well tested the Fat Elk anticline and reportedly obtained a flow of 750 Mcfd of gas at a depth of 500 m (1,600 ft). Well 2 obtained a flow of 1,000 Mcfd of gas at a depth of 357 m (1,170 ft). At present, however, salt water is flowing from the first well. These wells are located on the north nose of the structure, so it appears a test could be made upstructure by moving 2.4 km (1.5 mi) to the southwest.

WESTPORT ARCH

This is a double fold (?) with an east fold and a west fold both located on the peninsula between South Slough and east Coos Bay. Two wells have been drilled on the east structure; both had good gas shows. The Phillips Petroleum well Dobbyns 1 encountered Roseburg basalt at a depth of 700 m (2,300 ft). The Majestic Oil well, Rhoades-Menasha 1, went to a depth of only 480 m (1,600 ft). The Majestic well is more favorably located than the Phillips well, and possibly a deeper hole could be put down near it, as it apparently tested the highest part of the fold. The Phillips electric log indicates a gas sand at 312 to 317 m (1,025 to 1,040 ft), and the Majestic well had gas shows between 180 and 410 m (590 and 1,345 ft). Both wells encountered coal seams above the gas shows.

COQUILLE—CATCHING SLOUGH ANTICLINE

This is mapped as a long, northerly-trending anticline beginning just northwest of the town of Coquille and extending 13 km (8 mi) northward to Masters Landing and Catching Slough. Both ends appear to have closures due to plunge. The fold is widest at its southern end and includes fault closures. Rocks of the middle Coaledo Formation are exposed at the surface south of the fault and those of the upper Coaledo on the north side. Targets on this fold include sands in the lower Coaledo, Flournoy, and Roseburg Formations.

REEDSPORT—SILTCOOS LAKE ANTICLINE

This anticline passes through the town of Reedsport in a north to northeasterly trend. A northeast-trending fault may intersect the fold under the town of Reedsport. Plunges were not determined for either end of the fold, so it is difficult to recommend a drilling site. The best estimate is to test the structure north of where the fault intersects the fold axis.

NORWAY ANTICLINE

This fold appears to plunge southward from the volcanic high near Norway, 4 km (2.5 mi) north of Myrtle Point. The fold may be cut by a major northwest-trending fault zone. Objectives on this fold would include sands in the Roseburg Formation and possible Cretaceous sediments below the Roseburg Formation volcanic rocks.

CONTINENTAL SHELF

This investigation covers the north half of the Coos Bay AMS quadrangle and the adjacent shelf to longitude 125° W. As described earlier in the section on tectonics, the geologic structure of the Coos Basin and adjoining shelf is believed to have resulted from underthrusting of the oceanic crust beneath the continent. The region can be classified as a convergent-type basin, according to studies by Huff (1978).

Convergent margin basins contain compression-caused folds in conjunction with thrust faults. Anticlines occur along a broad front parallel to plate boundaries, and

imbricate thrusting is often associated. Structures are generally younger inland from the plate boundary. Most of the petroleum found thus far in thrust fold belts occurs in asymmetric, hanging-wall folds and the leading edge of fold belts along the trench front. Convergent plate boundaries also produce normal faults on the outer trench slope next to the descending plate and landward of the outer continental slope. Vertical uplift of slope sediments near the plate boundary causes ponding of sediment behind the outer high and thus forms a peripheral foreland basin. Folds and faults within the foreland basin afford traps for oil and gas, but historically these have not produced the large accumulations that are found in the outer thrust-belt highs. Reefs found along the margin of convergent boundaries have produced enormous amounts of petroleum (Harding and Lowell, 1979). However, data on the Oregon shelf collected to date do not indicate that large reefs will be found there.

Underthrusting produces compressive folds and often a combination of strike-slip faults, parallel to subparallel to the plate boundary. Wrench faults are also produced along convergent boundaries due to uneven warping of continental rocks during underthrusting. *En échelon* folds related to this type faulting often provide traps for hydrocarbons.

Shale diapirs have been located on the Oregon shelf by seismic surveys. Two deep exploration wells off the Washington coast were drilled in diapirs (Snavely and others, 1977). Usually, diapirs are associated with delta sediments, but large deltas are not likely to develop on converging margins. This suggests that the Oregon shelf has a more complex geologic history than models of basin types described by Huff (1978).

Therefore, petroleum prospects on the shelf off the southwestern Oregon coast are related to a variety of structures: faulted highs at the edge of the continental slope, fold structures behind these highs in the forearc basin, and secondary structural features such as wrench faults and shale diapirs. Generally, sediments supplied to convergent margin basins are from volcanic sources and thus provide poor reservoir rocks. This is not the case off the southwestern coast, because copious quantities of arkosic and metamorphic sediments were supplied to the basin from the Klamath highlands.

This author believes that chances are very good for finding commercial amounts of oil and gas on the continental shelf off the southwestern Oregon coast. Information obtained from several deep test holes and from geophysical data confirm that there is a great thickness of marine sedimentary rocks west of the continent. Thus, conditions for generating large amounts of oil and gas probably existed in Tertiary time. The two wells drilled off the southwest coast encountered good shows of petroleum gas; the Union Oil well OCS P-0130 also obtained good oil shows through a 75-m (250-ft) section of arkosic sandstone in the lower part of the hole.

Detailed lithologic logs of wells drilled in the study area are printed in the Department's Open-File Report O-80-13, which may be purchased at the Portland office of the Oregon Department of Geology and Mineral Industries. Micropaleontological species lists from four deep wells are also included in the open-file report.

GEOLOGY OF THE CONTINENTAL MARGIN NEAR FLORENCE, OREGON

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ACKNOWLEDGMENTS

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INTRODUCTION

Major fracture zones and mountainous ridges mark certain types of active boundaries between large lithospheric plates. Figure 11 schematically shows the kinematics of the plates off the coast of the Pacific Northwest. The San Andreas fault system in California and the Queen Charlotte-Fairweather fault system in British Columbia and southeastern Alaska comprise the transform faults along which the Pacific and North American Plates slide past one another in a right-lateral sense.

Between the San Andreas and Queen Charlotte-Fairweather transform faults, sea-floor spreading occurs along the Gorda, Juan de Fuca, and Explorer ridges as the Pacific and Juan de Fuca Plates diverge. The Blanco and Sovanco fracture zones, both right-lateral transform faults, offset the spreading ridges. The Juan de Fuca Plate moves toward the northeast relative to the North American Plate as a consequence of plate divergence approximately normal to the spreading ridges and right-lateral plate motion along the San Andreas and Queen Charlotte-Fairweather transform faults.

Convergence of the Juan de Fuca and North American Plates and subsequent oblique underthrusting of the Juan de Fuca Plate beneath the North American Plate occurs along the base of the continental slope off the coasts of Oregon, Washington, and southern British Columbia. The direction of motion of the Juan de Fuca Plate relative to the continental slope off Oregon is toward but oblique to the strike of the slope, and the rate of convergence is estimated to be approximately 2 cm/yr (1 in./yr) (Atwater, 1970). However, migration and changes in the orientation and number of ridges and fracture zones throughout geologic time have caused marked changes in the directions and velocities of plate convergence along the continental margin and in the composition and structure of the accreted and subducted materials.

Along the continental slope off the Pacific Northwest coast, sea-floor sediments are carried landward during plate convergence. At the subduction zone, some of these sediments apparently are scraped off the oceanic plate, accreted to the continental plate, and subsequently uplifted and emplaced in the continental slope (Byrne and others, 1966; Kulm and Fowler, 1974). Seely and others (1974) proposed an imbricate thrust model, wherein wedges of sediments are thrust successively one under another at the base of the slope, to explain the uplift and emplacement of deep-sea sediments on the continental slopes of convergent continental margins. Kulm and Fowler (1974) have shown that the imbricate thrust model is consistent with the composition, ages, and paleodepths of the sedimentary units which form the continental slope and outer continental shelf off the central Oregon coast. However, because data are sparse on the geology of the continental margin, it is not known to what extent the imbricate thrust model, when complicated by changes in the rates and directions of plate convergence, can explain the composition, structure, and evolution of the continental margin. The purpose of this section is to summarize the geophysical data obtained from the continental margin off the central Oregon coast near Florence, to present a geophysical model constructed to be consistent with the data, and to offer an interpretation of the model in the form of a geological crustal section.

GEOMORPHOLOGY

In Oregon, the zone of transition between true oceanic and continental crust extends from the deep-sea floor of Cascadia Abyssal Plain west of the continental slope to at least the high plateaus east of the Cascade Mountain Range. The transition zone includes the continental slope and continental shelf, which together comprise the sub-

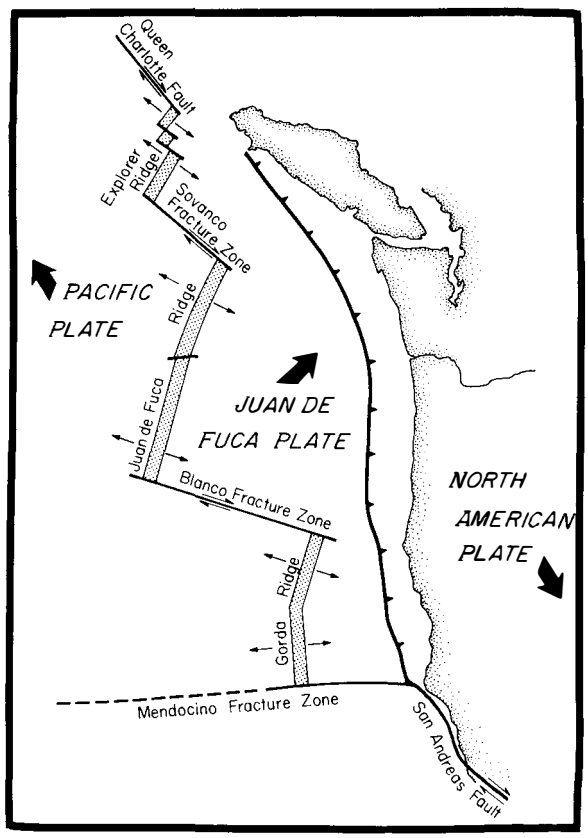

Figure 11. Plate tectonic motions in the northeast Pacific. Arrows indicate relative motion of the Pacific, North American, and Juan de Fuca Plates.

marine continental margin. Figure 12 outlines the general geomorphology of the central Oregon continental margin.

The continental shelf dips gently seaward and reaches depths of 200 to 300 m (650 to 1,000 ft) approximately 30 km (20 mi) seaward of the coast. Off Florence, the continental shelf is approximately 60 km (40 mi) wide and shoals to depths of less than 45 m (150 ft) over Heceta Bank on the outer continental shelf. Seaward of the continental shelf, the relatively steep continental slope descends to abyssal sea-floor depths of approximately 3,000 m (10,000 ft). North of Heceta Bank, a series of north- to northwest-trending ridges occurs on the slope in water depths of more than 1,000 m (3,300 ft) (Braislin and others, 1971; von Huene and Kulm, 1973; Kulm and others, 1974; Snavely and others, 1977). Figure 12 shows that the geophysical and geological cross sections of Figure 13 and Figure 14 are oriented approximately normal to the continental margin and pass through the south end of Heceta Bank.

MEASUREMENTS AND DATA

Figure 12 shows the lines along which both the Florence and Coos Bay crustal and subcrustal cross sections were constructed. The Florence section, oriented approximately normal to the continental margin, extends from a point in Cascadia Abyssal Plain, approximately 200 km (125 mi) west of the coast, to the east side of the Willamette Valley. The section intersects the south end of Heceta Bank and the Union Oil well OCS P-0130 (Fulmar 1), located on the continental shelf west of Heceta Head, and passes south of the Sinclair Mapleton 1 well, located north of Mapleton, Oregon. Logs of the two deep wells; bathymetric, gravity, magnetic, and seismic reflection and refraction measurements at sea; and topographic, geologic, gravity, and aeromagnetic observations on land constrain the geophysical model section.

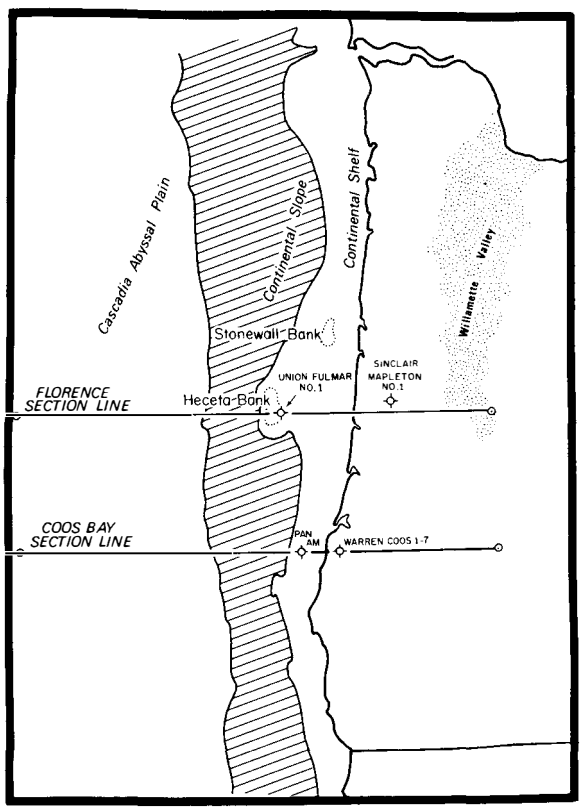

Figure 12. Geomorphology of the continental margin along the Oregon coast, showing locations of cross sections and wells.

Shor and others (1968) made seismic refraction measurements on the continental shelf west of the Union Oil well OCS P-0130 (Fulmar 1) and in Cascadia Abyssal Plain along lines parallel to the continental margin. Their measurements provide data on the depth and seismic velocities of the crustal layers and top of the mantle. Sonobuoy refraction measurements (Keser, 1978) near the section provide thicknesses and velocities of the sedimentary layers overlying the oceanic crust seaward of the slope and the shallow layers on the continental slope and shelf.

Seely and others (1974) show a multichannel seismic reflection profile shot by Exxon along the section line from the abyssal plain to a point east of the Union Oil well OCS P-0130. The reflection line provides information on water depths and the thicknesses of the sedimentary layers above the abyssal sea floor and above an acoustic basement on the continental margin.

When reduced to anomaly values by removal of appropriate regional fields (Swick, 1942, p. 61; International Association of Geomagnetism and Aeronomy, 1976), gravity and magnetic measurements made by the National Ocean Survey (National Oceanic and Atmospheric Administration, 1978) yield gravity and magnetic data along the marine portion of the section. Gravity anomalies reported by Thiruvathukal (1968) provide control for the land portion of the section. The empirical relations between seismic velocity and density (Ludwig and others, 1970) and well-log data guided the selection of model densities.

The crustal section assumes a two-dimensional structure, a standard mass column of 50 km (30 mi) and 6,442 mgal corresponding to a zero free-air gravity anomaly (Barday, 1974), and no lateral variations in density below a depth of 50 km (30 mi). Iterative adjustments of layer boundaries constrained by water depth, land elevation, abyssal sediment thickness, refracting horizons, and horizons determined from the well logs were made until the gravity, computed with the method of Talwani and others (1959) and Gemperle (1975), agreed with the observed free-air and Bouguer anomalies, and until the magnetic intensity, computed by the method of Lu and Keeling (1974), agreed with the observed magnetic intensity. This yielded the Florence geophysical cross section.

THE FLORENCE CRUSTAL AND SUBCRUSTAL CROSS SECTION

Figure 13 shows the Florence geophysical cross section. The section, approximately 300 km (180 mi) long, is oriented N. 91° E. normal to the continental margin and intersects the coastline north of Florence, Oregon. The crystalline oceanic crust at the seaward end of the section is approximately 6 km (4 mi) thick and is composed of a lower crustal layer with a density of 2.95 g/cm^3 and an upper layer with a density of 2.62 g/cm^3. More than 1 km (0.6 mi) of sediments with an average density of 2.15

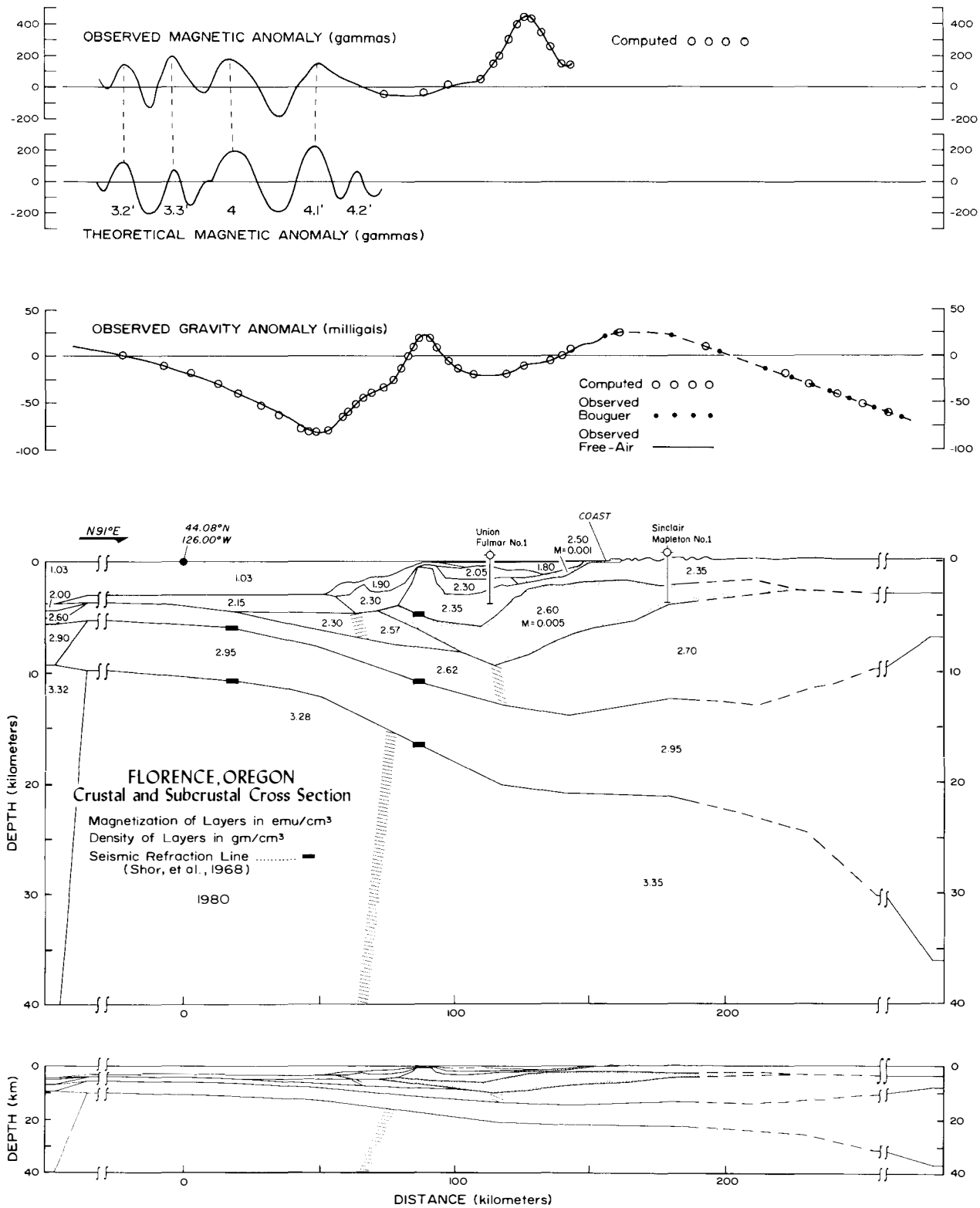

Figure 13. Geophysical crustal and subcrustal cross section of the continental margin north of Florence, Oregon. The section, oriented approximately east-west, extends from Cascadia Abyssal Plain to the east side of the Willamette Valley.

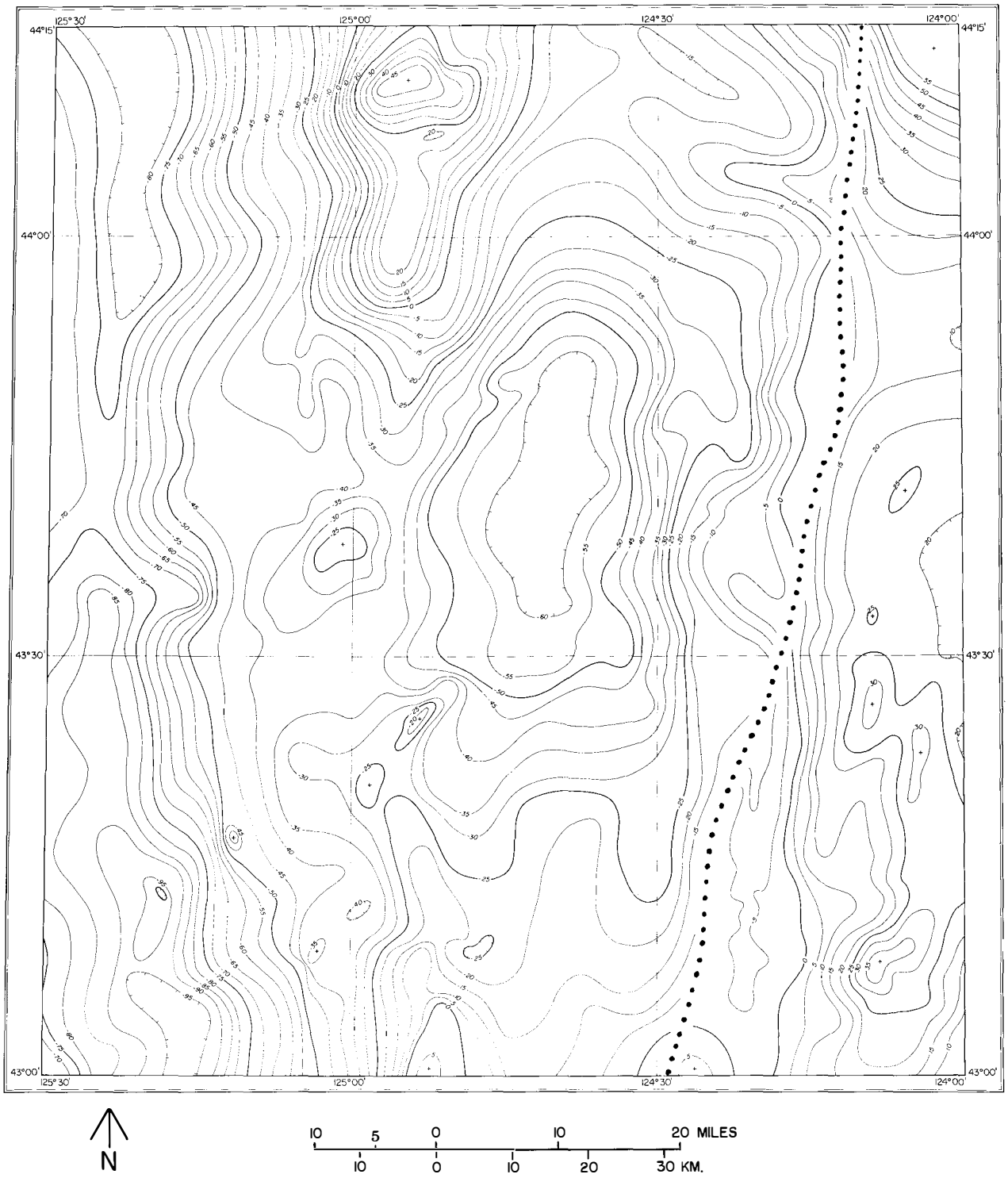

Figure 14. Gravity anomaly map of study area. Offshore gravity anomalies are free air; onshore gravity anomalies are complete Bouguer. Contour interval, 5 mgal; CBA reduction density, 2.67 g/cm³. Dotted line indicates coastline.

g/cm^3 overlie the basaltic rock of the upper oceanic crust. The total thickness of the oceanic crust of Cascadia Abyssal Plain, including 3 km (2 mi) of water, is approximately 10 km (6 mi).

The topmost lines of Figure 13 show the observed magnetic anomalies over the section and, for comparison, the theoretical sea-floor magnetic anomalies which assume an apparent half-spreading rate of 2.0 cm/yr (1 in./yr) and use the magnetic time scale of Blakely (1974) and Ness and others (1980). A good correlation exists between the observed and theoretical magnetic anomalies over the abyssal plain extending to just landward of the continental slope. The magnetic anomalies indicate that the age of the oceanic basement rock ranges from approximately 5.8 m.y. (anomaly 3.2′) to 8.4 m.y. (anomaly 4.2′).

The crystalline oceanic crust dips landward, and the depth to the top of the mantle beneath the continental shelf is 15 to 20 km (9 to 12 mi). Few gravity data and no seismic data are available to constrain or resolve the continental section, which is indicated by the blocks of density 2.35, 2.60, 2.70, and 2.95 g/cm^3 east of the coastline. However, the computed gravity based on the depicted structure and constrained by a standard mass column suggests that the depth to the top of the mantle is approximately 20 to 25 km (12 to 15 mi) beneath the Coast Range of the central portion of western Oregon.

On the continental shelf, a thick sedimentary basin, indicated by a 15-mgal negative gravity anomaly and composed of sediment layers with densities of 1.80, 2.05, 2.30, and 2.35 g/cm^3 deepens seaward. Near the outer edge of the continental shelf, the 2.30 and 2.35 g/cm^3 sedimentary layers rise steeply toward the surface beneath Heceta Bank and cause a marked positive gravity anomaly. The sedimentary layers overlie material which has a density of 2.60 g/cm^3 and a magnetization of 0.005 emu/cm^3. These rocks, identified in the Sinclair Mapleton 1 well as members of the Siletz River Volcanic Series, extend from the eastern slopes of the Coast Range to the middle of the continental slope. Near the coast, other rocks identified as Yachats Basalt (Snavely and MacLeod, 1974), with a density of 2.50 g/cm^3 and magnetization of 0.001 emu/cm^3, extend seaward beneath a thin cover of sediments. Connard and Levi (1979, personal communication) have used direct methods to identify other magnetic sources near the interface between the 2.30 and 2.35 g/cm^3 layers.

A large block of material of density 2.30 g/cm^3 underlies the continental slope and is interpreted as accreted oceanic and continental sediments. A relatively thin veneer of continental sediments of varying thickness overlies the accreted sediments of the slope. The section also shows layers of density 2.30 and 2.57 g/cm^3 beneath the sediments of Cascadia Abyssal Plain and beneath the continental slope, respectively. The layer of 2.30 g/cm^3 is visible on multichannel seismic reflection records (Seely and others, 1974) and is interpreted as partially compacted oceanic sediments which overlie the acoustic basement. The block of 2.57 g/cm^3 is also interpreted as sediments, but here they are thrust beneath rocks of the denser Siletz River Volcanic Series, resulting in an even greater density increase caused by additional compaction and dewatering.

Below the annotated section, which has a vertical exaggeration of 4:1, an unexaggerated 1:1 section is illustrated.

Figure 14 shows a free-air gravity anomaly map of the southwest Oregon continental margin. An elongate negative gravity anomaly which reaches values of −95 mgal occurs along the base of the continental slope. The axis of the negative anomaly approximately coincides with the base of the continental slope. As shown on the cross section in Figure 13, the landward-dipping oceanic crust and an increasing thickness of relatively light sediments, including those of the lower slope, cause the negative anomaly. The gravity map shows that the positive anomaly caused by the shoaling of denser sedimentary rocks extends north along the outer continental shelf. The continuity of the anomaly suggests that similar structures exist beneath the northern end of Heceta Bank and also possibly beneath Stonewall Bank, west of Newport, Oregon. South of Heceta Bank, a large negative gravity anomaly, which reaches values of −60 mgal, outlines a sedimentary basin whose center is located near the middle of the continental slope west of Reedsport. The anomaly values suggest that sediment thicknesses may exceed 7 km (4 mi). The anomaly gradients suggest that sedimentary layers probably thicken toward the south and that the outer structural high which was formed by the shoaling of the deeper sedimentary layers decreases in amplitude.

THE FLORENCE GEOLOGICAL SECTION

Figure 15 presents a geological interpretation of the geophysical cross section. Geological information is provided by the lithologic logs of the Union Oil OCS P-0130 (Fulmar 1) and Sinclair Mapleton 1 wells; by Deep-Sea Drilling Project holes drilled in Cascadia Basin (DSDP Site 174) and in the continental slope (DSDP Site 175) north of the section (Kulm, von Huene, and others, 1973); by marine core data (Kulm and Fowler, 1974); by studies of the geology of western central Oregon (Snavely and Vokes, 1949; Baldwin and Beaulieu, 1973; Baldwin, 1975, 1976; Snavely and others, 1977); and by the physical parameters, depths, and continuity of horizons provided by the geophysical data.

Magnetic anomalies indicate that the oceanic crust beneath the sediments is middle to late Miocene in age. The oldest identifiable anomaly along the section is about 12 m.y. old. However, the model suggests that the oceanic crust is continuous beneath the continental slope and the outer continental shelf. If this is correct, then the outer shelf sediments overlie oceanic crust approximately 15 m.y. old. The oceanic sediment in contact with the seafloor basalt is approximately the same age as the basalt and decreases in age upward. Multichannel seismic reflection data show acoustic horizons in the sediments indicative of unconformities (Seely and others, 1974). These were also observed in the cores at DSDP Site 174 (Kulm and others, 1973). The geologic section indicates the unconformities between the Miocene-Pleistocene and late Quaternary and between the Miocene-Pleistocene and late Miocene. Cores from DSDP Site 175 indicate that late Pleistocene muds of the continental slope overlie partially consolidated mudstones and silt turbidites from the adjacent abyssal plain (Kulm, von Huene, and others, 1973). The interpretation of multichannel reflection data by Seely and others (1974) suggests that these deposits are a series of imbricate thrusts. Penetration of the abyssal plain deposits in the lowermost part of the section at Site 175 also suggests imbrication of the sediments (Kulm, von Huene, and others, 1973; Kulm, 1979, personal communication).

Lithologic logs of the Sinclair Mapleton 1 well indicate that the hole penetrated approximately 2.5 km (1.5 mi) of

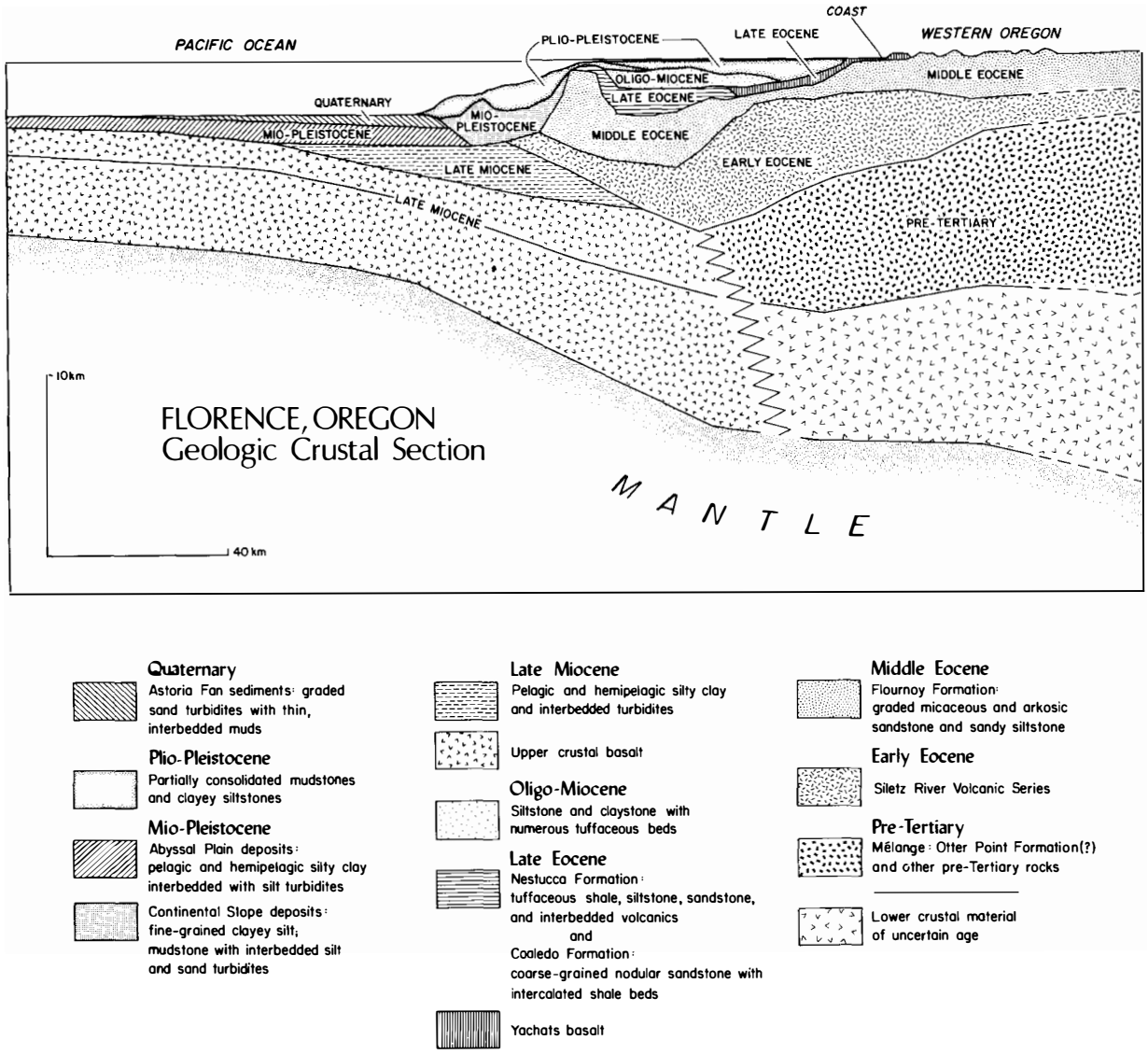

Figure 15. Geologic crustal section of the continental margin north of Florence, Oregon.

rocks of the Flournoy Formation and about 1.5 km (1 mi) of rocks of the Siletz River Volcanic Series (Roseburg Formation equivalent). Baldwin (1975, 1976) describes rocks of the Flournoy Formation as graded micaceous and arkosic sandstones and sandy siltstones. The Flournoy Formation is believed to be missing in the Union Oil well OCS P-0130. Yet, rocks of Eocene age were penetrated there also and are interpreted to be the major constituent of the structural high beneath Heceta Bank. The nature of the contact between these middle to early Eocene-age rocks and the Tertiary volcanic rocks of the Cascade Range is unknown. Sedimentary rocks of late Eocene age overlie rocks of the Flournoy Formation. These rocks are thought to be similar to the tuffaceous shale, siltstone, sandstone, and interbedded volcanic rocks of the Nestucca Formation described by Snavely and Vokes (1949) and/or the coarse-grained, nodular sandstone with intercalated shale beds of the Coaledo Formation described by Baldwin and Beaulieu (1973). These rocks are apparently capped by Oligocene-Miocene siltstones and claystones (Kulm and Fowler, 1974).

The lower section of the Siletz River Volcanic Series (Roseburg Formation equivalent), which underlies the Flournoy Formation, is considered to be formed of oceanic crustal rocks, whereas the upper part of the series is thought to have been deposited in shallower water (Snavely and Baldwin, 1948; Baldwin, 1976; Snavely and others, 1977). This sequence of rocks apparently extends from near the base of the continental slope on the west to the Tertiary volcanic rocks of the Cascade Range and has its thickest section beneath the continental shelf. The nature of the pre-Tertiary rocks beneath the Siletz River Volcanic Series is unknown. Baldwin (1979, personal communication) suggests the rocks may be a mélange similar to the Upper Jurassic Otter Point Formation described by Koch (1966).

The landward dip of the westernmost part of the Siletz River Volcanic Series, as depicted in the geological section, suggests that this section of the series may have been carried or thrust landward beneath the same rocks nearer the present coast by the subducting oceanic crust, thereby foreshortening the continental margin and apparently thickening the volcanic sequence beneath the continental shelf. In this process, the westernmost ends of the overlying beds of the Flournoy Formation, the Nestucca/Coaledo Formation, and Oligocene-Miocene sedimentary rocks were folded, faulted, and thrust upward to create an outer structural high that is manifested in the bathymetry as Heceta Bank.

Although the depth to the base of the Siletz River Volcanic Series is not well constrained by the available data, the configuration of the interface between the volcanic series and the underlying pre-Tertiary mélange suggests that the mélange also has been deformed contemporaneously with the deformation and uplift of the volcanic series. The deformation of the major crustal units appears to be greatest near the upper continental slope and outer continental shelf and to diminish toward the Willamette Valley.

CONCLUSIONS

The familiar rock units of western Oregon extend westward off the southwest Oregon coast to the edge of the continental shelf, and the oceanic crust of Cascadia Abyssal Plain has underthrust the continental margin eastward to at least the center of the continental shelf. The process(es) of thrusting or subduction profoundly influenced the conformation of the rock strata which form the continental margin. The convergence of the oceanic lithospheric plates and the continental plate appears to have uplifted and emplaced marine sediments in the continental slope, foreshortened the outer continental margin off the southwest Oregon coast, and folded and thrust up the sedimentary rocks to form an outer-shelf structural high.

THE STRUCTURE OF THE CONTINENTAL MARGIN NEAR COOS BAY, OREGON

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MEASUREMENTS AND DATA

Figure 12 shows the trace of the Coos Bay crustal and subcrustal cross section, located at latitude 43°15′ N. The section extends from a point in Cascadia Abyssal Plain, approximately 150 km (90 mi) west of the coast near Coos Bay, Oregon, to the east flank of the Coast Range north of Roseburg, Oregon. The section intersects the south end of the Coos Basin and the Pan American well OCS P-0112 on the continental shelf southwest of Coos Bay and the Warren well Coos County 1-7 southeast of Coos Bay. Logs of the two wells; bathymetric, gravity, and magnetic measurements at sea; and topographic, geologic, and gravity measurements on land constrain the geophysical model section.

Shor and others (1968) made seismic refraction measurements on the shelf and in Cascadia Abyssal Plain west of Florence, Oregon, along lines parallel to the continental margin. Their refraction lines do not extend south quite to the Coos Bay section; however, an extrapolation of their measurements along strike and dip provided a guide to the depth and thickness of the deeper layers of the section.

When reduced to anomaly values by removal of the appropriate regional fields (Swick, 1942, p. 61; International Association of Geomagnetism and Aeronomy, 1976), gravity and magnetic measurements made by the National Ocean Survey (National Oceanic and Atmospheric Administration, 1978) and Oregon State University yield gravity and magnetic data along the marine portion of the section. Gravity anomalies reported by Blank (1965), Thiruvathukal (1968), and Alemi (1978) provide control for the land portion of the section. The empirical relations between seismic velocity and density (Ludwig and others, 1970) and well-log data guided the selection of model densities.

The crustal section assumes a two-dimensional structure, a standard mass column of 50 km (30 mi) and 6,442 mgal corresponding to a zero free-air gravity anomaly (Barday, 1974), and no lateral variations on density below 50 km (30 mi) depth. Iterative adjustments of layer boundaries, constrained by water depth, land elevation, abyssal sediment thickness, refracting horizons, and horizons determined from the well logs, were made, until the gravity, computed with the method of Talwani and others (1959) and Gemperle (1975), agreed with the observed free-air and Bouguer anomalies, and until the magnetic intensity, computed by the method of Lu and Keeling (1974), agreed with the observed magnetic intensity. This process yielded the Coos Bay geophysical cross section.

THE COOS BAY GEOPHYSICAL CRUSTAL CROSS SECTION

Figure 16 shows the Coos Bay geophysical cross section. The section, approximately 300 km (190 mi) long, is oriented N. 90° E., approximately normal to the continental margin, and intersects the coastline south of Coos Bay, Oregon. The crystalline oceanic crust at the seaward end of the section is approximately 6 km (4 mi) thick and is composed of a lower crustal layer with a density of 2.95 g/cm^3 and an upper layer with a density of 2.65 g/cm^3. Approximately 1 km (0.6 mi) of sediments with an average density of 2.15 g/cm^3 overlie the basaltic rock of the upper oceanic crust of Cascadia Abyssal Plain approximately 120 km (75 mi) seaward of the coast. Near the toe of the continental slope, sediment thickness increases to about 2.5 km (1.5 mi) and the average density of the lower layers of sediment increases to 2.20 g/cm^3. The total thickness of the oceanic crust of Cascadia Abyssal Plain west of the coast, including 3 km (2 mi) of water, is approximately 10 km (6 mi).

The topmost lines of Figure 16 show the observed magnetic anomalies over the section and, for comparison, the theoretical sea-floor magnetic anomalies which assume a half-spreading rate of 3.3 cm/yr (1.3 in./yr) and use the magnetic time scale of Blakely (1974) and Ness and others (1980). A reasonable correlation exists between the observed and theoretical magnetic anomalies over the abyssal plain; however, a diminution of the anomaly amplitude occurs over a relatively short distance seaward of the continental slope. The decrease may be due to thermal, mechanical, or chemical alteration of the magnetic minerals in the upper crustal rocks seaward of the slope. Magnetic profiles north and south of the cross section (NOAA, 1972, 1974) support the interpretation of the larger amplitude anomaly as anomaly 4.1′. Hence the age of the sea floor near the toe of the slope is approximately 8 m.y. and decreases westward.

Near the base of the continental slope, the crystalline oceanic crust dips landward and is overlain by more than 2.5 km (1.5 mi) of sediments. The depth of the top of the mantle is approximately 21 km (13 mi) beneath the continental shelf. Only gravity data are available to constrain the continental section, indicated by the blocks of density 2.35, 2.60, 2.70, and 2.95 g/cm^3 east of the coastline. However, the computed gravity, based on the depicted structure and constrained by the standard mass column, suggests that the depth to the top of the mantle is approximately 22 to 25 km (14 to 15 mi) beneath the Coast Range of the south-central portion of western Oregon.

On the continental shelf, a 5-km (3-mi)-thick sequence of sedimentary layers with average densities of 1.60, 2.20, 2.35, 2.40, and 2.50 g/cm^3 forms the continental shelf and slope seaward of the coastline. The sediment layers overlie a magnetic basement formed of rocks of average density 2.60 g/cm^3 and magnetization 0.003 emu/cm^3. These magnetic basement rocks have been identified as early Eocene basalts of the Roseburg Formation where they crop out in the western mountains of the Coast Range. In this model section, the magnetic block extends from the continental slope to the east flank of the Coast Range near Roseburg. The upper surface of the magnetic block generally slopes seaward near the coast, but it also exhibits a very irregular surface that suggests marked folding and possibly faulting of the rock layers along easterly dipping faults east of the coastline.

The relatively low average densities of 2.40 and 2.50 g/cm^3 suggest that the rocks forming the continental slope are sedimentary. The configuration of the blocks in the model section suggests folding of the older, denser

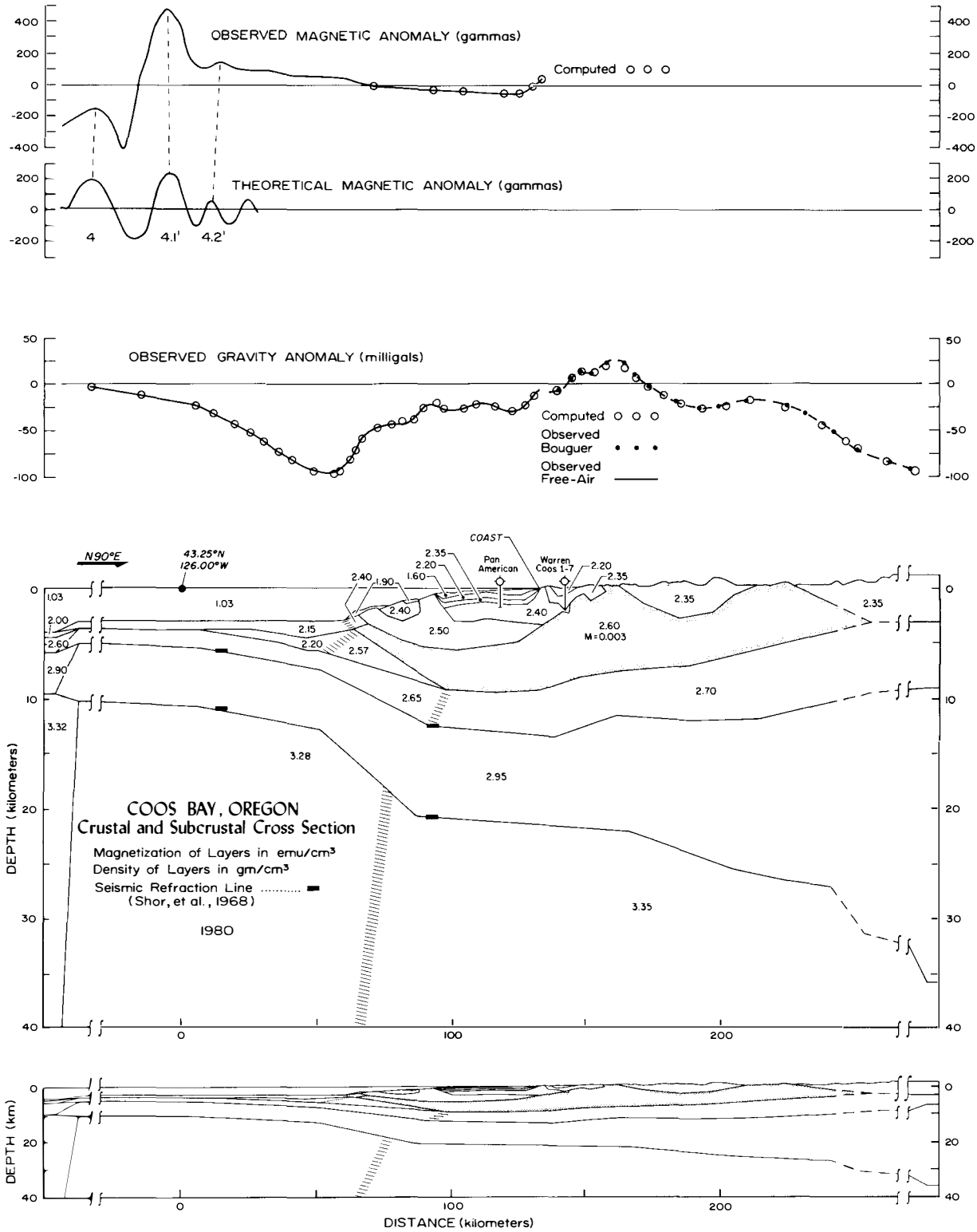

Figure 16. Geophysical crustal and subcrustal cross section of the continental margin south of Coos Bay, Oregon. This section is oriented N. 90° E.

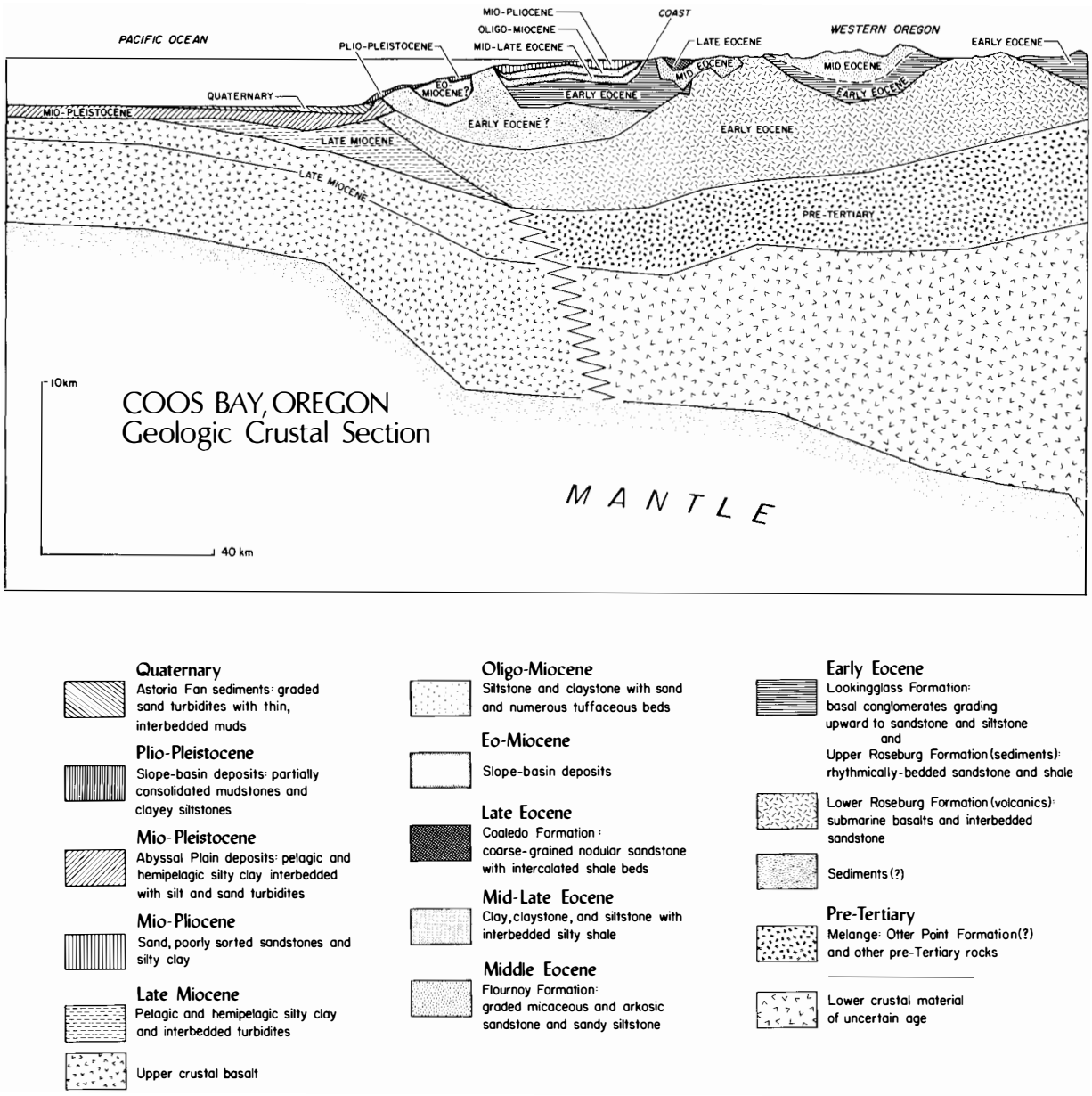

Figure 17. Geologic crustal section of the continental margin south of Coos Bay, Oregon.

sedimentary rocks, the development of slope basins, and subsequent or contemporary filling of the basins with lighter, younger sediments. A relatively thin veneer and occasional ponds of sediments of density 1.90 g/cm^3 or less overlie the older deformed rocks of the continental slope. The cross section also shows a layer of sediments of density 2.20 g/cm^3 overlying the basaltic basement of Cascadia Abyssal Plain near the slope base and a contiguous block of density 2.57 g/cm^3 beneath the continental slope. The location, density, and configuration of the block beneath the slope and the subduction tectonics of the region suggest the material in the block is composed of well-indurated and dewatered marine sediments that have been carried or thrust beneath the continental slope during the subduction of the oceanic lithosphere.

In the cross section, the continental slope includes a block of material with a density of 2.40 g/cm^3. The block suggests a slope basin approximately 1.5 to 2 km (1 to 1.2 mi) deep; however, if the basin fill has a lower density than depicted, the basin would be proportionately less deep. The density of the large block in the upper slope and shelf, indicated as 2.50 g/cm^3, and the absence of a magnetic anomaly caused by the block suggest the material is sedimentary. It overlies material with a density of 2.60 g/cm^3 and a magnetization of 0.003 emu/cm^3 that is interpreted to be volcanic rock of the Roseburg Formation. Hence, the block with a density of 2.50 g/cm^3 may include sediments of the upper Roseburg Formation.

Below the annotated section, which has a vertical exaggeration of 4:1, an unexaggerated 1:1 section is illustrated.

THE COOS BAY GEOLOGICAL SECTION

Figure 17 shows a geological interpretation of the geophysical cross section. Geological information pertinent to the interpretation is provided by the lithologic logs of the Pan American (OCS P-0112) and the Warren (Coos County 1-7) wells; by marine core data (Kulm and Fowler, 1974); by studies of the geology of western central Oregon (Snavely and Vokes, 1949; Baldwin and Beaulieu, 1973; Baldwin, 1975, 1976; Snavely and others, 1977, 1980; Baldwin and Perttu, 1980); and by the physical parameters, depths, and continuity of horizons provided by the geophysical data.

Magnetic anomalies indicate that the oceanic crust beneath the sediments is late Miocene in age. The oldest identifiable anomaly (anomaly 4′2) is 8.4 m.y. old and is located approximately 40 km (25 mi) west of the base of the continental slope. However, the model suggests that the oceanic crust extends beneath the continental slope and outer continental shelf. If this is correct, then the outer shelf sediments overlie late Miocene oceanic crust approximately 9 to 10 m.y. old. The oceanic sediment in contact with the sea-floor basalt is approximately the same age as the basalt and decreases in age upward. Because the age of the sediments decreases upward from the sea-floor basalt and the age of the basalt increases eastward toward the coast, the indicated change in the geology of the basal sea-floor sediments in the model section implies a change in age and not a change in lithology.

The model section suggests the continental shelf consists generally of a thick sequence of sedimentary rocks that overlie volcanic rocks of early Eocene age and generally decrease in age upward. The constitution of the continental slope is uncertain but appears to be formed of rocks of early to mid-Eocene age. Younger sediments fill basins and ponds behind and between ridges and folds in the older deformed sediments. The sediments that form the toe of the slope at this location may be uplifted sediments of the abyssal sea floor. The landward dip of the geologic units of the continental slope, indicated by the geophysical and geological cross sections, suggests large-scale imbricate thrusting along the outer continental margin.

Lithologic logs of the Pan American well indicate that it penetrated approximately 0.5 km (0.3 mi) of Pliocene-Miocene sandstone, silty sandstone, and sandy claystone; approximately 0.5 km (0.3 mi) of Oligocene-Miocene siltstone and claystone; and approximately 0.5 km (0.3 mi) of upper and middle Eocene claystone and siltstone before it bottomed in early Eocene shales, siltstones, claystones, and sandstones similar to and interpreted as sediments of the upper Roseburg or Lookingglass Formations. The geologic section suggests that the sedimentary section in the vicinity of the well extends to depths of approximately 5 km (3 mi).

The Warren well Coos County 1-7, approximately 7 km (4.5 mi) east of the coastline, penetrated approximately 0.7 km (0.4 mi) of coarse-grained, nodular sandstone and intercalated shales of the middle and upper Coaledo Formation and approximately 1.5 km (1 mi) of middle Eocene sandstone and siltstone of the lower Coaledo and Flournoy Formations. The geologic section suggests the well penetrated the sedimentary rocks a short distance east of the axis of a synclinal structure and nearly reached rocks of the Roseburg Formation that crop out approximately 14 km (8.5 mi) east of the well.

Volcanic rocks of the Roseburg Formation form the basement beneath the sediments. Baldwin (1974) and Baldwin and Perttu (1980) suggest the volcanic rocks of the Roseburg Formation were deposited on the sea floor and have subsequently been uplifted. The great thickness of the magnetic rocks in the block indicated as early Eocene rocks of the Roseburg Formation, particularly in the lower portion of the section, suggests that other magnetic rocks occur in the section. Alternatively, imbrication of the volcanic layers may have caused the present apparent thickness of the early Eocene section. The nature of the pre-Tertiary rocks beneath the Roseburg volcanic rocks is unknown. Baldwin (1980, personal communication) suggests the rocks may be a mélange similar to the Otter Point Formation of Late Jurassic age described by Koch (1966).

The geologic section in Figure 17 indicates the ages of the units but does not provide an indication of either the internal structure of the units or the tectonics of the formation of the section or emplacement of the units. The configuration of the crustal units, however, suggests the occurrence of major folding and faulting along the continental slope and near and immediately east of the coastline.

GRAVITY AND MAGNETIC DATA FROM THE CONTINENTAL MARGIN NEAR COOS BAY, OREGON

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INTRODUCTION

This report includes two new preliminary geophysical maps of the continental margin of Oregon near Coos Bay (Figures 14 and 18). Because geologic structures in the Coos Bay area extend offshore and because structures of potential economic interest extend westward to at least the continental slope approximately 100 km (60 mi) west of the coastline, the maps prepared for this study show gravity and magnetic anomalies to the base of the continental slope. Offshore gravity is shown with generalized geology of the shelf on the *Offshore Geology and Gravity Map of the Coos Basin, Oregon* (folded, in envelope).

GRAVITY ANOMALY MAP

Marine and terrestrial gravity measurements made from 1963 to 1973 in the Coos Bay area and on the continental shelf and slope west of Coos Bay have yielded data for constructing a gravity anomaly map of the area between latitudes 43° and 44°15′ N. and longitudes 124° and 125°30′ W. (Figure 14). The gravity measurements were made during cruises of the Oregon State University (OSU) Research Vessel *Yaquina* in 1963, 1967, 1971, 1971, 1973, and 1973 and by the National Oceanic and Atmospheric Administration (NOAA) research vessel, the U.S. Coast and Geodetic Survey (USC and GS) Ship *Surveyor,* in 1971 and 1972. These cruises obtained approximately 850 to 900 stations in the approximately 12,400 km^2 (4,800 mi^2) area for an average areal station density of about one station per 13 km^2 (5 mi^2). The station density along the ships' tracks is about one station every 1.5 km (1 mi). The root-mean-square uncertainty in the measurements, determined by values at 85 points where the ships' tracks cross, is 5.5 mgal.

Land gravity measurements in the Coos Bay area yield principal facts for approximately 450 stations for an average areal station density of approximately one station per 5 km^2 (2 mi^2). The estimated root-mean-square uncertainty in the values of the land stations is approximately 1 mgal.

MAGNETIC ANOMALY MAP

Magnetic measurements made by the R/V *Yaquina* in 1967, 1969, and 1973 and the USC and GS Ship *Surveyor* in 1971 and 1972 were superimposed on a magnetic map of the offshore area of Oregon prepared by D. Emilia, J. Berg, Jr., and W. Bales (Berg and others, 1966; Emilia and others, 1966). The newer data allowed an extensive refinement of the earlier work and yielded a map of the area between latitude 43° and 44°15′ N. and longitude 124° and 125°30′ W., with a contour interval of 50 gammas (Figure 18). The average areal station density is approximately one station per 20 km^2 (8 mi^2), and the estimated root-mean-square uncertainty, based on measurements at 34 crossings of the survey ships' tracks, is 14.5 gammas.

Only one flight line was available over the land portion of the map, and hence no attempt was made to contour anomalies on land. Although Figure 18 shows the major anomalies on the continental shelf, the areal station density is relatively low, and no land data are available to relate marine and terrestrial structures.

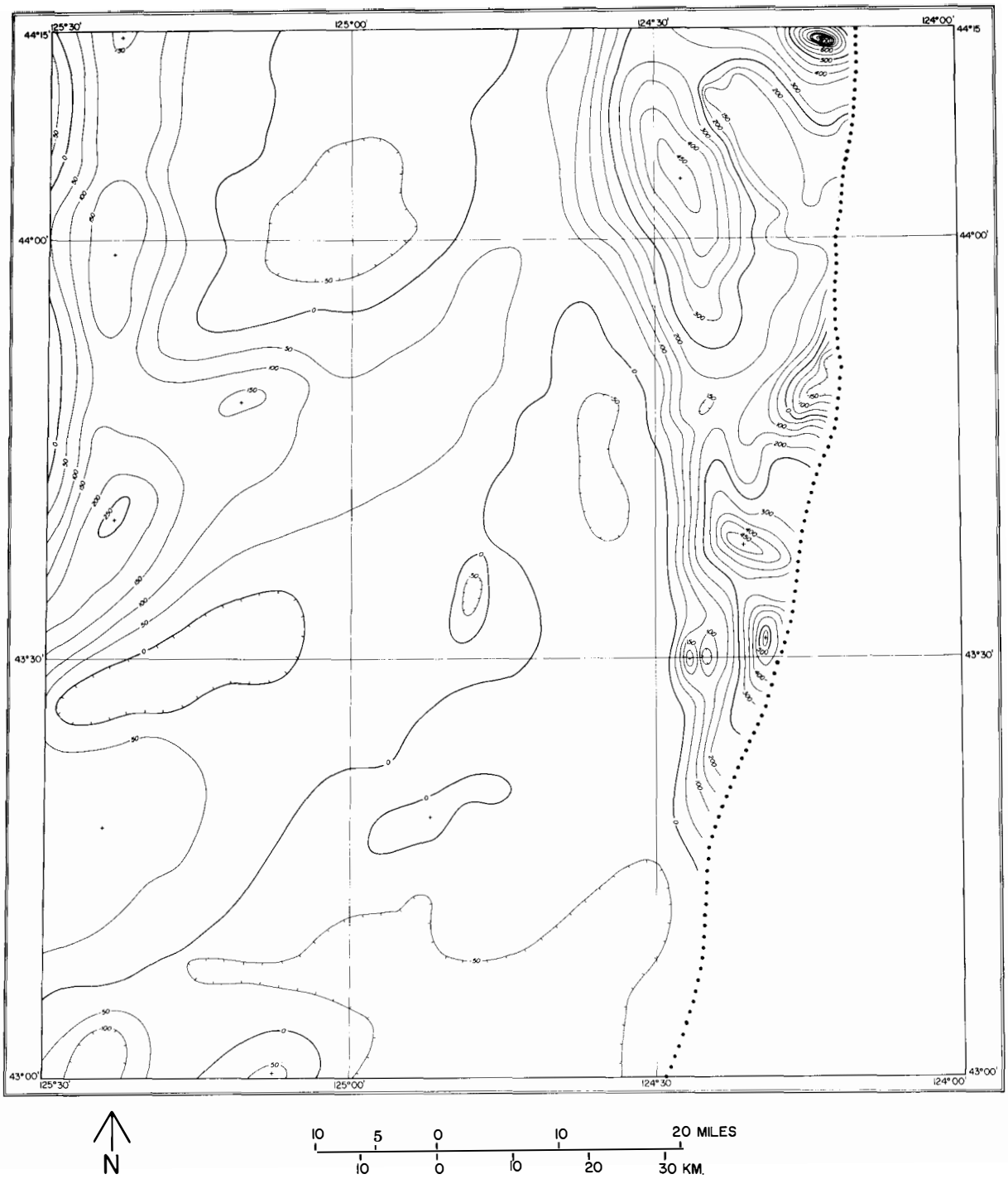

Figure 18. Magnetic anomaly map of the area offshore of the central Oregon coast. Contour interval, 50 gammas. Dotted line indicates coastline.

SEDIMENTARY ROCKS OF THE CENTRAL OREGON CONTINENTAL SHELF

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TEXTURAL PROPERTIES AND ROCK CLASSIFICATION

All rock samples collected on the central Oregon continental shelf were analyzed for their textural characteristics. Each consolidated rock sample was disaggregated in a buffered, weak acid solution. The sand fraction (> 62 microns) of the unconsolidated sediment was then analyzed in a settling tube for its content. The silt and clay fractions (< 62 microns) were analyzed with a soils hydrometer to obtain their content. The combined sand, silt, and clay contents total to 100 percent. Each of these textural components is expressed as a percentage of the total rock as shown in the diagrams in Figures 19 and 20.

This textural analysis indicates that all rocks on the central Oregon shelf are sedimentary in origin (Figures 21 and 22). Furthermore, the lithologies of the shelf are dominated by fine-grained mudstones (i.e., the silt and clay contents constitute the bulk of the rock). A few rocks are classified as sandstones (i.e., sand predominates over silt or clay).

AGES OF SEDIMENTARY ROCKS

The ages of the mudstones were determined through the use of planktonic Foraminifera (microfossils) when present in the rocks. A few mudstones and most sandstones were barren of Foraminifera, and no ages could be determined for those lithologies. The ages of the sedimentary rocks were assigned by Gerald A. Fowler (Figures 23 and 24). He found that all sedimentary rocks recovered from the central Oregon continental shelf range in age from late Miocene to Pleistocene.

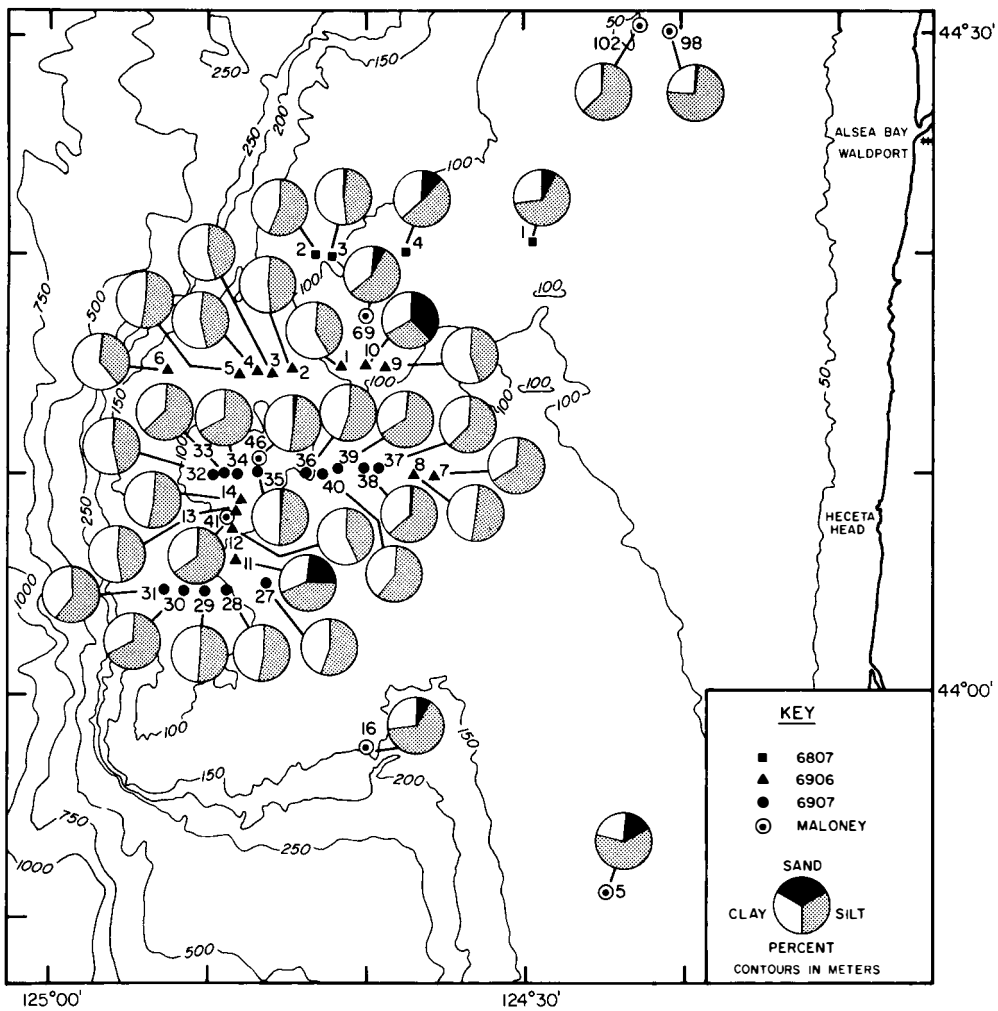

Figure 19. Texture of sedimentary rocks collected on Heceta Bank on the outer continental shelf off Heceta Head. Oregon State University (OSU) cruises are indicated by symbols.

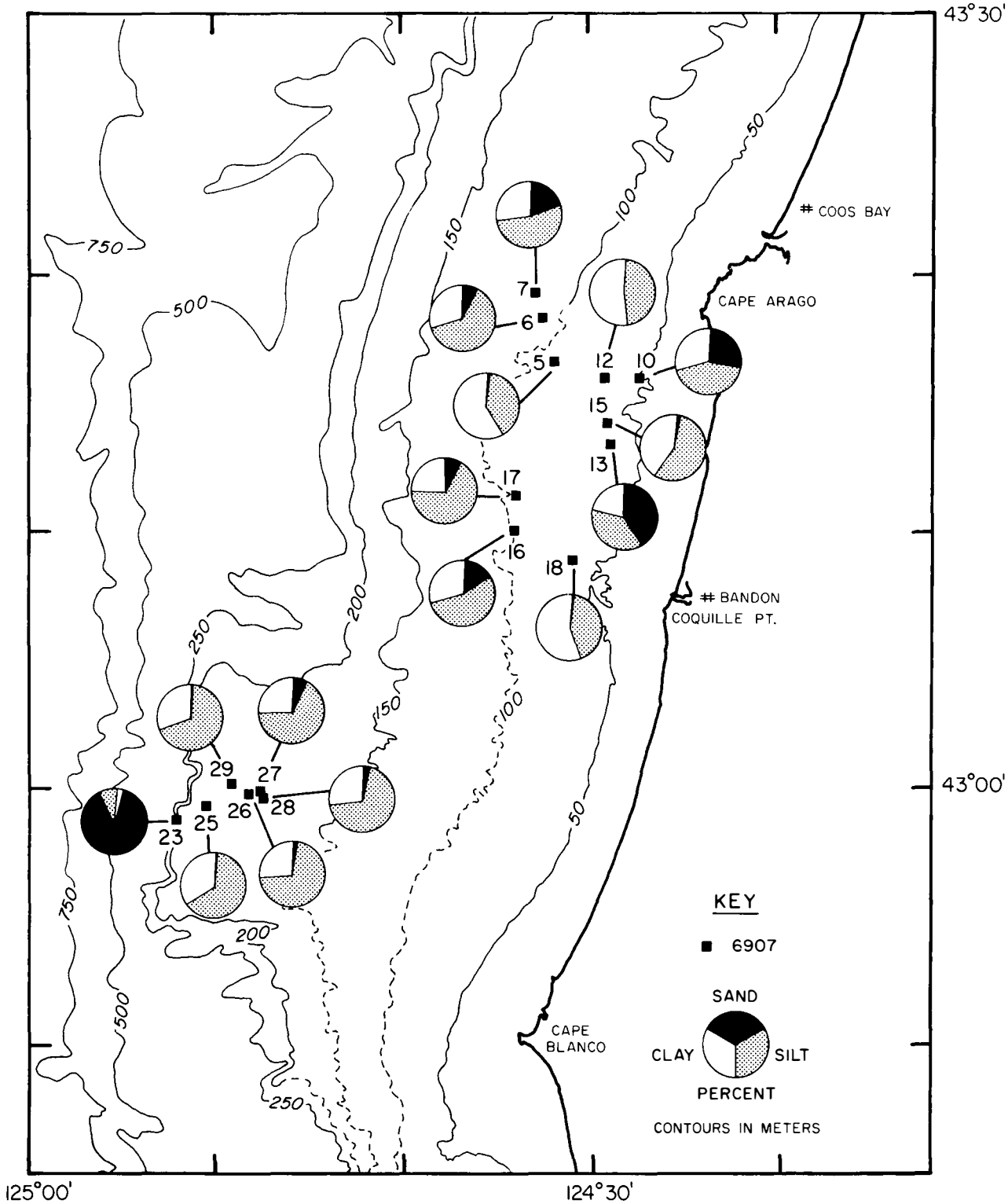

Figure 20. Texture of sedimentary rocks collected from the continental shelf between Cape Arago and Bandon and on Coquille Bank between Bandon and Cape Blanco. All rocks were collected on Oregon State University Cayuse *cruise 6907.*

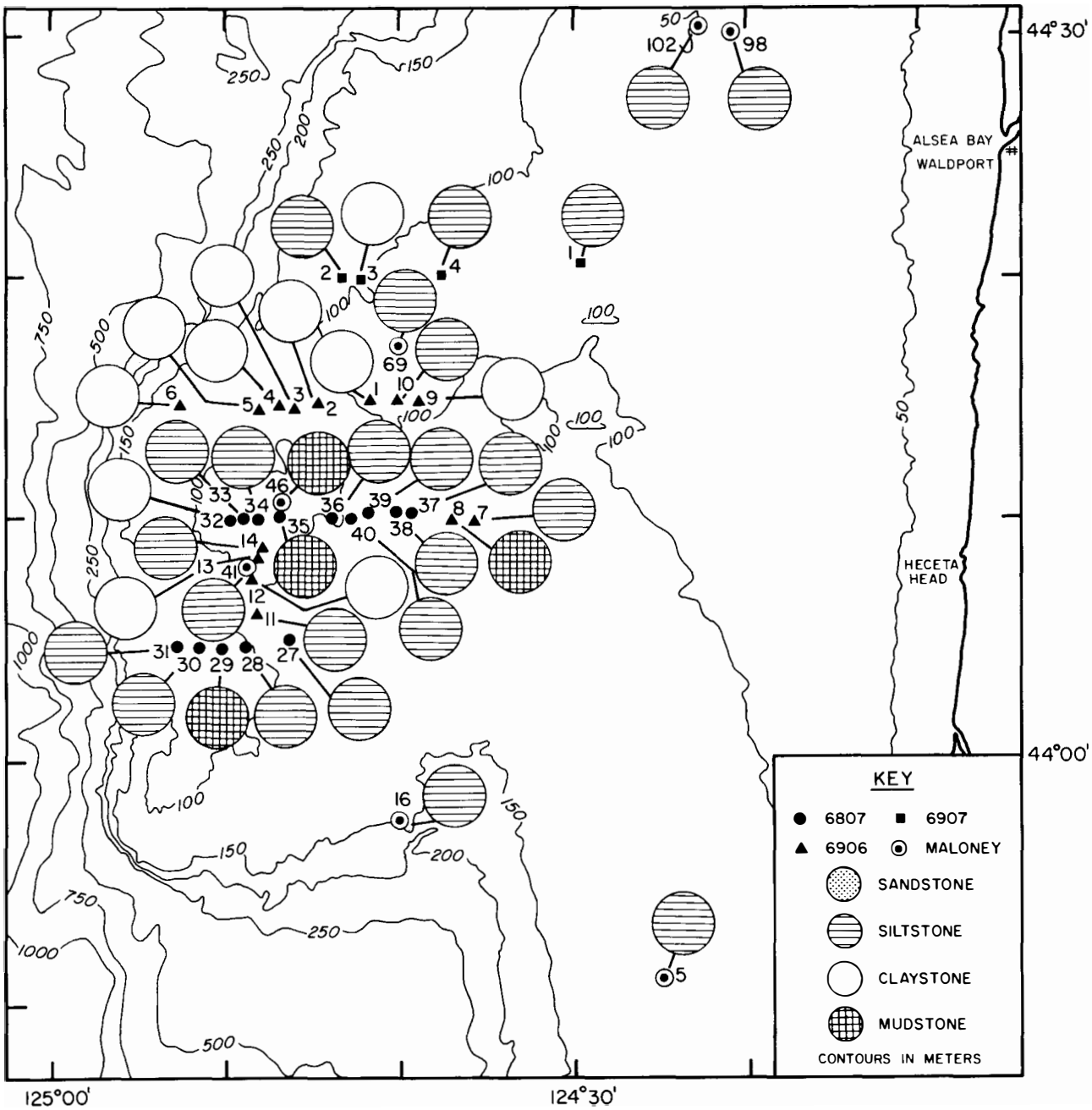

Figure 21. Types of sedimentary rocks collected on Heceta Bank on the outer continental shelf off Heceta Head. OSU cruises are indicated by symbols.

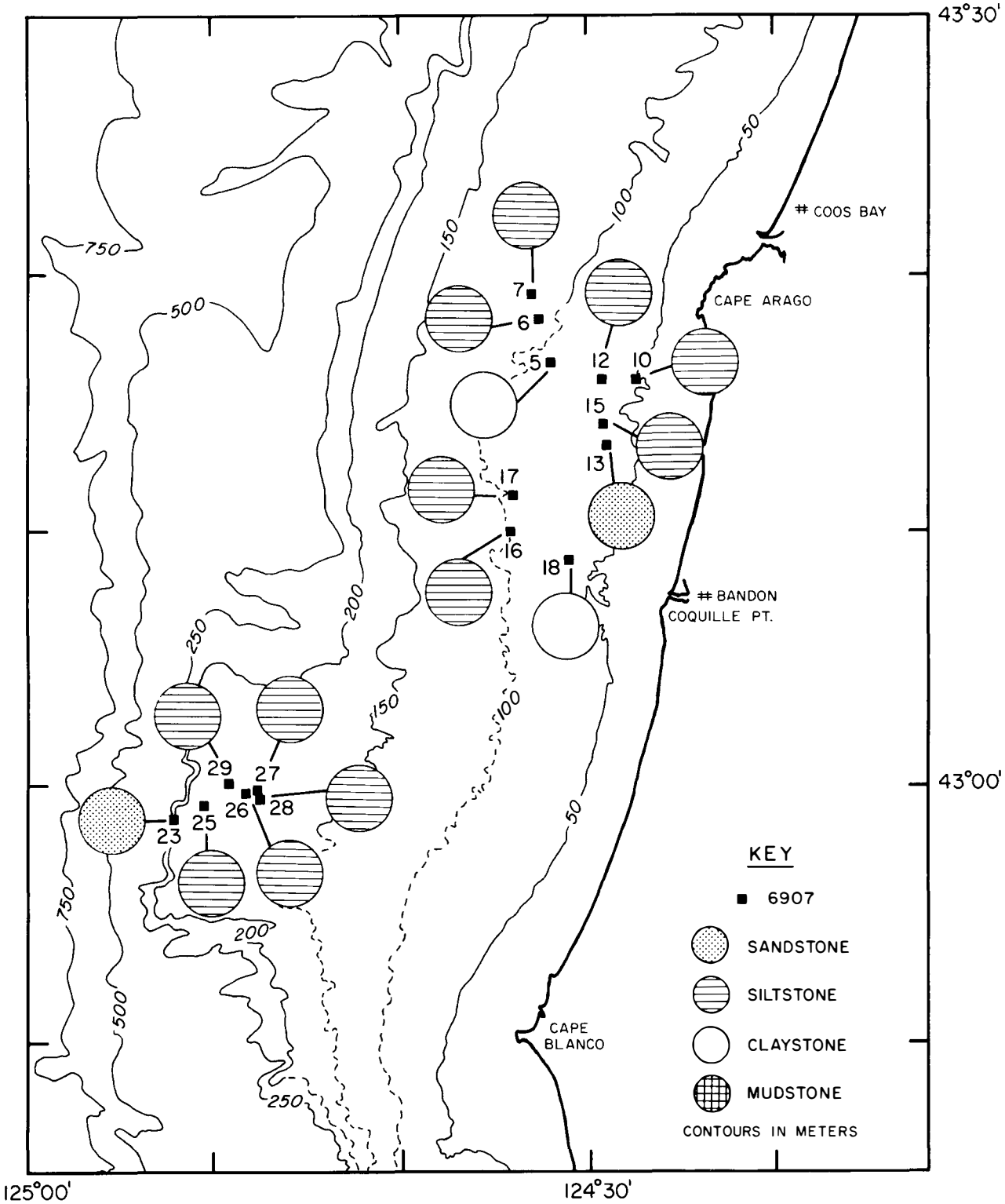

Figure 22. Types of sedimentary rocks collected from the continental shelf between Cape Arago and Bandon and on Coquille Bank between Bandon and Cape Blanco. All rocks were collected on OSU Cayuse *cruise 6907.*

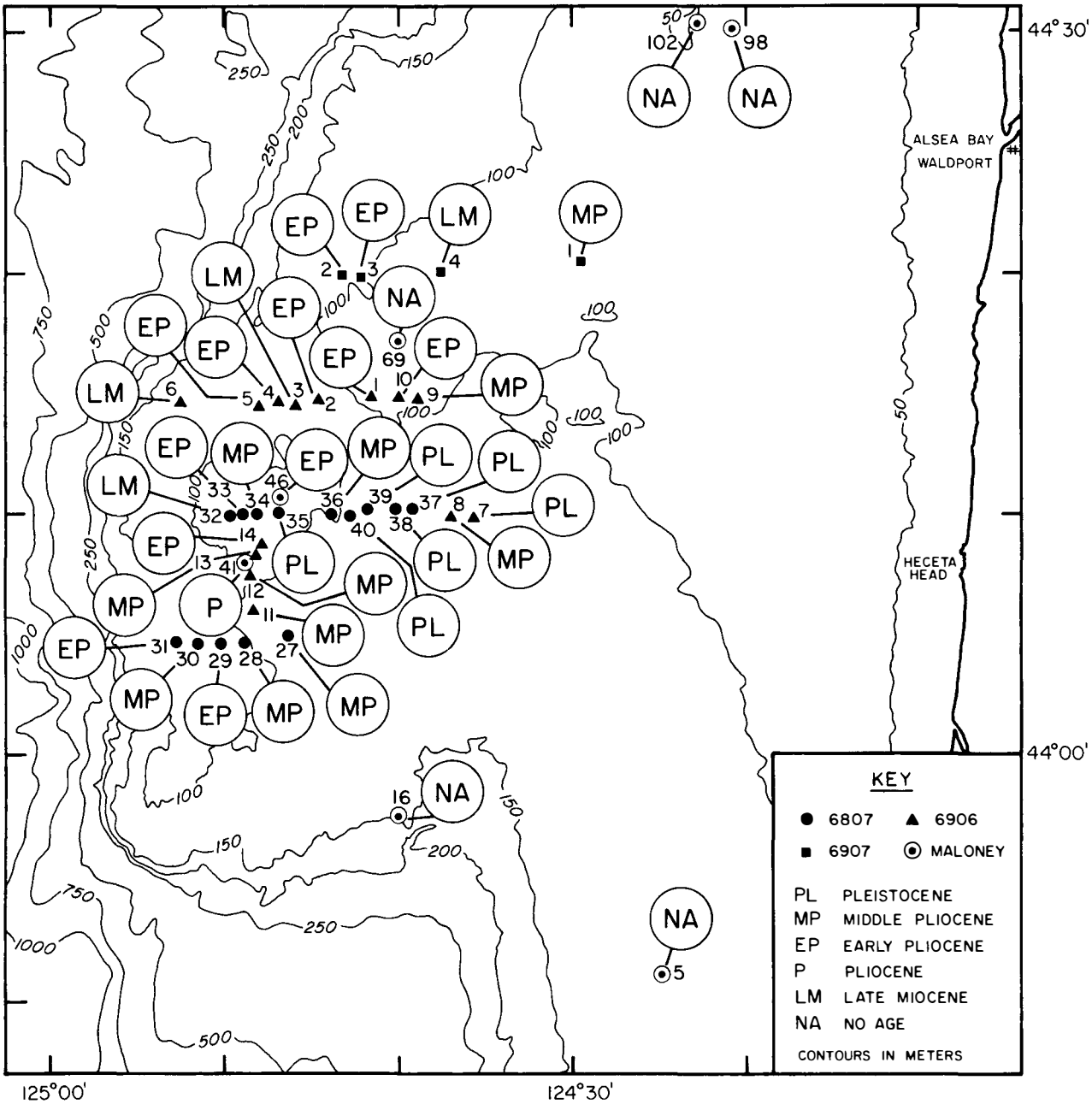

Figure 23. Ages of sedimentary rocks collected on Heceta Bank. OSU cruises are indicated by symbols.

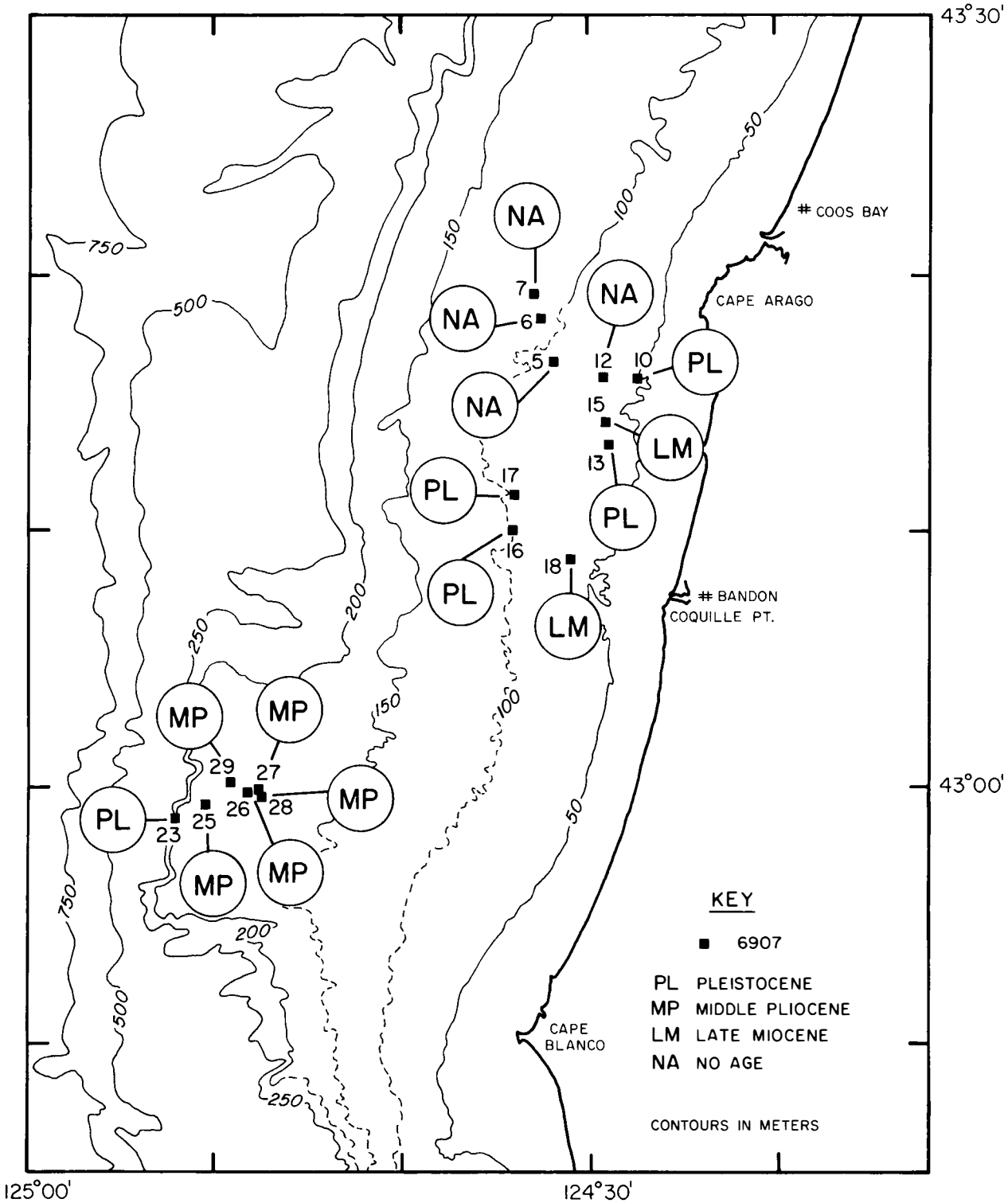

Figure 24. Ages of sedimentary rocks collected between Cape Arago and Bandon and on Coquille Bank between Bandon and Cape Blanco. All rocks were collected on OSU Cayuse *cruise 6907.*

PETROGRAPHIC ANALYSIS OF SANDSTONES, ROSEBURG, FLOURNOY, AND COALEDO FORMATIONS, SOUTHWESTERN OREGON

By Robert O. Van Atta, Earth Sciences Department, Portland State University, Portland, Oregon

INTRODUCTION

This report is based upon microscopic study of thin sections and grain mounts of 16 samples of sandstones supplied by the Oregon Department of Geology and Mineral Industries. Seven of the specimens were sufficiently fresh so that thin sections could be prepared. The other nine specimens were impregnated, and thin sections were made, although original texture cannot be studied by this method. Grain mounts were made of the sand-size (>62 micron) fraction of all specimens. These were stained, using a modification of the methods of Bailey and Stevens (1960). Types of quartz, feldspar, rock fragments, and mica were identified, and line counts were made of thin sections and stained grain mounts to determine percentage composition. In addition, sorting, packing (number of grain-to-grain contacts), effects of diagenesis (including cementation), and porosity were estimated from thin sections. The results of line counts are shown in Table 1. Totals of quartz, potassium (K) and plagioclase (Pl) feldspar, total rock fragments, mica, and heavy minerals represent 100 percent of rock composition. The sandstones are classified according to Dott (1964) and Folk (1974) by recalculating quartz, total feldspar, and rock fragments to 100 percent. Folk's classification ignores matrix (< 62 micron size), and Dott's classification uses the name "wacke" when the fines are greater than 15 percent. Grouping of these sandstones according to Folk's classification is shown in Figure 25.

Although identification of types of rock fragments is not always easy, especially in weathered friable specimens or in very fine-grained sandstones, it was attempted for this study. In some samples, only a small percentage of the total rock fragment population of grains was identifiable, but selected recounts of grains, concentrating upon rock fragments alone, revealed the same relative percentages of each type of rock as those determined in original counts of all components. Classification of sandstones based upon types of rock fragments (recalculated to 100 percent) is shown in Figure 26.

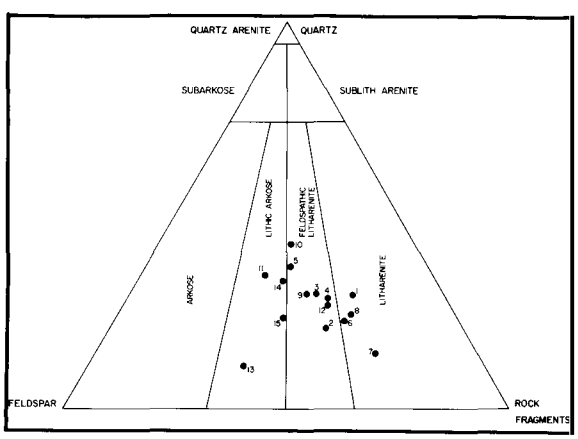

Figure 25. Classification of sandstones of the Roseburg, Flournoy, and Coaledo Formations, according to the system of Folk (1974). Numbers indicate samples in Table 1.

DISCUSSION AND CONCLUSIONS

Classification of sandstone samples from the Roseburg, Flournoy, and Coaledo Formations, according to Folk, indicates no very great difference in rock type. The relative percentages of volcanic, sedimentary, and metamorphic rock fragments do, however, point out subtle differences, as shown by grouping of samples in Figure 26. In this study, we are dealing with a relatively small number of samples from the Flournoy Formation and the upper member of the Coaledo Formation, and although there are few identifiable rock fragments in most samples, varying percentages of certain types of rock fragments allow grouping by geologic units.

The Roseburg Formation sandstones are characterized by a very low percentage of volcanic rock fragments, as compared to the Flournoy and Coaledo Formations. Sandstones of the lower member of the Coaledo Formation are quite variable in their content of volcanic, sedimentary, and metamorphic rock fragments, while the Flournoy and upper member of the Coaledo Formation sandstones are quite similar.

It must be recognized, of course, that in each sample there is a large percentage of total rock fragments which could not be identified with certainty. It is assumed that

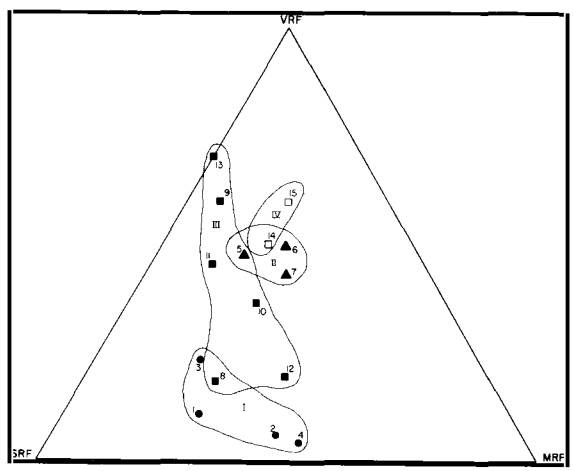

Figure 26. Classification of sandstones of the Roseburg, Flournoy, and Coaledo Formations, based on identifiable rock fragments. VRF = volcanic rock fragments; SRF = sedimentary rock fragments; MRF = metamorphic rock fragments. Fields shown: I — Roseburg Formation; II — Flournoy Formation; III — lower member of the Coaledo Formation; IV — upper member of the Coaledo Formation. Numbers indicate samples in Table 1.

Table 1. *Percentage composition of sandstones of the Roseburg, Flournoy, and Coaledo Formations, Oregon*

Formation Sample location	Quartz	Feldspar K	 (Pl)	Rock fragments[1] VRF	 SRF	 MRF	Total	Mica	Heavies[2]	Cement or matrix	Porosity	Cl[3]	Remarks
Roseburg													
1. NW14, 28S, 14W	27	3	15	5	27	12	44	3	7	?	?	?	——
2. SE27, 28S, 14W	18	9	23	3	22	20	45	4	1	Chlorite Smectite	Nil	3	Thin section
3. SE11, 28S, 12W	29	7	20	2	5	2	42	3	T	?	?	?	——
4. SW4, 29S, 12W	30	13	13	1	11	12	42	2	T	Clay	Nil	3	Thin section
Flournoy													
5. Center 31, 24S, 11W	34	8	22	14	10	5	30	4	2	Smectite	Nil	2	Thin section
6. SE26, 28S, 14W	23	10	15	2	1	1	51	1	T	Smectite ?	?	?	——
7. SW15, 23S, 12W	17	5	13	3	2	2	52	10	3	?	?	?	——
Lower member Coaledo													
8. SW19, 28S, 13W	25	7	16	4	12	6	51	1	T	?	?	?	——
9. E¼Cor. 13, 28S, 14W	30	7	21	8	5	1	39	2	1	Clay	Nil	2	Fossiliferous glauconite; thin section
10. NE36, 28S, 14W	26	15	24	3	2	3	30	3	2	Calcite Clay	Nil	3	Glauconite; thin section
11. SE25, 28S, 14W	29	9	24	8	7	2	24	13	1	Sparry calcite	Nil	1	——
12. NE29, 27S, 12W	27	9	17	1	2	2	45	2	T	?	?	?	Fossiliferous wood, glauconite; thin section
13. 30, 27S, 12W	10	2	46	7	3	T	32	4	6	Clay	?	?	——
Upper member Coaledo													
14. NW3, 28S, 13W	31	3	21	17	10	7	34	5	6	Clay	?	4	Thin section
15. SW20, 26S, 12W	18	2	28	3	1	1	29	14	9	?	?	?	Carbonaceous; pebbly

[1] Rock fragments: VRF = volcanic; SRF = sedimentary (chert, graywacke); MRF = metamorphic (phyllite, quartz schist). Total includes identified and unidentifiable rock fragments.
[2] T = Trace, less than 1%.
[3] Cl = Grain contacts per grain.

Table 2. *Classification of Tertiary sandstone samples*

Formation	Sample no.	Folk	Dott
Roseburg	1	Litharenite	(Original matrix not determined)
	2	Feldspathic litharenite	Lithic arenite
	3	Feldspathic litharenite	(Original matrix not determined)
	4	Feldspathic litharenite	Lithic arenite
Flournoy	5	Feldspathic litharenite	Lithic arenite
	6	Litharenite	(Original matrix not determined)
	7	Litharenite	(Original matrix not determined)
Lower member Coaledo	8	Litharenite	(Original matrix not determined)
	9	Feldspathic litharenite	Lithic arenite
	10	Feldspathic litharenite	Lithic arenite
	11	Lithic arkose	Arkosic arenite
	12	Feldspathic litharenite	(Original matrix not determined)
	13	Lithic arkose	Arkosic arenite
Upper member Coaledo	14	Lithic arkose	Arkosic arenite
	15	Lithic arkose	Arkosic graywacke

the relative percentage of each identified type of rock would be the same in the group of unidentifiable grains, but this is admittedly a weak assumption. It is common that volcanic rock fragments with a high glass content may be so badly altered that they appear to be nearly opaque with iron-manganese oxides. This author believes that although this might be the case, it would not affect the relative distinction between the formations, since it would merely increase the percentage of volcanic rock fragments in all of the samples.

The porosity, where it is estimated in thin section, is very low in these sandstones, due to good compaction. The cement in most of the sandstones (thin sections of fresh rock) is a mixture of chlorite and smectite, most of which is diagenetic. Two of the sandstones of the lower member of the Coaledo Formation have sparry calcite cement which has replaced the clay matrix and partially replaced quartz and feldspar.

Sandstones of the lower member of the Coaledo Formation are glauconitic, and one sandstone sample of the upper member of the Coaledo Formation is carbonaceous. For individual sample descriptions see Tables 1 and 2.

PALEONTOLOGICAL INTERPRETATION OF FIVE SOUTHWESTERN OREGON WELLS

By Daniel R. McKeel, Route 1, Box 157A, Otis, Oregon

SUMMARY STATEMENT

After studying the Foraminifera in five deep onshore and offshore southwestern Oregon wells (Phillips Petroleum Dobbyns 1, Coos County; Sinclair Oil and Gas Company Mapleton 1, Lane County; E. M. Warren Coos County 1-7, Coos County; Pan American Corporation OCS P-0112, offshore Coos Bay; and Union Oil Company OCS P-0130 [Fulmar 1], offshore Florence), I believe that the following observations may be significant to the area in general.

There is a major change in depositional regimes from the Narizian to pre-Narizian sediments. In fact, there seems to be a widespread hiatus at this point in the section, as often part, sometimes all, of the lower Ulatisian is missing. Above the proposed hiatus, sediments were deposited quickly, close to shore. Below the hiatus, sedimentation rates were much lower, and deposition appears to have been significantly farther from shore. A consistently high planktonic to benthonic foraminiferal ratio occurs in the pre-Narizian sediments. The pre-Narizian benthonic Foraminifera are relatively rare, and the entire benthonic faunas are diminutive, a curious feature. Perhaps an offshore cool water mass kept foraminiferal metabolism high. This in turn would keep life span short and specimen size small.

Because of the general scarcity and diminutive size of pre-Narizian benthonic Foraminifera in the Oregon wells studied, it is difficult to recognize pre-Narizian stages of Mallory (1959), which are based primarily on benthonic Foraminifera. Therefore, one must rely heavily on planktonic species for biostratigraphic interpretation of these older Oregon sediments.

The distribution of pre-Narizian planktonic Foraminifera in southwestern Oregon wells has been compared to that in the section at Media Agua Creek, Kern County, California. This section is the type area of the zones of Ynezian and Bulitian Stages, and of Penutian Stage, all of Mallory (1959). It contains abundant specimens of both benthonic and planktonic Foraminifera. Media Agua Creek planktonic Foraminifera are the same species and occur in the same general sequence as in the southwestern Oregon wells studied. In this manner, sediments equivalent to the Penutian, Bulitian, and possibly even pre-Bulitian Stages of Mallory (1959) were recognized in some of the Oregon wells.

Thus, there is an important possibility that in the southern Oregon offshore area, below 5,000 ft (1,500 m) in the Pan American well OCS P-0112 and below 5,000 ft (1,500 m) in the Union Oil well OCS P-0130, there are sediments of pre-Eocene or perhaps even pre-Tertiary age. The Paleocene fauna at 5,041 ft (1,536 m) in the Union Oil well has also been found in an outcrop 6 mi (10 km) northeast of Bandon.

Species lists for each sample from four of the five wells examined for this study are contained in the Oregon Department of Geology and Mineral Industries Open-File Report O-80-13. The open-file report is available for sale in the Department's Portland office. The species list for the E. M. Warren Coos County 1-7 well is included later in this Oil and Gas Investigation.

PHILLIPS PETROLEUM DOBBYNS 1, COOS COUNTY, OREGON

The following foraminiferal report lists interpretations of 50 ditch sample residues within the interval from 50 to 6,938 ft (15 to 2,115 m). Processed samples were borrowed from the Oregon Department of Geology and Mineral Industries in Portland.

There are essentially two fossiliferous intervals in the well. The higher one, from 1,800 to 2,330 ft (550 to 710 m), presents a problem. It contains a cold water, nearshore benthonic foraminiferal fauna. Some of the species present are incompatible with regard to both age and paleobathymetry. Abundant specimens of the bathyal genus *Gyroidina* occur with rare inner neritic *Elphidium californicum. E. californicum* and *Gyroidina guayabalensis,* considered restricted to Ulatisian sediments or older in California (Mallory, 1959), occur with common *Cribrononion* cf. *roemeri,* which is believed to be restricted to the Refugian in the Gulf of Alaska (R. S. Boettcher, 1980, personal communication). Hence the present author's interpretation of Narizian, Coaledo Formation, for this interval 1,800 to 2,330 ft (550 to 710 m) is probable at best. Since the benthonic fauna in this interval represents cold bottom water (very low species diversity), an outer neritic environment is suggested here; the deep water species of *Gyroidina* could have migrated onto the outer shelf, finding similar temperatures to its normal bathyal habitat.

The lower fossiliferous interval, from 5,040 to 6,410 ft (1,536 to 1,954 m), contains an offshore open marine fauna consisting almost entirely of diminutive planktonic foraminifers and radiolarians. However, a few mature identifiable specimens of planktonic Foraminifera are known in southwestern Oregon from only the Roseburg Formation (Miles, 1977). These fossils, plus the predominantly volcanic lithology from 2,340 ft (713 m) to total depth, indicate that the bottom two-thirds of the well are in the lower member of the Roseburg Formation. Indigenous fossils were not seen in the upper and lower parts of the volcanic interval from 2,340 to 5,030 ft (713 to 1,533 m), and 6,420 to 6,938 ft (1,957 to 2,115 m), but interbeds of shale yielded faunas from 5,040 to 6,410 ft (1,536 to 1,954 m), thus documenting the submarine nature and lower Paleogene age of the basalts (Baldwin, 1973, p. 18). This fossiliferous interval could not be assigned directly to California benthonic stages, due to the extreme rarity of diagnostic benthonic Foraminifera. The interval from 5,400 to 6,230 ft (1,646 to 1,899 m) is probably Bulitian to Penutian in age, and the sample from 6,240 to 6,290 ft (1,902 to 1,917 m) is possibly Ynezian to Bulitian.

The species list for the samples from this well is printed in the Department's Open-File Report O-80-13, which is available in the Portland office.

Table 3. *Foraminiferal report, Phillips Petroleum Dobbyns 1, Coos County, Oregon*

Depth (ft)	Age/Stage	Formation	Paleoenvironment
50- 104	Indeterminate	Indeterminate	Indeterminate
240- 290	Indeterminate	Indeterminate	Indeterminate
415- 460	Indeterminate	Indeterminate	Marginal marine
600- 650	Indeterminate	Indeterminate	Marginal marine
780- 830	Indeterminate	Indeterminate	Indeterminate
900- 950	Indeterminate	Indeterminate	Indeterminate
1,020-1,070	Indeterminate	Indeterminate	Indeterminate
1,140-1,190	Indeterminate	Indeterminate	Indeterminate
1,260-1,310	Indeterminate	Indeterminate	Indeterminate
1,380-1,430	Indeterminate	Indeterminate	Indeterminate
1,560-1,610	Indeterminate	Indeterminate	Indeterminate
1,740-1,790	Indeterminate	Indeterminate	Indeterminate
1,800-1,850	Probable Narizian	Probable Coaledo	Probable outer neritic
1,860-1,910	Probable Narizian	Probable Coaledo	Probable outer neritic
1,920-1,970	Probable Narizian	Probable Coaledo	Probable outer neritic
1,980-2,030	Probable Narizian	Probable Coaledo	Probable outer neritic
2,040-2,090	Probable Narizian	Probable Coaledo	Probable outer neritic
2,100-2,150	Probable Narizian	Probable Coaledo	Probable outer neritic
2,160-2,210	Probable Narizian	Probable Coaledo	Probable outer neritic
2,220-2,270	Probable Narizian	Probable Coaledo	Probable outer neritic
2,280-2,330	Probable Narizian	Probable Coaledo	Probable outer neritic
Unconformity—Flournoy, Lookingglass and upper Roseburg Formations missing			
2,340-2,390	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
2,400-2,450	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
2,760-2,810	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
3,180-3,230	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
3,600-3,650	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
3,960-4,010	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
4,380-4,430	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
4,800-4,850	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
4,980-5,030	Probable lower Paleogene*	Probable lower Roseburg*	Indeterminate
5,040-5,090	Probable lower Paleogene*	Probable lower Roseburg*	Probable marine
5,100-5,150	Paleogene	Probable lower Roseburg**	Open marine
5,160-5,210	Paleogene	Probable lower Roseburg**	Open marine
5,340-5,390	Paleogene	Probable lower Roseburg**	Open marine
5,400-5,450	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
5,460-5,510	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
5,520-5,570	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
5,580-5,630	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
5,760-5,810	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
5,880-5,930	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
5,940-5,990	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
6,060-6,110	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
6,120-6,170	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
6,180-6,230	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
6,240-6,290	Possible Paleocene	Lower Roseburg	Open marine
6,300-6,350	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
6,360-6,410	Upper Paleocene-lower Eocene	Lower Roseburg	Open marine
6,420-6,470	Probable lower Paleogene	Probable lower Roseburg*	Indeterminate
6,660-6,710	Probable lower Paleogene	Probable lower Roseburg*	Indeterminate
6,900-6,938	Probable lower Paleogene	Probable lower Roseburg*	Indeterminate

* Based on lithology only.

** Based primarily on lithology.

SINCLAIR OIL AND GAS COMPANY MAPLETON 1, LANE COUNTY, OREGON

The following foraminiferal report is based on the analysis of 22 previously unprocessed dry ditch samples from 970 to 6,650 ft (295 to 2,025 m). The samples were borrowed from the core collection of the Oregon Department of Geology and Mineral Industries in Portland. Small cuts were boiled in a Quaternary "O" solution in my laboratory.

A survey of a previously processed set of samples indicated a poorly fossiliferous interval from approximately 2,700 to 6,700 ft (820 to 2,040 m) (McKeel to Newton, 1979, personal communication). I decided to concentrate primarily on this part of the well only. Because only about ten percent of the studied interval was analyzed, approximately one 20-ft (6-m) ditch sample for each 200 ft (60 m) of section, the following interpretations are tentative.

The well penetrated strata of Ulatisian or older (but probably Ulatisian) age from 2,770 to 5,790 ft (840 to 1,760 m). Age-diagnostic benthonic Foraminifera are virtually nonexistent, making benthonic stage identification very difficult. However, a diminutive planktonic foraminiferal fauna at 3,370 to 3,390 ft (1,027 to 1,033 m) is most similar to that of the Flournoy Formation (Miles, 1977). The sample examined at 6,010 to 6,030 ft (1,830 to 1,840 m) contains rare planktonic Foraminifera known only from the lower Eocene Roseburg Formation (Miles, 1977). Again, benthonic forms are very sparse and generally not age-diagnostic. However, the planktonic species *Pseudohastigerina* (*"Nonion"*) *wilcoxensis, s.s.* (at 6,010 to 6,030 ft [1,830 to 1,840 m]) and *Morozovella subbotinae* (at 6,150 to 6,200 ft [1,874 to 1,890 m]) are restricted to the Penutian Stage or older (Mallory, 1959; McKeel, unpublished research).

Planktonic Foraminifera and Radiolaria indicate open marine conditions from 2,770 to 6,150 ft (845 to 1,875 m). A high planktonic to benthonic ratio at 3,370 to 3,390 ft (1,027 to 1,033 m) suggests deposition far from shore. Rare benthonic forms from 4,750 to 6,150 ft (1,450 to 1,875 m) indicate depths at least as great as outer neritic, and probably bathyal. The presence of "larger" Foraminifera from 6,150 to 6,550 ft (1,875 to 1,995 m) can only mean very warm, very shallow marine water. Both the deeper water benthonic fossils and the planktonic forms in this interval probably represent contamination from above.

Included in this report is a list of age and paleoenvironmental interpretations for each sample studied. The species list is printed in the Department's Open-File Report O-80-13 which is available in the Portland office of the Oregon Department of Geology and Mineral Industries.

Table 4. *Foraminiferal report, Sinclair Oil and Gas Company, Mapleton 1, Lane County, Oregon*

Depth (ft)	Stage (Age)	Paleoenvironment
970- 990	Indeterminate	Indeterminate
2,170-2,190	Indeterminate	Indeterminate
2,530-2,550	Indeterminate	Indeterminate
2,770-2,790	Ulatisian or older	Open marine
3,190-3,210	Ulatisian or older	Open marine
3,370-3,390	Ulatisian (close to middle Eocene-lower Eocene boundary)	Offshore open marine
3,550-3,570	Ulatisian or older	Open marine
3,730-3,750	Ulatisian or older	Open marine
4,090-4,110	Ulatisian or older	Open marine
4,270-4,290	Ulatisian or older	Open marine
4,510-4,530	Ulatisian or older	Open marine
4,750-4,770	Ulatisian or older	Open marine, outer neritic to bathyal
4,870-4,890	Ulatisian or older	Open marine, outer neritic to bathyal
5,170-5,190	Ulatisian or older	Open marine, outer neritic to bathyal
5,530-5,550	Ulatisian or older	Open marine, outer neritic to bathyal
5,770-5,790	Ulatisian or older	Open marine, outer neritic to bathyal
6,010-6,030	Penutian (lower Eocene)	Open marine, outer neritic to bathyal
6,030-6,040	Penutian or older	Open marine
6,150-6,200	Penutian or older	Mixed tropical inner neritic, open marine, and outer neritic to bathyal
6,350-6,400	Penutian or older	Mixed tropical inner neritic, open marine, and outer neritic to bathyal
6,520-6,550	Penutian or older	Mixed tropical inner neritic, open marine, and outer neritic to bathyal
6,620-6,650	Indeterminate	Indeterminate

E. M. WARREN COOS COUNTY 1-7, COOS COUNTY, OREGON

This study was undertaken to determine how deep indigenous Narizian foraminiferal faunas extend in the well and if the well possibly penetrated older than Narizian horizons.

The deepest indigenous Narizian fauna, in the opinion of this author, occurs at about 5,710 ft (1,740 m) (Table 5). The interval from 5,710 to 6,340 ft (1,740 to 1,930 m) is interpreted to be probably barren of indigenous Foraminifera; therefore, the age of this part of the section is indeterminate.

The possibility of repeated section in the well was suggested to this author by Dick Robertson, Northwest Exploration Company, Denver. An examination of Rau's (1973) preliminary checklist with this in mind, plus reexamination of approximately 40 samples throughout the well, did indicate a possible repeated section in the lower half. However, a detailed quantitative study of consecutive samples (both float and tailings) would be necessary to confirm this possibility. A project of this nature would exceed the scope of the present study.

Table 5. *Species list, selected samples near bottom of well, E. M. Warren Coos County 1-7, Coos County, Oregon*

Sample depth (ft)	Foraminiferal species
5,200	*Amphimorphina jenkinsi* (juvenile) VR*, Arenaceous indeterminate VR, *Bolivina basisenta* VR, *Bulimina schencki* C, *Cribrononion* cf. *roemeri* (juv.) R, *Gyroidina simiensis* C, *Haplophragmoides* sp. (small, crushed) VR, *Lenticulina* spp. R, *Nonionella*? sp. VR, ostracods VR.
5,680	*Amphimorphina jenkinsi* VR, *Bolivina basisenta* VR, *Bolivina kleinpelli* ? VR, *Bulimina schencki* C, gastropods VR, *Globobulimina* sp. VR, *Gyroidina condoni* R, *Gyroidina simiensis* C, *Haplophragmoides* sp. (small, crushed) R, ostracods VR.
5,710	*Bulimina schencki* R, *Cribrononion* cf. *roemeri* VR, *Eponides yeguaensis* VR, *Gyroidina condoni* ? (broken) VR, *Gyroidina simiensis* C, *Lenticulina* sp. VR, *Nonion/Nonionella* sp. R, *Quinqueloculina* spp. R, *Spumellaria* VR.
5,770	*Bolivina basisenta* VR, *Bulimina schencki* R, diatoms (pyritized) VR, *Gyroidina simiensis* R. Probably barren of indigenous Foraminifera.
5,830	Arenaceous indeterminate VR, *Bolivina* sp. VR, *Bulimina schencki* VR, *Eponides yeguaensis* VR, *Lenticulina* spp. R, *Plectofrondicularia searsi* VR. Probably barren of indigenous Foraminifera.
5,890	*Amphimorphina jenkinsi* VR, arenaceous indeterminate VR, *Bathysiphon* sp. (small, thin) VR, *Cibicides* sp. (small) VR, diatoms (pyritized) R, *Gyroidina condoni* R, *Gyroidina simiensis* R, *Nonion* sp. VR, ostracods VR. Probably barren of indigenous Foraminifera.
5,980	*Bulimina schencki* VR, *Cassidulina globosa* VR, *Globobulimina* sp. VR, *Gyroidina simiensis* VR, *Lenticulina* spp. R, *Spumellaria* VR. Barren of indigenous Foraminifera.
6,070	*Bathysiphon*? sp. VR, *Bulimina schencki* VR, *Cassidulina globosa* VR, *Gyroidina simiensis* R. Barren of indigenous Foraminifera.
6,160	Arenaceous indeterminate (very small) VR, *Bulimina schencki* VR, *Spumellaria* VR. Barren of indigenous Foraminifera.
6,280	Arenaceous indeterminate VR. Barren of indigenous Foraminifera.
6,340	*Plectofrondicularia vokesi* (of Mallory, 1959) VR. Barren of indigenous Foraminifera.

* VR = 1-2 specimens; R = 2-10; C = 11-32.

PAN AMERICAN PETROLEUM CORPORATION OCS P-0112, OFFSHORE COOS BAY, OREGON

The following foraminiferal report lists interpretations of 33 sample residues, 28 ditch and five sidewall cores (SWC), within the interval from 950 to 6,140 ft (290 to 1,870 m). The samples were processed by Pan American Petroleum Corporation (now AMOCO Production Company).

The interval examined represents all or part of the Saucesian, Zemorrian, Refugian, Narizian, Ulatisian, and Penutian California benthonic foraminiferal stages (lower Miocene to lower Eocene) of Schenck and Kleinpell (1936), Kleinpell (1938), and Mallory (1959). Traditionally, West Coast workers have considered the Refugian, Narizian, and Ulatisian Stages to be Oligocene, upper Eocene, and middle Eocene in age, respectively. Recent work, however, suggests that (1) the lower Refugian is upper Eocene (Tipton, 1975), (2) the lower Narizian is middle Eocene (Poore and Brabb, 1977), and (3) the lower Ulatisian is lower Eocene (Berggren and Van Couvering, 1973). To avoid confusion, the following report correlates the California benthonic foraminiferal stages (as recognized in the OCS P-0112) with the Oregon coastal formations (see McKeel and Lipps, 1975; Rau, 1975; Thoms, 1975; Tipton, 1975).

The Department's Open-File Report O-80-13 includes a key to abbreviated genera and species lists with paleobathymetric interpretations for each sample.

Table 6. *Foraminiferal report, Pan American Petroleum Corporation OCS P-0112, offshore Coos Bay, Oregon*

Depth (ft)	Stage	Formation
1,010-1,040	Saucesian	Nye equivalent
1,040-1,070	Saucesian	Nye equivalent
1,430-1,460	Saucesian	Nye equivalent
1,550-1,580	Saucesian	Nye equivalent
1,580-1,610	Saucesian	Nye equivalent
1,820-1,850	Saucesian	Nye equivalent
2,090-2,120	Upper Zemorrian-lower Saucesian	Upper Alsea to Nye equivalent
2,270-2,300	Upper Zemorrian-lower Saucesian	Upper Alsea to Nye equivalent
2,510-2,540	Upper Zemorrian	Upper Alsea-Yaquina equivalent
2,660-2,690	Upper Zemorrian	Upper Alsea-Yaquina equivalent
2,780-2,810	Upper Zemorrian	Upper Alsea-Yaquina equivalent
2,930-2,960	Upper Zemorrian	Upper Alsea-Yaquina equivalent
Hiatus—Tunnel Point Sandstone and uppermost Bastendorff Formation missing		
2,960-2,990	Lower Refugian	Upper Bastendorff
3,020-3,050	Lower Refugian	Upper Bastendorff
3,290-3,320	Lower Refugian	Upper Bastendorff
3,500-3,530	Lower Refugian	Upper Bastendorff
3,740-3,770	Narizian	Upper Coaledo or lower Bastendorff
3,890-3,920	Lower Narizian	Lower to middle Coaledo
3,918 SWC*	Lower Narizian	Lower to middle Coaledo
4,220-4,250	Lower Narizian	Lower to middle Coaledo
4,490 SWC*	Upper Ulatisian	Flournoy
4,550-4,580	Upper Ulatisian	Flournoy
Unconformity—lower Ulatisian not represented (see Miles, 1977)		
4,610 SWC*	Penutian	Roseburg/Lookingglass
4,610-4,640	Penutian	Roseburg/Lookingglass
4,850-4,880	Penutian	Roseburg/Lookingglass
4,852 SWC*	Penutian	Roseburg/Lookingglass
Possible unconformity.		
5,030-5,060	Possible Cretaceous	Possible Hunters Cove
5,060-5,090	Possible Cretaceous	Possible Hunters Cove
5,210-5,240	Indeterminate	Indeterminate
5,510-5,540	Indeterminate	Indeterminate
5,810-5,840	Indeterminate	Indeterminate
6,110-6,140	Indeterminate	Indeterminate
6,131 SWC*	Indeterminate	Indeterminate

* SWC = Sidewall core.

UNION OIL COMPANY OCS P-0130 (FULMAR 1), OFFSHORE FLORENCE, OREGON

The following foraminiferal report contains interpretations of 26 samples, 21 ditch and five sidewall cores (SWC), within the interval from 760 to 12,285 ft (230-3,745 m). The samples examined were previously processed for paleontology by Union Oil Company.

The interval examined contains faunas which represent all or part of the Venturian (?), Repettian, Mohnian, Luisian, Saucesian, Zemorrian, Narizian, Penutian, and Bulitian California benthonic foraminiferal stages of Schenck and Kleinpell (1936), Kleinpell (1938), Natland (1952) and Mallory (1959).

Several Paleogene age interpretations in this report are tentative, due to mixed faunas. For example, the sample at 4,540 ft (1,385 m) contains both middle and lower Eocene species; the younger assemblage is considered indigenous because the sample at 4,720 ft (1,440 m) contains no specimens older than middle Eocene. The samples at 5,000, 5,041, 5,370, and 5,400 ft (1,524, 1,536, 1,636, and 1,645 m) all contain mixed faunas. In each of these cases, the author has interpreted the older fauna to be indigenous. It is believed that these samples represent a relatively slow rate of sedimentation far from shore.

A single Cretaceous foraminifer was found at 5,400 ft (1,645 m). Although this specimen is well preserved, the possibility that it is reworked requires that the Cretaceous age call at 5,400 ft (1,645 m) be very tentative.

The age interpretations in the "Series" column of this report in some cases differ from the original published provincial age assignments of the California benthonic foraminiferal stages. The reason for these discrepancies primarily is that recent research with planktonic microfossils is taken into account here. For example, the lower Mohnian Stage is now considered to be middle Miocene in age (A. D. Warren, personal communication). Originally, Kleinpell (1938) assigned his Mohnian Stage to the upper Miocene. In these cases, both the Oregon age interpretation by this author and the original California provincial age are listed.

The Department's Open-File Report O-80-13 includes a key to abbreviated genera and species lists with paleobathymetric interpretations for each sample studied.

Table 7. *Foraminiferal report, Union Oil Company, OCS P-0130 (Fulmar 1), offshore Florence, Oregon*

Depth (ft)	California stage equivalent	Series
760	Venturian? (provincial middle Pliocene)	Probable upper Pliocene
1,340 SWC	Repettian? (provincial lower Pliocene)	Pliocene
1,450 SWC	Repettian	Lower Pliocene
Probable hiatus		
1,850 SWC	Lower Mohnian (provincial upper Miocene)	Middle Miocene
2,020 SWC	Lowest Mohnian (provincial upper Miocene)	Middle Miocene
2,140 SWC	Uppermost Luisian	Middle Miocene

Table 7. *Foraminiferal report, Union Oil Company, OCS P-0130 (Fulmar 1), offshore Florence, Oregon.—Continued*

Depth (ft)	California stage equivalent	Series
2,800	Relizian to Luisian, undifferentiated (provincial middle Miocene)	Lower to middle Miocene
2,980	Saucesian	Lower Miocene
3,250	Upper Zemorrian to lower Saucesian	Upper Oligocene to lower Miocene
3,760	Zemorrian	Probable Oligocene
4,240	Zemorrian	Probable Oligocene
4,300	Upper Refugian to Zemorrian	Probable Oligocene
Probable hiatus		
4,540	Probable Narizian (provincial upper Eocene)	Probable middle Eocene
4,720	Probable Narizian (provincial upper Eocene)	Probable middle Eocene
Probable hiatus		
4,930	Penutian	Lower Eocene
5,000	Probable Bulitian	Probable upper Paleocene
5,041	Probable Bulitian	Probable upper Paleocene
5,370	Bulitian to Ynezian, undifferentiated	Paleocene
Possible hiatus		
5,400	Possible Campanian	Possible upper Cretaceous
6,330	Indeterminate	Indeterminate
7,350	Indeterminate	Indeterminate
8,340	Indeterminate	Indeterminate
9,330	Indeterminate	Indeterminate
10,320	Indeterminate	Indeterminate
11,310	Indeterminate	Indeterminate
12,285	Indeterminate	Indeterminate

* SWC = sidewall core.

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APPENDICES

Appendix A. Oil and gas test wells drilled in or adjacent to the study area

Table 8a. *Data from onshore wells*

Company	Well name	Location	Date	Depth (ft)	Remarks (including information from well records kept by the Oregon Department of Geology and Mineral Industries)
Bear Creek Well	Flam 1	East of Bandon W¼ corner sec. 35, T. 28 S., R. 14 W.	1930's	2,300	Cable tools. Bottomed in Flournoy Formation. Some gas at 800 ft. Hole was drilled with 2-in. bit.
Chandler, W.S.	George Vernon property (coal prospect hole)	Westport Arch approx. sec. 4, T. 26 S., R. 13 W.	Before 1914	600	Reportedly found oil in coal prospect hole.
Coast Oil Co.	Fat Elk 1	Coquille area SE¼ sec. 11, T. 28 S., R. 13 W.	1929-1934	2,526	Cable tools. Drilled originally to 1,476 ft by Fat Elk Oil Co. Later deepened by Coast Oil Co. group. Encountered strong gas blow at 1,000 to 1,200 ft, blew for several days, and was then cased off. Thin oil sands were hit at approximately 1,500 ft. Oil coated cable tools when they were pulled from hole. Gas sand at 1,680 ft reportedly flowed at an estimated 750 Mcfd rate. Saltwater sand was hit at 1,745 ft. Well flowed trickle of gassy salt water in 1978 (J.E. Loreman and J.O. Bryant, 1930, reports, and Rex Roth, 1978, Coquille, Oregon, personal communication).
Coast Oil Co.	Well 2	Coquille area SW¼ sec. 10, T. 28 S., R. 13 W., 200 ft west of center of sec. 10	1939	2,255	Cable tools. Reportedly completed as producing gas well; estimated rate was 1,000 Mcfd. Producing zone was encountered between 1,050 and 1,170 ft. A 4-in. pipeline was laid across Coquille Valley to city of Coquille; however, for unexplained reason, field was never developed.
Coast Oil Co.	Well 3	Coquille area SW¼SE¼ sec. 10, T. 28 S., R. 13 W., 1,050 ft north and 1,000 ft west from SE corner sec. 10	1939	1,640	Cable tools. Reported to be small gas well.
Coast Oil Co.	Well 4	Coquille area near center sec. 11, T. 28 S., R. 13 W., 2,100 ft north and 1,700 ft east from SW corner sec. 11	1939	1,640	Cable tools. Hit flowing salt water.
General Petroleum Corp.	Long Bell 1	North of Reedsport SW¼ sec. 27, T. 20 S., R. 10 W., 1,640 ft east and 1,244 ft north from SW corner	1957	9,004	Rotary. Formation test 4,368 to 4,493 ft. Recovered 45-ft rise of drilling mud. Slight gas show at 5,345 ft. Hydrocarbon cut in cores at 5,590 and 6,040 ft.

Note: Drill stem test denotes test inside casing; formation test indicates open-hole test.

Table 8a. *Data from onshore wells.*—Continued

Company	Well name	Location	Date	Depth (ft)	Remarks (including information from well records kept by the Oregon Department of Geology and Mineral Industries)
Majestic Oil Co.	Rhoades-Menasha 1	Westport Arch NE¼ SW¼ sec. 32, T. 26 S., R. 13 W., 582 ft south and 243 ft west from center of sec. 32	1938	1,600	Cable tools. Good gas shows at 600 to 1,365 ft. Several coal seams encountered. Traces of oil at 880 and 900 ft.
Newport Mine	——	Libby NE¼ sec. 4, T. 26 S., R. 13 W.	1855	——	Pitch coal veins, a form of asphalt found in Newport Mine. Vertical veins of pitch coal are cut by beds of lignite (Diller, 1901).
Oregon Coastal Corp.	J. Coy 1	Bandon area SE¼ sec. 4, T. 29 S., R. 14 W. 330 ft south and 330 ft east from E¼ corner	1953	1,894	Rotary. Gas shows 1,200 to 1,300 ft. Rocks mostly shale. Well blew out for short time while drilling at 1,208 ft. After hole was abandoned, gas bubbled up through mud. Wellhead pressure 170 psi (E.G. Ray, McMinnville, 1960, personal communication).
Pacific Petroleum Corp.	Morrison 1	Bandon area SE¼ sec. 28, T. 28 S., R. 14 W.	1936	2,282	Because of crooked hole, rig was skidded 20 ft and new hole started.
Pacific Petroleum Corp. (J.B. Ewell)	Morrison 2	Bandon area SE¼ sec. 28, T. 28 S., R. 14 W. 500 ft south of N¼ corner	1936-1937	2,700	Rotary. Twisted off in first well at 700 ft. Skidded rig 20 ft and started second well. Gas shows at 570 to 1,060 ft. Oil show at 2,100 to 2,200 ft. Gas bubbling through drilling mud was used for cooking at camp near rig. Heavy mud had to be used to hold down gas (Mrs. Lola Fredericks, formerly Mrs. J.B. Ewell, 1978, personal communication). Hole was plugged with cement and converted to water well (O. Gant, Bandon, 1979, personal communication).
Pacific Power and Light Co.	Eden Ridge 101	Eden Ridge NW¼ SW¼ sec. 21, T. 33 S., R. 11 W.	1957	1,200	Encountered thin coal seams at 300 to 320 ft and 1,000 to 1,020 ft. Gas was encountered in one of three deep core holes, possibly this one? Spud in Tyee, bottomed in partially metamorphosed shale.
Phillips Petroleum Co.	Dobbyns 1	Coos Bay area SW¼ sec. 28, T. 26 S., R. 13 W. 330 ft south and 300 ft east from W¼ corner	1943-1944	6,941	Rotary. Encountered gas sand at 1,040 ft (electric log). Drilled into Roseburg Formation at 2,340 ft, directly beneath Coaledo Formation. Considerable amounts of sediments were intermixed with submarine basalt in Roseburg Formation. No shows were reported.
Riverton Mine	——	Beaver Slough NW¼ sec. 17, T. 28 S., R. 13 W.	1895	——	Pitch coal as found in Newport Mine. Oil noted in loads of coal delivered from Riverton (Rex Roth, Coquille, 1978, personal communication).

Note: Drill stem test denotes test inside casing; formation test indicates open-hole test.

Table 8a. *Data from onshore wells.*—Continued

Company	Well name	Location	Date	Depth (ft)	Remarks (including information from well records kept by the Oregon Department of Geology and Mineral Industries)
Sinclair Oil and Gas Co.	Mapleton 1	Mapleton SE¼ sec. 12, T. 16 S., R. 10 W. 1,629 ft north and 246 ft west from SE corner	1956	12,880	Rotary. Oil shows at 4,980 and 5,310 ft. Some gas at 2,490 and 3,824 ft. Bottom 6,200 ft drilled mostly basalt. No formation tests run. Core from 6,042 to 6,052 ft had 71 percent water saturation.
Sunset Oil Co. (J.B. Ewell)	Bandon	Bandon area sec. 4, T. 29 S., R. 14 W.	1944	1,089	Rotary. Oil shows and some gas (E.G. Ray, McMinnville, 1960, personal communication). Set 6¼-in. casing at 643 ft, drilled rat hole to 1,089 ft.
Warren, E.M.	Coos County 1-7	Coquille area SW¼ SE¼ sec. 7, T. 27 S., R. 13 W. 450 ft north and 2,200 ft east from SE corner	1963	6,337	Rotary. Coal seams and associated gas shows at 2,900 to 4,800 ft. Oil fluorescence in shale at 5,200 to 5,300 ft. Wire-line formation test at 5,533 ft. Recovered 0.3 ft^3 gas and 7,000 cm^3 of mud, sand, and salt water.
West Shore Oil Co.	B. Button 1	South of Bandon NW¼ sec. 23, T. 30 S., R. 14 W.	1913-1919	2,600	Hole drilled to 2,000 ft by West Shore Oil Co. Deepened by Majestic Oil Company to 2,600 ft.

Note: Drill stem test denotes test inside casing; formation test indicates open-hole test.

Table 8b. *Data from offshore wells*

Company	Well name	Location	Date	Depth (ft)	Remarks (including information from well records kept by the Oregon Department of Geology and Mineral Industries)
Pan American Petroleum	OCS P-0112	Offshore Bandon Lat 43.24° N. Long 124.59° W.	1967	6,146	Strong gas show at 5,350 ft to 5,440 ft in tight sandstone: Methane 600,000 ppm Ethane 1,400 ppm Propane 1,000 ppm Butane 166 ppm Isobutane 137 ppm Petrol vapors 60 ppm DST #1—5,198 to 5,445 ft Flowed at 96 Mcfd rate, recovered 2,790 ft of gassy salt water in drill pipe. FSIP 3,177 psi, IFP 1,109 psi, FFP 110 psi, ISIP 2,219 psi, FSIP 3,148 psi. DST #2—5,368 to 5,442 ft Flowed at 101 Mcfd rate, recovered 90 ft of gas cut mud in drill pipe. FSIP 3,232 psi, IFP 288 psi, FFP 193 psi, ISIP 2,986 psi.
Union Oil	OCS P-0130	Heceta Bank Lat 44.059° N. Long 124.64° W.	1966	12,285	Good petroleum gas shows in sandstone at 4,775 to 9,380 ft; excellent petroleum gas shows at 9,610 to 11,130 ft in arkosic sandstone; oil and gas shows at 11,130 to 11,300 ft in thinly bedded sandstone. No formation tests run. Well has potential for commercial gas production.

Note: Drill stem test denotes test inside casing; formation test indicates open-hole test.

APPENDIX B. ANALYSES OF NATURAL GAS SAMPLES

Table 9. *Analyses of natural gas samples from southwestern Oregon (percent by volume)*

Company and well	Location Sec.	T.S.	R.W.	CO_2	N_2	C_1	C_2	C_3	iC_4	nC_4	C_5
Coast Oil Fat Elk 1	11	28	13	0.21	75.4	24.4	0.05	(Air contaminated sample)			
John Graves* (water well)	26	26	7	0.11	54.9	44.6	0.23	0.43	0.27	0.002	0.011
Majestic Oil Rhoades-Menasha 1	32	26	13	----	----	97.0	3.0	(Includes heavier fractions)			
Pacific Petroleum Morrison 1	28	28	14	Tr	----	94.9	0.41	0.1	Tr**	0.05	0.03
Pan American OCS P-0112	Lat 43.24° N., Long 124.59° W.			----	----	99.6	0.22	0.15	0.02	0.01	----
Union Oil OCS P-0130	Lat 44.059° N., Long 124.64° W.			----	----	93.2	26.8	(Includes heavier fractions)			

* Well drilled in the southern end of the western Tertiary basin (SW¼ sec. 26, T. 26 S., R. 7 W.), 25 mi east of the Coos Basin.
** Tr = trace.

APPENDIX C. ANALYSIS OF FORMATION WATER, COAST OIL FAT ELK 1 WELL

Table 10. *Analysis of formation water, Coast Oil Fat Elk 1 well (dissolved minerals, ppm)*

Company and well name	Location	Ca	Na	Cl	I	K	B	SO_3	Mg	Total dissolved solids
Coast Oil Fat Elk 1	Sec. 11, T. 28 S., R. 13 W.	2,100	4,000	Not tested	32	17	4.1	0.1	55	17,660

APPENDIX D. PETROGRAPHY OF THIN SECTIONS FROM PAN AMERICAN WELL OCS P-0112

By R. O. Van Atta, Earth Sciences Department, Portland State University, Portland, Oregon

The six rock thin sections from the Pan American well supplied for petrographic analyses fall into three groups:

Group 1.

Section 5405 is a muddy, very fine pebble conglomerate or a very coarse-grained muddy litharenite. The clasts consist of mudstone and muddy siltstone, together with a few clasts of chert. Brown organic material is found bordering some clasts, in some fractures, and in some parts of the muddy matrix. Heavy minerals which are recognizable include epidote and clinopyroxene; a little authigenic calcite is present in some siltstone clasts. The rock does not appear to be cemented.

Group 2.

Section 5993 consists of a micaceous, muddy lithic arkose in which framework grains of quartz, feldspar, and rock fragments are present in subequal amounts. The matrix consists of chloritic and smectitic clay, together with a "hash" of very fine quartz and feldspar. Compaction is good, porosity is nil, sorting is poor to very poor, and structure consists of subparallel alignment of mica (biotite and muscovite) flakes, which probably lends a laminated character to the rock. The thin sections are cut normal to this apparent lamination.

Table 11. *Petrography of Pan American well OCS P-0112 sample 5993 (by point count, 500 points)*

Quartz (noncrystalline and polycrystalline)	22%
Feldspar (predominantly plagioclase with potash feldspar (microcline, orthoclase?))	24%
Rock fragments (mostly chert, with lesser amounts of foliated metamorphics, volcanics and micaceous quartz arenite)	20%
Matrix	33%
Mica (mostly biotite)	1%
Total	100%
Modal composition: Quartz 33%, feldspar 36%, rock fragments 30%	100%

Group 3.

Sections 5872, 5880, 5886, and 5979 are all of basaltic rocks. Samples 5872 and 5880 are very much alike. Both are doleritic (diabasic) in texture. The texture is also intersertal with 22 percent hydrothermally altered glass in interstices. The glass is altered to a mixture of green smectite (nontronite) and a chlorite (probably penninite). The clinopyroxene is mostly pigeonite, but some augite is present, too. A little biotite (probably phlogopite) is found and a very small amount of olivine. Opaque magnetite/ilmenite is common.

Sample 5886 is a thoroughly altered basalt porphyry. The phenocrysts appear to be albitized; the An content is less than 10. Clinopyroxene phenocrysts are almost totally replaced by calcite. The groundmass consists of microlites of plagioclase together with a dust (10-15 micron size) of opaques (magnetite/ilmenite?) and altered glass. The rock is probably best described as spilite.

Sample 5979 is a basalt, consisting of plagioclase feldspar (An 62) and clinopyroxene (augite and pigeonite), a few grains of olivine, and interstitial hydrothermally altered glass. The glass is mostly replaced by calcite (restricted to vesicles) and a mixture of smectite, chlorite, and hydrated iron oxide. Opaques consist of intergrown magnetite and ilmenite.

Table 12. *Petrography of basaltic rock samples from Pan American well OCS P-0112 (composition in percent)*

Mineral	Sample 5872	Sample 5880	Sample 5886	Sample 5979
Plagioclase				
Anorthite 56	45	42	-	42
Anorthite 10	-	-	33	-
Groundmass (in porph.) (glass and clay)	-	-	49	-
Pyroxene	25	32	1	28
Olivine	1	-	-	-
Biotite (phlogopite)	1	1	-	-
Opaques (magnetite/ilmenite)	6	3	13	5
Glass (deuterically altered)	22	22	-	23
Deuteric alteration (nontronite (smectite), chlorite, calcite)	-	-	4	2
	100	100	100	100

It cannot be said with any certainty which of the southwestern Tertiary formations the sedimentary rock came from. Mudrock pebble conglomerate like sample 5405 is not common. It could be a mudrock breccia, but the clasts are fairly well rounded. Rock like this could easily occur in the Coaledo, Elkton, Tyee, Flournoy, or Lookingglass Formations. The same is true of sample 5993, although it does not look like Tyee. Usually the Tyee has more authigenic material in the matrix. Closer to the Klamaths, the Tyee has less matrix and is somewhat coarser.

The dolerites and basalts, especially the spilitized one, sample 5886, are probably from the Roseburg Formation. They were compared with several thin sections of the Roseburg Formation from Blue Ridge, Coos County, and the nontronitic alteration of the glass in samples 5872 and 5880 had the same fibrous character which is commonly found in rocks of the Roseburg Formation.

APPENDIX E. CORE ANALYSES OF UNION OIL WELL OCS P-0130 SAMPLES

Table 13. *Core analyses of Union Oil well OCS P-0130 samples**

Depth (ft)	Permeability (Millidarcies)	Porosity (%)	Residual saturation (% pore space) Oil	Water	Sample description
					All samples: sand, gray, very fine-grained. No stain.
5,692	135	17.1	0.0	63.8	Silty, well-cemented. No fluorescence.
6,079	45	17.4	0.0	71.8	Very silty, shaly. No fluorescence.
6,573	1.3	17.3	0.0	61.2	Silty.
6,574	0.7	12.4	0.0	89.5	Silty.
6,577	1.0	20.5	0.0	60.6	Silty.
6,579	0.3	13.2	0.0	90.1	Silty.
6,584	0.5	12.0	0.0	88.3	Silty.
6,596	0.8	12.7	0.0	87.4	Silty.
6,904	32	22.3	0.0	71.4	Silty, well-cemented. No fluorescence.
7,162	125	17.7	0.0	71.3	Silty, well-cemented. No fluorescence.
7,199	180	21.6	1.4	71.3	Silty, well-cemented. Bright gold-streaked fluorescence.
7,589	58	28.4	0.0	80.6	Very silty, slight carbon. No fluorescence.
7,607	210	23.3	0.0	74.0	Very silty, very limy, shells. Faint gold-flecked fluorescence.
7,624	270	26.3	0.0	70.0	Silty. No fluorescence.

*Tests made by Core Laboratories, Inc., Dallas, Texas.

APPENDIX F. RESULTS OF ORGANIC MATURATION ANALYSES, GEOCHEM JOB NO. 1227

By Paul Tybor, Geologist, GeoChem Laboratories, Inc., Houston, Texas

The following report describes the results of organic geochemical analyses carried out on eight Eocene outcrop samples from Oregon (GeoChem job nos. 1227-001 through 1227-008). Table 14 shows the types of geochemical analyses that were performed on the samples, whose locations are listed in Table 15.

Table 14. *Types of geochemical analyses performed on eight Eocene outcrop samples, GeoChem job 1227-001—008*

Number of analyses	Type of analysis	Figure	Table
8	Total organic carbon	27	15, 17
8	Visual kerogen	27	15, 16
4	C_{15+} soxhlet extraction + deasphaltening	27	18A, -B, -C
4	Complete liquid chromatography	27	18A, -B, -C
4	C_{15+} P-N gas chromatography	28, 29, 30, 31, 32	19A, -B
4	Vitrinite reflectance	33, 34, 35, 36, 37	20

THERMAL MATURITY OF SEDIMENTS

The Eocene samples analyzed have a moderately immature thermal maturity and hence are at the initial oil-generative state. At this level of petroleum generation, the sections represented by these samples would be expected to have generated heavy, low-A.P.I.-gravity oil.

The yellow to orange-brown coloration of the plant cuticle and spores contained in the kerogen isolated from these samples (Table 16) corresponds to a moderately immature maturation index of Stage 2- to 2. The low average-percent-reflectance (percent R_o) values from the interpreted indigenous populations in the vitrinite reflectance analyses (Figures 33-37; Table 20) were also used in determining the moderately immature character of these Eocene-age sections. This maturity rating is substantiated by the abundance of steranes and terpanes, as seen in the C_{15+} paraffin-naphthene gas chromatograms of these samples (Figures 28-32; Table 19). Steranes and terpanes are naturally occurring cholesterols usually found in Recent and immature sediments which, with increasing geothermal diagenesis, will break down to naphthenes and paraffins.

HYDROCARBON SOURCE CHARACTER

Oil source

The Eocene sedimentary units represented by the eight analyzed outcrop samples have a very poor oil source character. This rating is based on the very poor C_{15+} total extractable bitumen content (188 ppm mean; Figure 27; Table 18-B) and the C_{15+} total estimated hydrocarbon content (37 ppm mean; Figure 27; Table 18-B).

Gas source

With the exception of upper Coaledo Formation sample 1227-008, the Eocene sedimentary units have a poor to fair gas source character. This rating is based on the poor to fair amounts of organic matter analyzed in these samples (0.38 percent minimum, 0.88 percent maximum, 0.53 percent mean organic carbon; Figure 27; Tables 15 and 17) which is comprised of predominately woody (gas-prone) kerogen type (Figure 27; Tables 15 and 17).

The upper Coaledo Formation, represented by the coal sample 1227-008, is assigned a very good C_1 methane gas source character due to excellent amounts of organic matter (50.14 percent organic carbon; Figure 27; Tables 15 and 16) which is comprised of coaly (gas-prone) kerogen type.

Table 15. *Summary of organic carbon and visual kerogen analyses, GeoChem job no. 1227*

Geologic formation	GeoChem sample number	Oregon sample location	Organic carbon (% of rock)	Visual kerogen Type*	Visual kerogen Alteration (1-5 scale)
Roseburg	1227-001	W¼ sec. 36, T. 28 S., R. 12 W.	0.46	H-W;-;Am	2- to 2
Roseburg	1227-002	SE¼ sec. 8, T. 29 S., R. 12 W.	0.41	W;H;-	2- to 2
Flournoy	1227-003	E¼ sec. 26, T. 21 S., R. 12 W.	0.88	H;W;-	2- to 2
Flournoy	1227-004	E½ sec. 6, T. 25 S., R. 11 W.	0.38	H-W;-;-	2- to 2
Lower Coaledo	1227-005	SW¼ sec. 30, T. 28 S., R. 14 W.	0.45	W;H;Am	2- to 2
Lower Coaledo	1227-006	Cape Arago	0.43	W;H;Am	2- to 2
Upper Coaledo	1227-007	NW¼ sec. 19, T. 28 S., R. 13 W.	0.75	W;H;Al	2- to 2
Upper Coaledo	1227-008	NW¼ sec. 3, T. 28 S., R. 13 W.	50.14	C;-;-	2 to 2+

* For kerogen type, see symbol key, Figure 27.

Table 16. *Visual kerogen assessment worksheet, GeoChem job no. 1227*

		INDIGENOUS POPULATION (INTERPRETED)			GENERAL CHARACTERISTICS					CAVED AND/OR REWORKED POPULATION(S)			SUMMARY ORGANIC MATTER TYPE
		TYPE OF ORGANIC MATTER	MATURATION INDEX		COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	%			TYPE OF ORGANIC MATTER	MATURATION INDEX		
GEOCHEM No	Eocene Formation			REMARKS								REMARKS	
1227-001	Roseburg			H-W;-;Am								W;C;H	W;H;C(Am)
1227-002	Roseburg			W;H;-								W-C;H;-	W;H-C;-
1227-003	Flournoy			H;W;-									H;W;-
1227-004	Flournoy			H-W;-;-								W;C;H	H-W;-;C
1227-005	L. Coaledo			W;H;Am								W;C;H	W;H-C;Am
1227-006	L. Coaledo			W;H;Am								W;-;C	W;-;H(Am-C)
1227-007	U. Coaledo			W;H;Al								W;-;C	W;H;Al(C)
1227-008	U. Coaledo		est.	C;-;-									C;-;-

There are unaltered to slightly altered pollen grains in all the samples; these ratings are based on the assumption that these are Pleistocene or Recent contaminants. The abundant and diverse dinoflagellates in -007 may be in place or may be recent marine contaminants. For meaning of symbols, see Figure 27.

Table 17. *Organic carbon analyses and gross lithological descriptions, GeoChem job no. 1227*

GeoChem sample number	Eocene outcrop formation	Gross lithological description	GSA color code	Total organic carbon (% of rock)
1227-001 -A	Roseburg	100% shale, noncalcareous, silty, blocky, moderately hard, dark-gray	N3	0.46
1227-003 -A	Flournoy	100% shale, noncalcareous, very silty, blocky, moderately hard, medium-dark-gray	N4	0.88
1227-005 -A	Lower Coaledo	100% shale, noncalcareous, silty, very sandy grading into a sandstone; sand is very fine- to fine-grained, subrounded to subangular, frosted to clear; blocky, soft, weathered, medium-dark-gray	N4	0.45
1227-007 -A	Upper Coaledo	100% shale, slightly calcareous, silty, very sandy; sand is very fine- to fine-grained, subrounded to subangular, frosted to clear; blocky, soft, slightly weathered, medium-dark-gray	N4	0.75

Table 18. *Summary of C_{15+} soxhlet extraction, deasphaltening, and liquid chromatography, GeoChem job no. 1227*

A. *Weights of extracts and chromatographic fractions*

GeoChem sample number	Oregon sample location	Weight of rock extd. (grams)	Total extract (grams)	Precipitated asphaltenes (grams)	N-C5 soluble (grams)	Sulfur (grams)	Paraffins-naphthenes (grams)	Aromatics (grams)	Eluted NSO'S (grams)	Non-eluted NSO'S (grams)
1227-001	T. 28 S., R. 12 W.	100.0	0.0182	0.0138	0.0044	N.D.*	N.D.	N.D.	N.D.	N.D.
1227-003	T. 21 S., R. 12 W.	99.2	0.0184	0.0098	0.0086	N.D.	N.D.	N.D.	N.D.	N.D.
1227-005	T. 28 S., R. 14 W.	100.0	0.0155	0.0110	0.0045	N.D.	N.D.	N.D.	N.D.	N.D.
1227-007	T. 28 S., R. 13 W.	99.6	0.0230	0.0113	0.0117	N.D.	0.0017	0.0044	0.0050	0.0006

* N.D. = no data.

B. *Concentration of extracted materials in rock*

GeoChem sample number	Oregon sample location	Total extract (ppm)	Hydrocarbons: Paraffin-naphthene (ppm)	Hydrocarbons: Aromatic (ppm)	Hydrocarbons: Total (ppm)	Hydrocarbons: Sulfur (ppm)	Nonhydrocarbons: Preciptd. asphaltene (ppm)	Nonhydrocarbons: Eluted NSO'S (ppm)	Nonhydrocarbons: Noneluted NSO'S (ppm)	Nonhydrocarbons: Total (ppm)
1227-001	T. 28 S., R. 12 W.	182	-	-	22 e*	-	138	-	-	-
1227-003	T. 21 S., R. 12 W.	185	-	-	43 e	-	99	-	-	-
1227-005	T. 28 S., R. 14 W.	155	-	-	22 e	-	110	-	-	-
1227-007	T. 28 S., R. 13 W.	231	17	44	61	-	113	50	6	170

* e = estimated.

C. *Composition of extracts*

GeoChem sample number	Oregon sample location	Hydrocarbons: Paraffin-naphthene %	Hydrocarbons: Aro-matic %	Hydrocarbons: PN/ Arom	Hydrocarbons: Sulfur %	Nonhydrocarbons: Eluted NSO'S %	Nonhydrocarbons: Noneluted NSO'S %	Nonhydrocarbons: Preciptd. asphaltene %	Nonhydrocarbons: Asph/ NSO	Nonhydrocarbons: HC'S %	Nonhydrocarbons: HC/ Non HC
1227-001	T. 28 S., R. 12 W.	-	-	-	-	-	-	75.8	-	-	-
1227-003	T. 21 S., R. 12 W.	-	-	-	-	-	-	53.3	-	-	-
1227-005	T. 28 S., R. 14 W.	-	-	-	-	-	-	71.0	-	-	-
1227-007	T. 28 S., R. 13 W.	7.4	19.1	0.39	-	21.7	2.6	49.1	2.02	26.5	0.36

Table 19. *Saturate hydrocarbon analyses, GeoChem job no. 1227*

A. *Summary of paraffin-naphthene distribution*

GeoChem sample number	Oregon sample location	Paraffin %	Isoprenoid %	Naphthene %	C-P Index A	C-P Index B	ip19/ip20
1227-001	T. 28 S., R. 12 W.	7.6	2.2	90.2	-	-	1.15
1227-003	T. 21 S., R. 12 W.	8.4	2.9	88.7	-	-	3.00
1227-005	T. 28 S., R. 14 W.	4.6	2.8	92.7	-	-	1.78
1227-007	T. 28 S., R. 13 W.	4.8	4.5	90.6	-	-	0.89

B. *Normalized paraffin distribution*

GeoChem sample number	Oregon sample location	nC15 %	nC16 %	nC17 %	ip19 %	nC16 %	ip20 %	nC19 %	nC20 %	nC21 %	nC22 %	nC23 %	nC24 %	nC25 %	nC26 %	nC27 %	nC28 %	nC29 %	nC30 %	nC31 %	nC32 %	nC33 %	nC34 %	nC35 %
1227-001	T. 28 S., R. 12 W.	0.8	4.6	12.2	11.8	10.3	10.3	9.9	8.0	8.0	6.9	8.0	5.0	0.0	0.0	0.0	0.0	3.8	0.4	0.0	0.0	0.0	0.0	0.0
1227-003	T. 21 S., R. 12 W.	1.5	4.0	8.5	19.5	9.5	6.5	8.2	10.0	5.5	4.5	7.5	0.0	0.0	0.0	0.0	0.0	13.0	0.2	1.5	0.0	0.0	0.0	0.0
1227-005	T. 28 S., R. 14 W.	0.2	2.4	9.3	24.1	15.4	13.5	10.4	8.0	4.3	3.7	3.5	2.2	0.0	0.0	0.0	0.0	2.0	0.4	0.7	0.0	0.0	0.0	0.0
1227-007	T. 28 S., R. 13 W.	1.0	2.8	7.5	22.9	8.2	25.7	8.0	7.2	4.9	6.1	4.5	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0

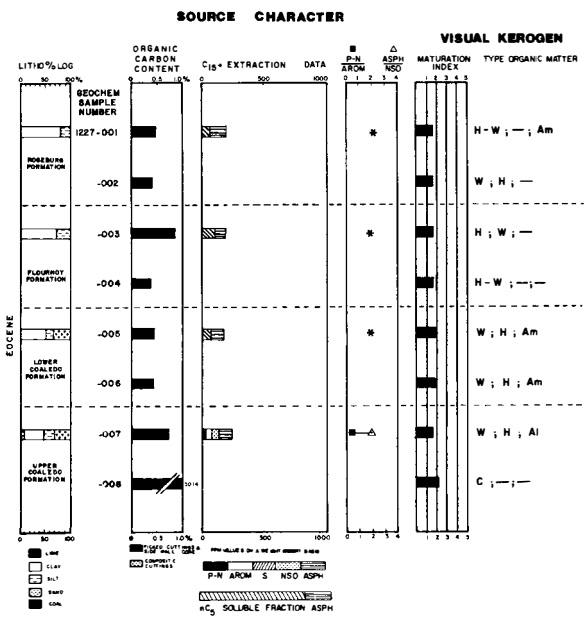


*Figure 27. Summary of organic analyses, GeoChem job no. 1227. P-N = paraffin-naphthene hydrocarbons; AROM = aromatic hydrocarbon; S = elemental free sulfur; NSO = nitrogen-sulfur oxygen compounds; ASPH = asphaltene; * = no data; Al = algal; Am = amorphous sapropel; H = herbaceous spore cuticle; W = woody; C = coaly; U = unidentified material; H+ = degraded herbaceous; Am+ = relict amorphous.*

Table 20. *Vitrinite reflectance summary, GeoChem job no. 1227*

GeoChem sample number	Number of readings	Minimum reflect. (% R_0)	Maximum reflect. (% R_0)	Average reflect. (% R_0)
1227-001	50	0.36	1.20	-
(Population 1)	48	0.36	0.54	0.43
(Population 2)	2	1.07	1.20	1.14
1227-003	45	0.27	0.67	-
(Population 1)	44	0.27	0.46	0.33
(Population 2)	1	0.67	0.67	0.67
1227-005	45	0.29	0.45	0.38
1227-007	45	0.32	0.45	0.36

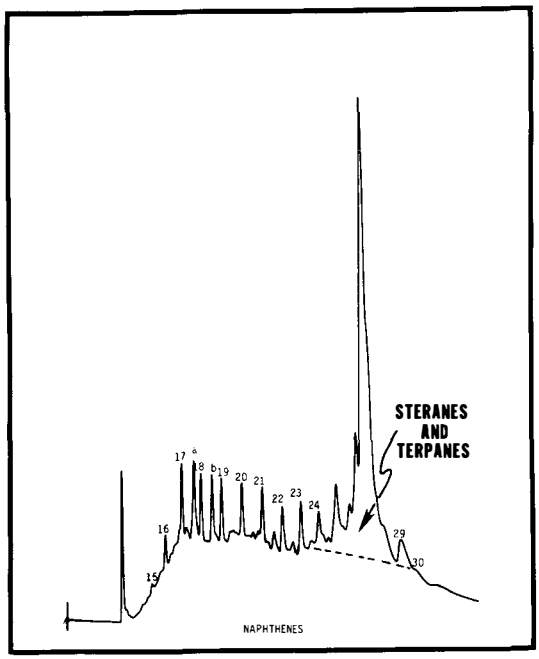


Figure 28. Naphthenes, sample 1227-001.

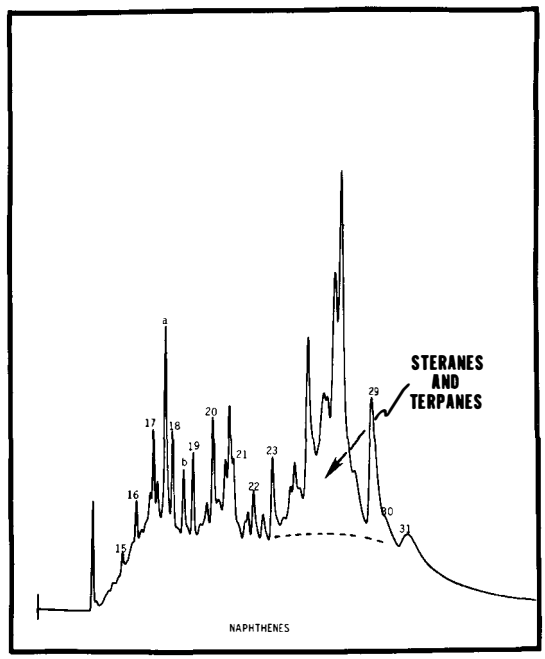


Figure 29. Naphthenes, sample 1227-003.

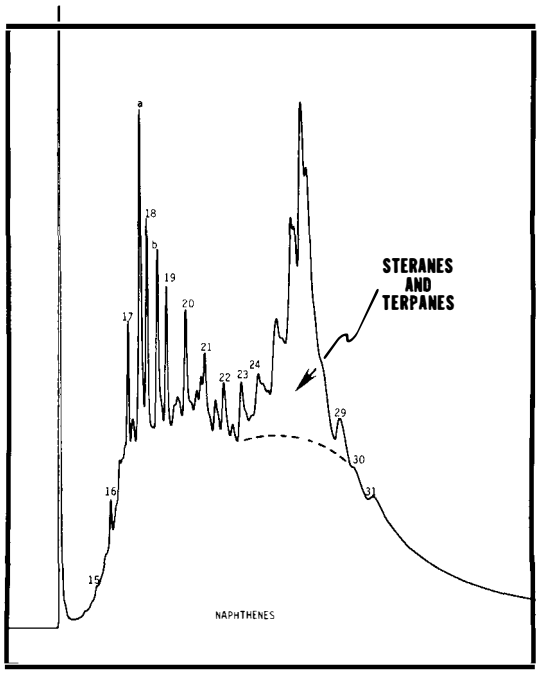


Figure 30. Naphthenes, sample 1227-005.

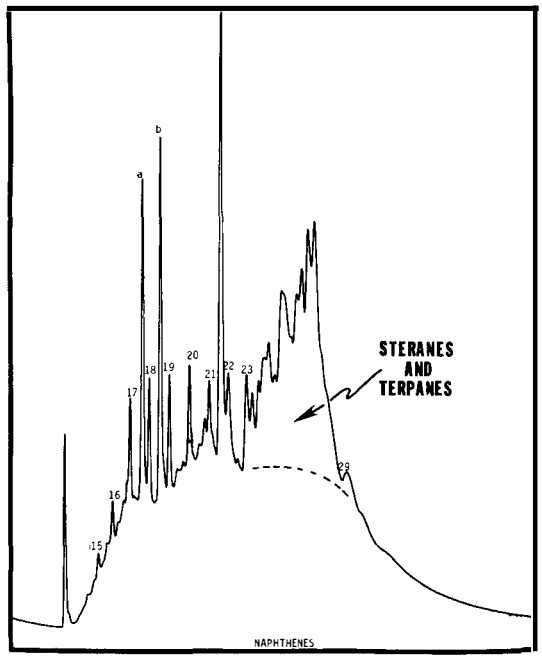


Figure 31. Naphthenes, sample 1227-007.

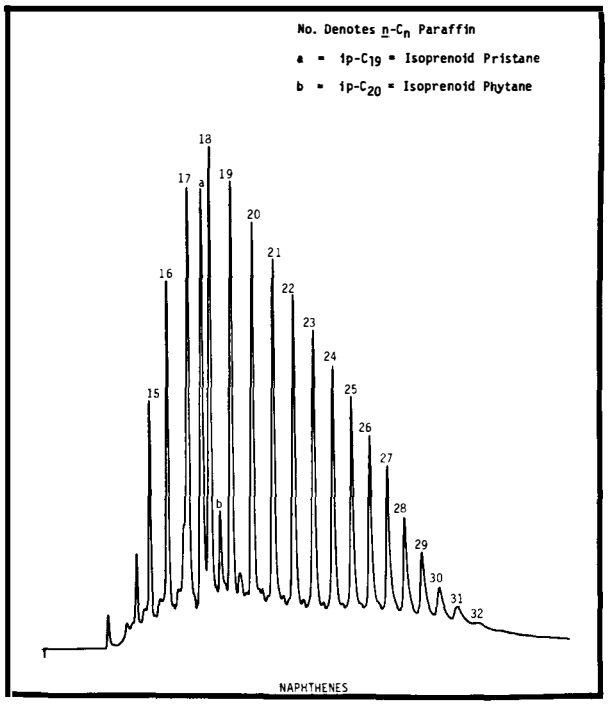


Figure 32. Naphthenes, standard.

COMPANY State of Oregon GEOCHEM NO 1227-001 NUMBER OF OBSERVATIONS 50

WELL OR OUTCROP Outcrop LOCATION Oregon DEPTH OR SAMPLE NO Sec. 36, T28S, R12W

MIN REFLECTANCE .36 (%Ro) MAX REFLECTANCE 1.20 (%Ro) AVG REFLECTANCE - (%Ro)

POP 1: NO OF OBS 48 MIN Ro .36 (%Ro) MAX. Ro .54 (%Ro) AVG Ro .43 (%Ro) REMARKS

POP 2: NO OF OBS 2 MIN Ro 1.07 (%Ro) MAX. Ro 1.20 (%Ro) AVG Ro 1.14 (%Ro) REMARKS

POP 3: NO OF OBS MIN Ro (%Ro) MAX. Ro (%Ro) AVG Ro (%Ro) REMARKS

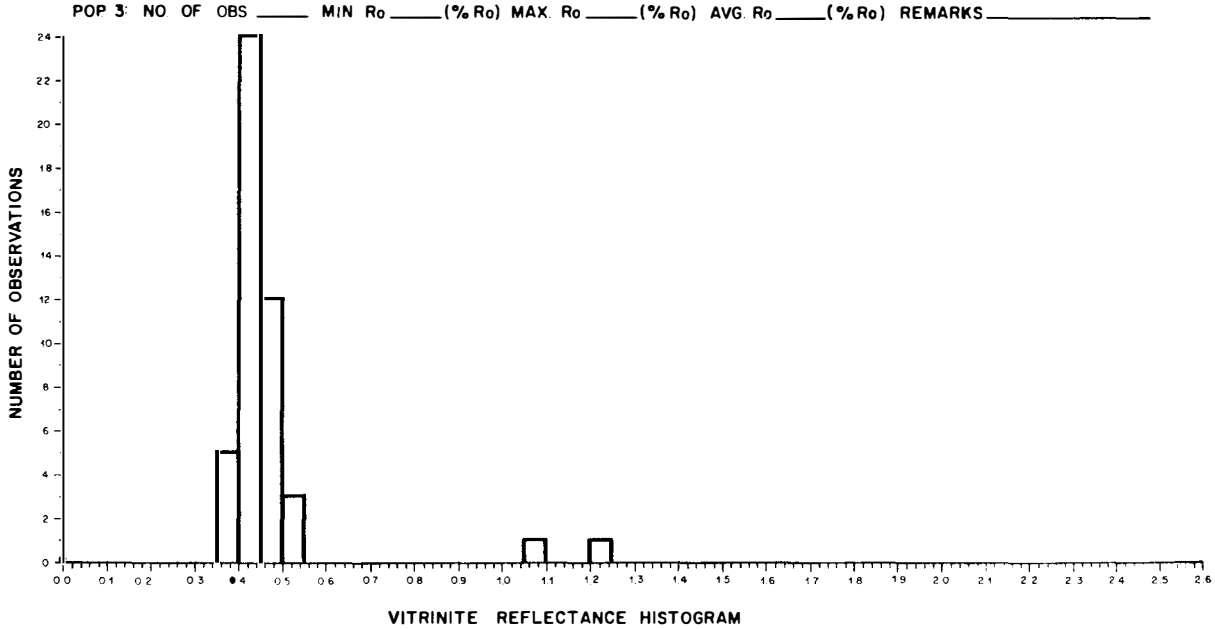


Figure 33. Vitrinite reflectance histogram, sample 1227-001.

COMPANY State of Oregon GEOCHEM NO 1227-003 NUMBER OF OBSERVATIONS 45

WELL OR OUTCROP Outcrop LOCATION Oregon DEPTH OR SAMPLE NO Sec. 26, T21S, R12W

MIN REFLECTANCE .27 (% Ro) MAX REFLECTANCE .67 (%Ro) AVG REFLECTANCE - (% Ro)

POP 1: NO. OF OBS 44 MIN Ro .27 (% Ro) MAX. Ro .46 (% Ro) AVG. Ro .33 (% Ro) REMARKS

POP 2: NO OF OBS 1 MIN Ro .67 (% Ro) MAX. Ro .67 (% Ro) AVG. Ro .67 (% Ro) REMARKS

POP 3: NO. OF OBS MIN Ro (% Ro) MAX. Ro (% Ro) AVG. Ro (% Ro) REMARKS

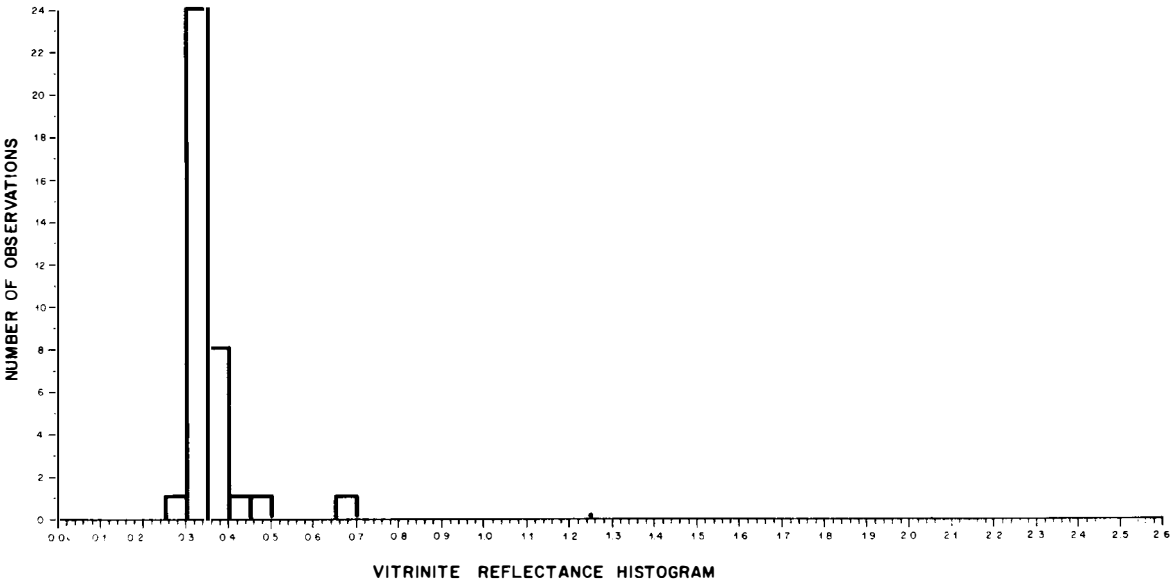


Figure 34. Vitrinite reflectance histogram, sample 1227-003.

COMPANY State of Oregon GEOCHEM NO 1227-005 NUMBER OF OBSERVATIONS 45

WELL OR OUTCROP Outcrop LOCATION Oregon DEPTH OR SAMPLE NO Sec. 30, T28S, R14W

MIN REFLECTANCE .29 (% Ro) MAX REFLECTANCE .45 (%Ro) AVG REFLECTANCE .38 (%Ro)

POP 1: NO. OF OBS MIN Ro (% Ro) MAX. Ro (% Ro) AVG. Ro (% Ro) REMARKS

POP 2: NO. OF OBS MIN Ro (% Ro) MAX. Ro (% Ro) AVG. Ro (% Ro) REMARKS

POP 3: NO. OF OBS MIN Ro (% Ro) MAX. Ro (% Ro) AVG. Ro (% Ro) REMARKS

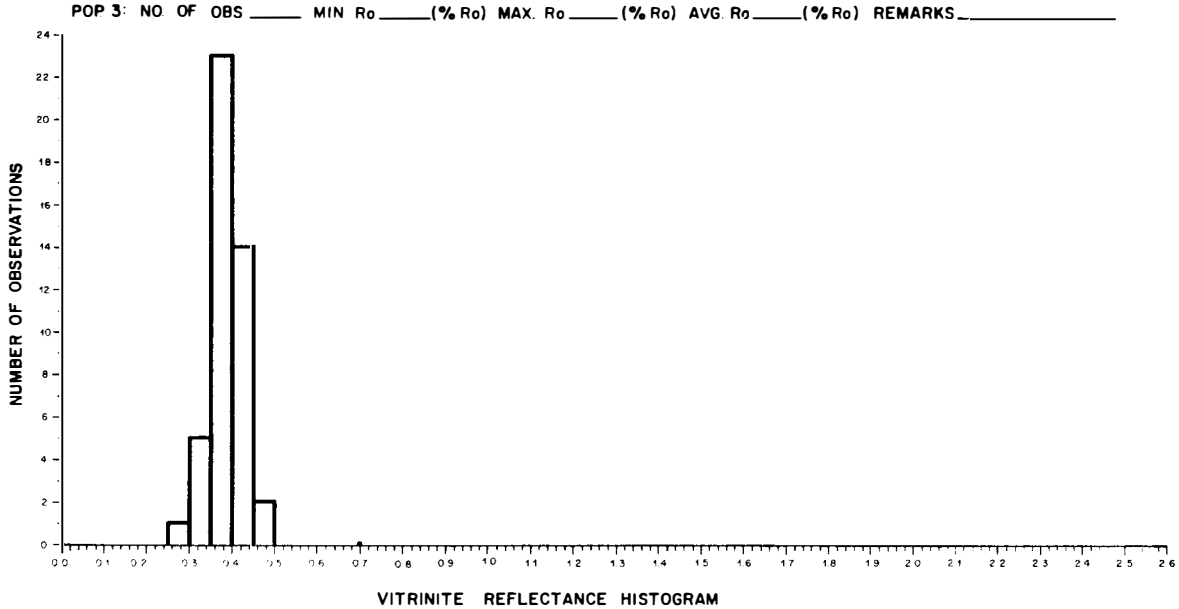


Figure 35. Vitrinite reflectance histogram, sample 1227-005.

COMPANY State of Oregon GEOCHEM NO 1227-007 NUMBER OF OBSERVATIONS 45

WELL OR OUTCROP Outcrop LOCATION Oregon DEPTH OR SAMPLE NO Sec. 19, T28S, R13W

MIN REFLECTANCE .32 (%Ro) MAX REFLECTANCE .45 (%Ro) AVG REFLECTANCE .36 (%Ro)

POP. 1: NO. OF OBS. ____ MIN. Ro ____ (%Ro) MAX. Ro ____ (%Ro) AVG. Ro ____ (%Ro) REMARKS ____

POP. 2: NO. OF OBS. ____ MIN. Ro ____ (%Ro) MAX. Ro ____ (%Ro) AVG. Ro ____ (%Ro) REMARKS ____

POP. 3: NO. OF OBS. ____ MIN. Ro ____ (%Ro) MAX. Ro ____ (%Ro) AVG. Ro ____ (%Ro) REMARKS ____

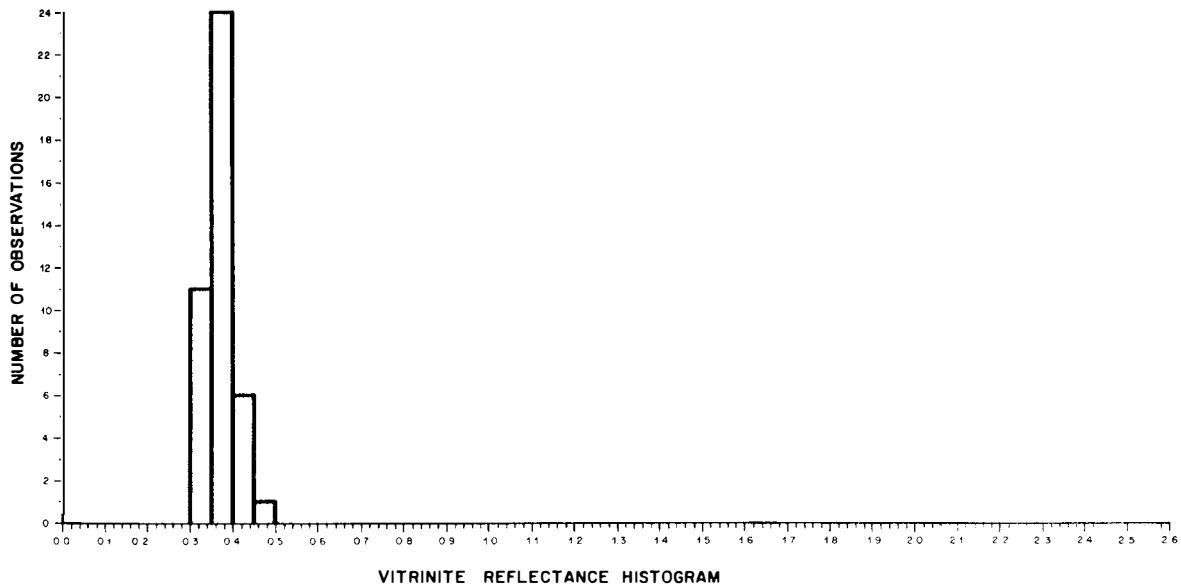


Figure 36. Vitrinite reflectance histogram, sample 1227-007.

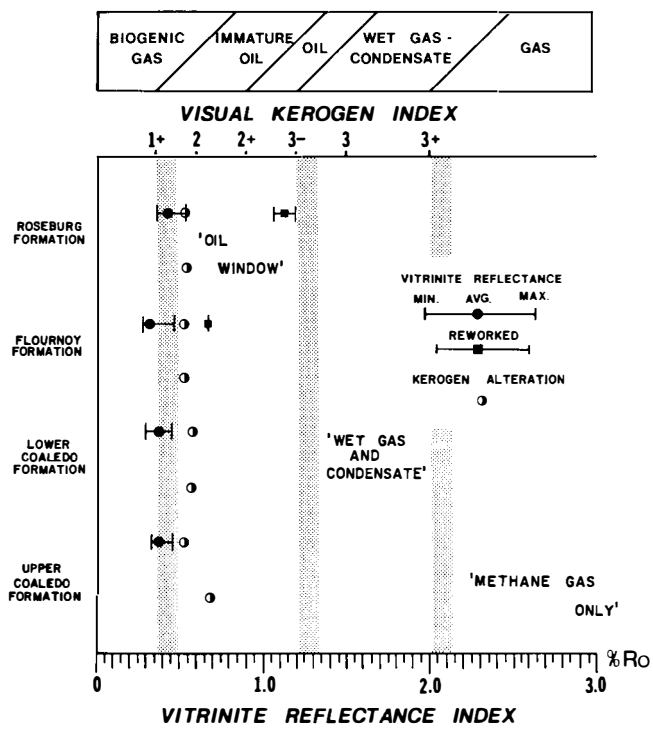


Figure 37. Summation of vitrinite reflectance and visual kerogen alteration results, GeoChem job no. 1227.

APPENDIX G. RESULTS OF ORGANIC MATURATION ANALYSES, GEOCHEM JOB NO. 1575

By Joseph Haykus, GeoChem Laboratories, Inc., Houston, Texas

The following report describes results of organic geochemical analyses performed on ten surface samples from southwestern Oregon. Upon arrival at GeoChem Laboratories, the samples, whose locations are given in Table 22, were assigned job no. 1575 and are identified as follows:

1575-001	Libbey Coal Mine
1575-002	Flournoy-Coaledo?
1575-003	Yoakam Point
1575-004	Sunset Bay
1575-005	Fat Elk Coal
1575-006	Maple Creek
1575-007	Flournoy
1575-008	Crown Point Dump
1575-009	Bastendorff Beach
1575-010	Middle Coaledo

As per instructions, these samples were lithologically descibed and analyzed for total organic carbon content. Based on the results of these analyses, eight samples were submitted for visual kerogen analysis for determination of organic-matter type and state of thermal maturity. Two coal samples were submitted for vitrinite reflectance analysis.

The summarized organic-carbon contents, visual kerogen data, and mean vitrinite reflectance values, along with a tentative hydrocarbon source rating for the samples, are reported in Table 21. Table 22 contains the gross lithological descriptions. The visual kerogen assessment worksheet is presented as Table 23. A summary of the vitrinite reflectance analysis is presented as Table 24, with the vitrinite reflectance histograms presented as Figures 38 and 39.

As shown in Tables 21 and 23, all samples contain predominant amounts of the gas-prone woody- and herbaceous-type kerogen material. All samples with the exception of 1575-001 are rated as immature to moderately immature. The high vitrinite reflectance values for sample 1575-001 (5.34 percent R_o mean) places this sample in the meta-anthracite range of the coal rank.

The total organic carbon contents are characteristically high for the two coal samples. The other samples exhibit poor to fair amounts of organic carbon, with the exception of 1575-010, which contains good amounts.

It is therefore interpreted that these samples represent sections which are nonprospective for the indigenous generation of liquid petroleum but which may be considered prospective for minor amounts of "dry" biogenic methane gas.

Table 21. *Summary of organic carbon and visual kerogen analyses, GeoChem job no. 1575*

GeoChem sample number	Sample source	Organic carbon (%)	Visual kerogen: Organic matter type**	Visual kerogen: Alteration (1-5 scale)	Vitrinite reflectance (% R_o)	Hydrocarbon source character at present level of thermal maturity
1575-001	Libbey Coal Mine (Upper Coaledo Formation)	32.03	--	--	5.34	Meta-anthracite; non-source for petroleum-related hydrocarbons.
1575-002	Flournoy-Coaledo ?	0.52	W;H;-	1+	--	Immature, fair "dry" biogenic methane gas source.
1575-003	Yoakam Point (Upper Coaledo Formation)	0.79	W;H;Al	2−	--	Moderately immature, fair "dry" biogenic methane gas source.
1575-004	Sunset Bay (Middle Coaledo Formation)	0.86	W;H;-	1+ to 2−	--	Immature, fair "dry" biogenic methane gas source.
1575-005	Fat Elk Coal (Upper Coaledo Formation)	32.44; 30.81R*	--	--	0.35	Immature, bituminous coal; fair methane gas source.
1575-006	Maple Creek (Flournoy Formation)	0.83	H-W;-;-	1+	--	Immature, fair "dry" biogenic methane gas source.
1575-007	Flournoy	0.31	W;H;Al	1+ to 2−	--	Immature, poor "dry" biogenic methane gas source.
1575-008	Crown Point Dump (Bastendorff Formation)	0.51	W;H;-	1+	--	Immature, fair "dry" biogenic methane gas source.
1575-009	Bastendorff Beach	0.61	H-W;I;-	1+to 2−	--	Immature, fair "dry" biogenic methane gas source.
1575-010	Middle Coaledo	1.11	H;Al-W;I	1+ to 2−	--	Immature, good "dry" biogenic methane gas source.

* R = Repeat.

** For symbol key, see Figure 27.

Table 22. *Organic carbon analyses and gross lithological descriptions, GeoChem job no. 1575*

GeoChem sample number	Location	Gross lithological description	GSA color code	Total organic carbon (% of rock)
1575-001-A	SE¼ sec. 4, T. 26 S., R. 13 W. Libbey Mine	100% coal, meta-anthracite, soft, black	N1	32.03
1575-002-A	NW¼ sec. 15, T. 21 S., R. 12 W.	100% siltstone, noncalcareous, quartzose, micaceous, slightly feldspathic, moderately soft, very fine subangular grains, light olive-gray	5Y 6/1	0.52
1575-003-A	SE¼ sec. 4, T. 26 S., R. 14 W. Yoakam Point	100% siltstone, noncalcareous, quartzose, micaceous, slightly feldspathic, abundant fossils occur as bivalves weathered to chalk and as plant remains, moderately soft, very fine subangular grains, light olive-gray to olive-gray	5Y 5/1	0.79
1575-004-A	NW¼ sec. 9, T. 26 S., R. 14 W. Sunset Bay	100% siltstone, noncalcareous, quartzose, micaceous, moderately soft, very fine subangular grains, olive-gray	5Y 4/1	0.86
1575-005-A	NW¼ sec. 3, T. 28 S., R. 13 W.	100% coal, bituminous, moderately soft, black	N1	32.44; 30.81R
1575-006-A	NW¼ sec. 29, T. 19 S., R. 11 W.	50% sandstone, noncalcareous, quartzose, micaceous, moderately hard, subangular, coarse sand to clay-sized grains, poor porosity, light olive-gray	5Y 6/1	0.83
1575-006-B	NW¼ sec. 29, T. 19 S., R. 11 W.	50% mudstone, noncalcareous, quartzose, micaceous, moderately hard, light-gray to olive-gray	5Y 5/1	--
1575-007-A	S½ sec. 13, T. 18 S., R. 11 W.	100% mudstone, slightly calcareous, quartzose, micaceous, moderately hard, light olive-gray to olive-gray	5Y 5/1	0.31
1575-008-A	NW¼ sec. 18, T. 26 S., R. 13 W.	100% siltstone, noncalcareous, quartzose, micaceous, abundant plant remains, moderately soft, subangular silt to clay-sized grains, light olive-gray to olive-gray	5Y 5/1	0.51
1575-009-A	SW¼ sec. 3, T. 26 S., R. 14 W. Bastendorff Beach	100% mudstone, noncalcareous, quartzose, slightly micaceous, moderately soft, light olive-gray to olive gray	5Y 5/1	0.61
1575-010-A	NW¼ sec. 7, T. 28 S., R. 13 W.	100% mudstone, noncalcareous, quartzose, very slightly micaceous, moderately soft, olive-gray	5Y 4/1	1.11

Table 23. *Visual kerogen assessment worksheet, GeoChem job no. 1575*

GEOCHEM No	DEPTH	INDIGENOUS POPULATION (INTERPRETED) TYPE OF ORGANIC MATTER	MATURATION INDEX	REMARKS	GENERAL CHARACTERISTICS COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	%	CAVED AND/OR REWORKED POPULATION(S) TYPE OF ORGANIC MATTER	MATURATION INDEX	REMARKS	SUMMARY ORGANIC MATTER TYPE *
1575-002	Fat Elk			W;H-							W;H;-
1575-003	Yocum Pt.			W;H;Al							W;H;Al
1575-004	Sunset Bay			W;H;-							W;H;-
1575-006	Flournoy			H-W,-;-							H-W;-;-
1575-007	Flournoy			W;H;Al							W;H;Al
1575-008	Maple Ck.			W;H;-							W;H;-
1575-009	Bastendorff			H-W;I;-							H-W;I;-
1575-010	M Coaledo			H;Al-W;I							H;Al-W;I

* For meaning of symbols, see Figure 27.

Table 24. *Vitrinite reflectance summary, GeoChem job no. 1575*

GeoChem sample number	Type of sample	No. of rdngs.	Min. reflect. (% R_0)	Max. reflect. (% R_0)	Mean reflect. (% R_0)	Std. dev. (% R_0)
1575-001	Outcrop	60	4.97	5.75	5.34	0.195
1575-005	Outcrop	60	0.30	0.39	0.35	0.017

GEOCHEM NO. 1575-001 TYPE OF SAMPLE: OUTCROP DEPTH/SAMPLE NO.

CLIENT'S NAME OREGON DEPT. GEOL. WELL NAME SEC.4 T26S R13W

(NO. OF READINGS = 60) 4.97 4.99 5.02 5.04 5.05 5.09 5.09 5.11 5.11 5.11 5.12 5.14 5.16 5.17
5.17 5.20 5.20 5.21 5.22 5.25 5.25 5.27 5.28 5.28 5.28 5.31 5.32 5.33 5.35 5.35 5.36 5.39
5.39 5.40 5.41 5.41 5.41 5.42 5.44 5.44 5.44 5.45 5.46 5.46 5.47 5.49 5.51 5.51 5.51 5.53
5.54 5.56 5.58 5.61 5.63 5.64 5.66 5.66 5.67 5.75

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD. DEV. (%)	REMARKS
(1)	60	4.97	5.75	5.34	0.195	

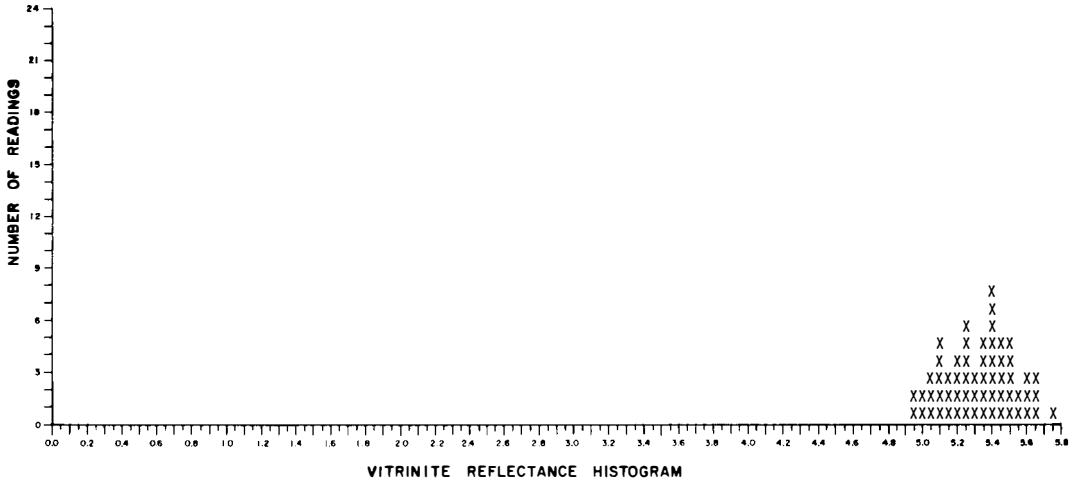


Figure 38. Vitrinite reflectance histogram, sample 1575-001.

GEOCHEM NO. 1575-005 TYPE OF SAMPLE: OUTCROP DEPTH / SAMPLE NO.

CLIENT'S NAME OREGON DEPT. GEOL. WELL NAME SEC.3 T28S R13W

(NO. OF READINGS = 60) 0.30 0.31 0.32 0.32 0.33 0.33 0.33 0.33 0.33 0.33 0.33 0.33 0.33 0.33 0.33
0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.34 0.35 0.35 0.35
0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.36 0.36 0.36 0.36 0.36 0.36
0.36 0.36 0.37 0.37 0.37 0.37 0.37 0.38 0.38 0.39

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD. DEV. (%)	REMARKS
(1)	60	0.30	0.39	0.35	0.017	

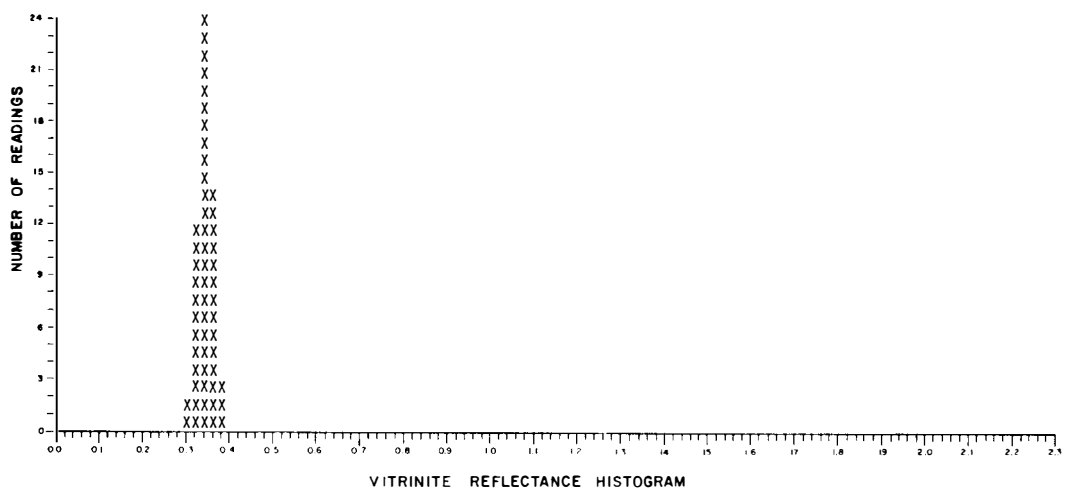


Figure 39. Vitrinite reflectance histogram, sample 1575-005.

APPENDIX H. POROSITY AND PERMEABILITY TESTS ON TERTIARY SANDSTONE SAMPLES

Table 25. *Porosity and permeability tests on Tertiary sandstone samples from southwestern Oregon**

Geologic formation	Sample location ¼	sec.	T.S.	R.W.	Permeability (millidarcies)	Porosity (% volume)	Description of sample
Upper Coaledo	NW	3	28	13	339.0	28.2	Lithic arkose, fine-grained, somewhat micaceous, thinly bedded, some coal seams.
Upper Coaledo	SW	20	26	12	667.0	38.3	Lithic arkose, fine- to medium-grained, micaceous, carbonaceous, pebbly.
Upper Coaledo	NE	30	27	12	51.0	33.7	Arkosic arenite, very fine-grained, silty, very firm.
Lower Coaledo	NW	6	19	11	73.0	43.2	Feldspathic litharenite, very fine- to medium-grained, micaceous, silty, fossiliferous.
Lower Coaledo	E½	13	28	14	4.5	18.3	Feldspathic litharenite, very fine-grained, very silty, some mica, fossiliferous.
Lower Coaledo	S cor	30	27	12	232.0	34.0	Lithic arkose, fine-grained, clayey, some mica.
Lower Coaledo	NE	29	27	12	200.0	30.2	Feldspathic litharenite, fine- to medium-grained, carbonaceous material, fossiliferous.
Lower Coaledo	NE	36	28	14	689.0	28.6	Feldspathic litharenite, fine- to medium-grained, a little mica, some limy matrix.
Lower Coaledo	SW	19	28	13	1,788.0	35.3	Litharenitic, fine- to medium-grained.
Lower Coaledo	SE	25	28	14	646.0	28.2	Lithic arkose, fine- to medium-grained, with coal beds.
Flournoy	SE	26	28	14	397.0	30.7	Litharenitic, fine- to medium-grained, micaceous.
Flournoy	Ctr	31	24	11	24.8	33.6	Feldspathic litharenite.
Flournoy	SW	15	23	12	154.0	38.2	Litharenite, thinly bedded, fine- to medium-grained, micaceous.
Flournoy	SW	15	23	12	77.0	33.9	Litharenite, fine- to medium-grained, micaceous.
Flournoy	E cor	36	20	12	37.0	31.1	Litharenite, massive, fine- to medium-grained, firm to friable, very micaceous.
Flournoy	N½	22	18	11	63.0	25.0	Litharenite, fine- to coarse-grained, silty, very firm.
Roseburg	NW	14	28	14	0.95	11.3	Litharenite, fine-grained, hard, silty, some mica.
Roseburg	SW	4	29	12	15.4	10.0	Feldspathic litharenite, fine-grained, hard, some mica.
Roseburg	SE	11	28	12	32.6	28.3	Litharenite, feldspathic, massive, fine-grained, silty, hard, some mica.
Roseburg	SE	27	28	14	382.0	32.6	Feldspathic litharenite, medium to coarse, silty, firm, some lime, some mica.

*Core Laboratories, Inc., Dallas, Texas.

OFFSHORE GEOLOGY AND GRAVITY MAP OF THE COOS BASIN, OREGON

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

Geology Modified from: A.J. MacKay (1969), L.D. Kulm and G.A. Fowler (1974).

Gravity anomaly contours by Richard Couch, 1979

EXPLANATION

Qp — **Pleistocene sediments:** *Age equivalent of Pliocene terraces onshore* (Qt)

Tpm — **Miocene - Pliocene sediments:** *Age equivalent of Empire Formation* (Tpe) *and Miocene sediments* (Tms) *onshore*

Toe — **Eocene - Oligocene sediments:** *Age equivalent of Tunnel Point Formation* (Totp), *Bastendorff Formation* (Teob), *Coaledo Formation* (Tec), *Flournoy Formation* (Tef), *and possibly some Lookingglass Formation* (Telg) *onshore*

Ms — **Pre - Tertiary unit:** *Age equivalent of Early Cretaceous Humbug Mountain Conglomerate and Late Jurassic Otter Point, Galice, and Rogue Formations onshore*

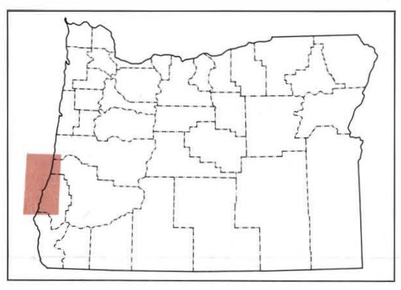
Gravity Anomaly Contours ± 5 milligals

WELL SYMBOLS

- Abandoned Dry Hole
- Abandoned Hole, Gas Show
- Abandoned Hole, Oil Show
- Abandoned Hole, Oil and Gas Shows

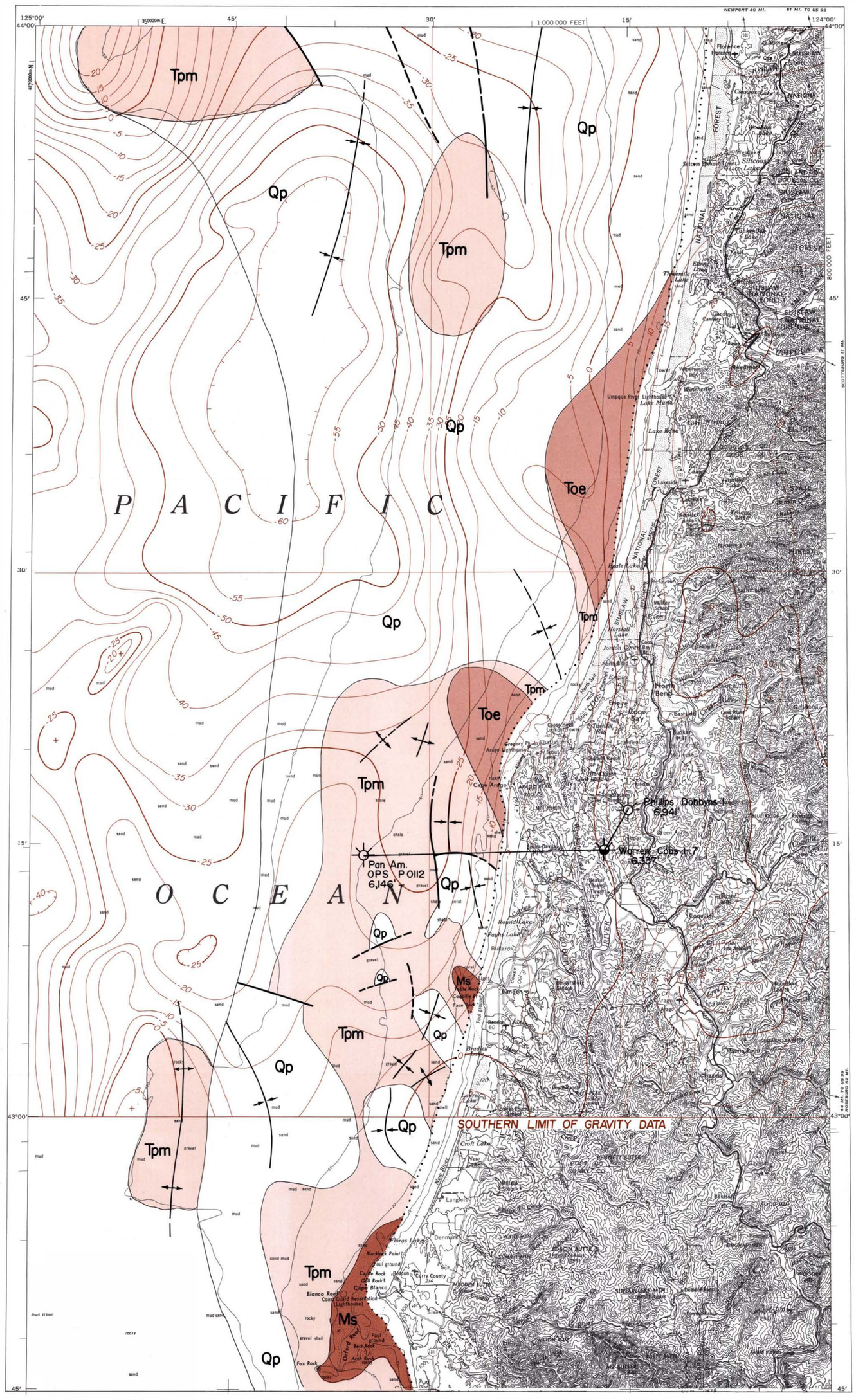
GEOLOGIC SYMBOLS

Contacts — Syncline
Folds
Faults — Anticline



Scale 1:250,000

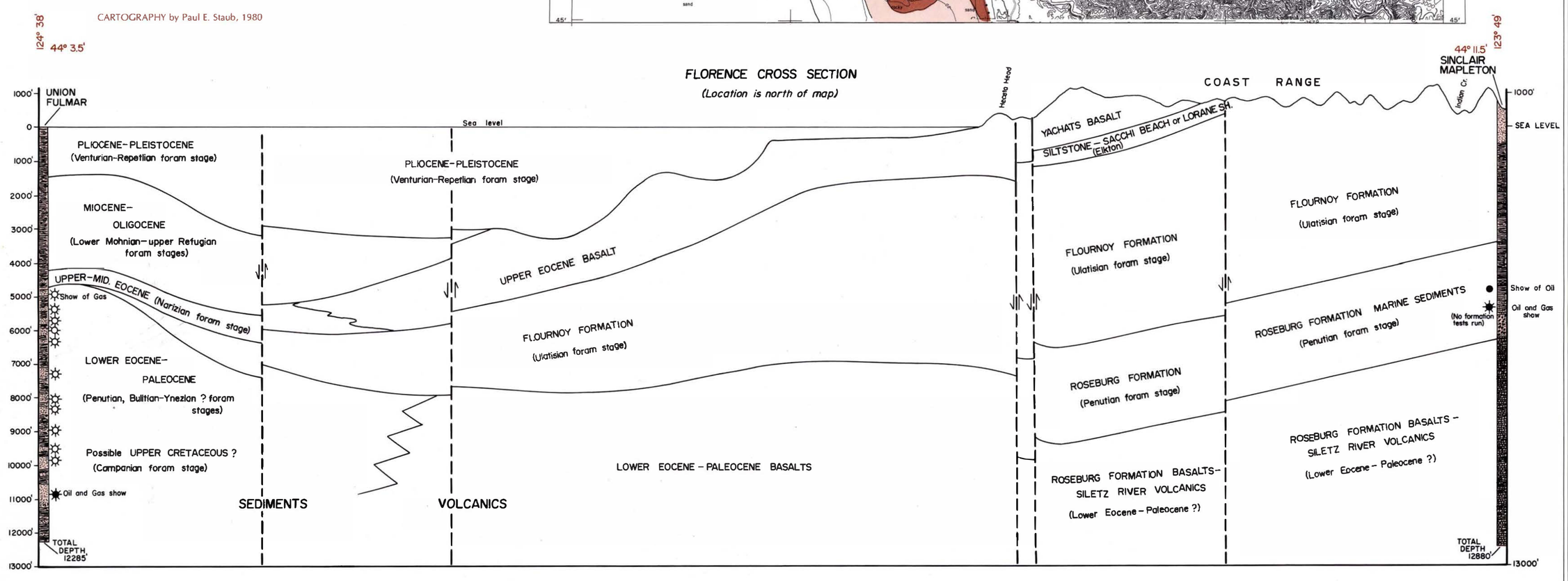
CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

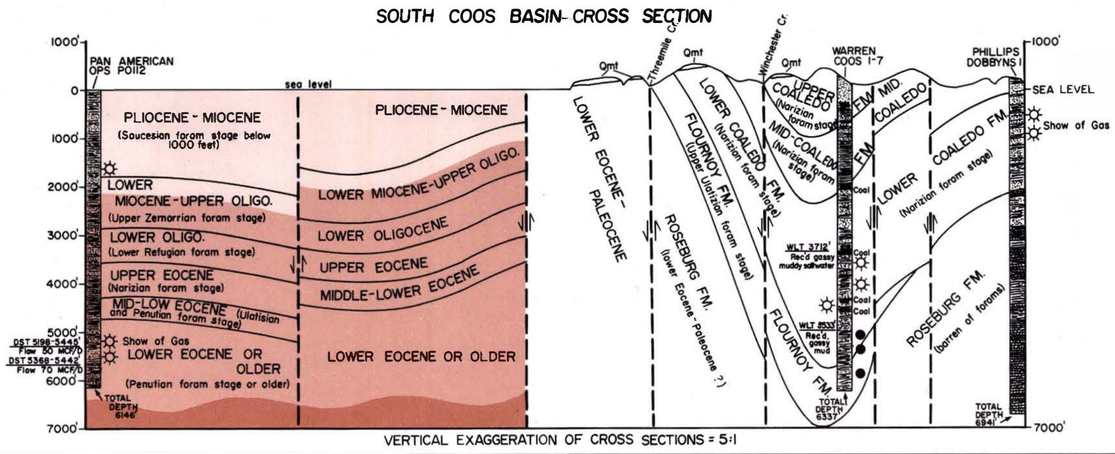


Base map from U.S. Army Map Service, with revisions by U.S. Geological Survey

Depth contours in fathoms

CARTOGRAPHY by Paul E. Staub, 1980





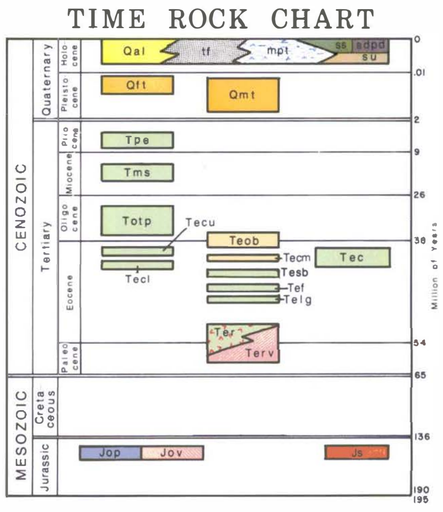
VERTICAL EXAGGERATION OF CROSS SECTIONS = 5:1

OIL AND GAS INVESTIGATION NO. 6 — PROSPECTS FOR OIL AND GAS IN THE COOS BASIN, WESTERN COOS, DOUGLAS, AND LANE COUNTIES, OREGON

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

GEOLOGIC MAP OF THE NORTHERN COOS BASIN AREA, OREGON

TIME ROCK CHART



EXPLANATION

SURFICIAL GEOLOGIC UNITS

fs — **Fill and spoils:** *Sand, silt, gravel, sawdust, wood chips, dredge spoils, and other material placed in wetland areas and on slopes for disposal or to provide space for development*

ss — **Stable sand:** *Unconsolidated fine- to medium-grained dune sand; thickness up to 200 ft in large dune fields; much thinner south of Bandon; organic soils and ancient soil horizons; does not include stable sand overlying* **Qmt**

su — **Unstable dune sand:** *Unconsolidated fine- to medium-grained sand of large dunes*

sdpb — **Deflation plain and beach sand:** *Unconsolidated fine- to medium-grained sand of beaches, flat-lying interdune areas, and transverse dune fields*

tf — **Tidal flat:** *Unconsolidated mud, silt, clay, and sand in the tidal zone of estuaries and other coastal wetlands; sediments compacted or high in organic material locally*

mpt — **Marsh and peat:** *Unconsolidated organic soils of silt, clay, and sand in estuarine and fresh-water wetland areas*

Qal — **Quaternary alluvium:** *Unconsolidated deposits of sand, silt, clay, and mud in the flood plains of major streams draining sandstone and siltstone terrain, and gravel, sand, and silt along the middle and upper reaches of rivers draining pre-Tertiary or volcanic terrain*

Qft — **Quaternary fluvial terrace deposits:** *Unconsolidated to semiconsolidated flat-lying and elevated deposits of river alluvium overlooking present stream valleys (Quaternary alluvium); includes fine-grained terrace deposits of estuarine origin*

Qmt — **Quaternary marine terrace deposits:** *Unconsolidated to semiconsolidated flat-lying and elevated marine deposits of sand, silt, clay, and gravel locally; thicknesses vary from 10 to 50 ft but locally are as little as 2 to 3 ft; elevations range from a few feet to several hundred feet near Coos Bay to almost 2,000 ft farther inland; exposures mapped as terrace deposits in Siltcoos-Tahkenitch Lake areas poorly understood*

BEDROCK GEOLOGIC UNITS

Tpe — **Empire Formation:** *Massive marine sandstone with minor interbeds of siltstone; includes a fossiliferous conglomerate lens at Fossil Point*

Tms — **Miocene sedimentary rock:** *Calcareous, medium-grained gray sandstone exposed at Pigeon Point near Empire; presence of the unit in Coos Bay is inferred from dredgings*

Totp — **Tunnel Point Formation:** *Coarse- to fine-grained tuffaceous sandstone and minor siltstone exposed only at Tunnel Point near the entrance to Coos Bay*

Teob — **Bastendorff Formation:** *Thinly bedded gray to buff shale and minor sandstone*

Tecl, Tecm, Tecu — **Coaledo Formation:** *Sequence has three members: lower and upper members (***Tecl** *and* **Tecu***) consist of coal-bearing, cross-bedded, tuffaceous sandstone; middle member (***Tecm***) consists of thin-bedded siltstone with minor sandstone*

Tec — **Coaledo Formation:** *Undifferentiated*

Tesb — **Sacchi Beach Beds:** *Micaceous siltstone and thinly interbedded arkosic sandstone*

Tef — **Flournoy Formation:** *Generally well indurated, rhythmically bedded micaceous sandstone passing upward into thin-bedded sandstone and siltstone*

Telg — **Lookingglass Formation:** *Rhythmically bedded sandstone and siltstone; well indurated; basal beds are coal bearing and conglomeratic locally near the base of the section*

Ter, Terv — **Roseburg Formation:** *Thick sequence of sandstone and siltstone; well indurated; rhythmically bedded locally; contains minor conglomerate and massive sandstone; pillowed and brecciated submarine basalts (***Terv***) are abundant locally*

Jop, Jov, Js — **Otter Point Formation:** *Tectonically sheared marine sedimentary rocks; includes graywacke, some chert-pebble conglomerate, and radiolarian chert. Also includes altered andesitic and keratophyric breccias and pillows (***Jov***) and isolated blocks of blueschist (***Js***)*

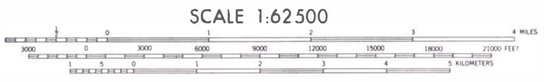
WELL SYMBOLS

- Abandoned Dry Hole
- Abandoned Hole, Gas Show
- Abandoned Hole, Oil Show
- Abandoned Hole, Oil and Gas Shows

GEOLOGIC SYMBOLS

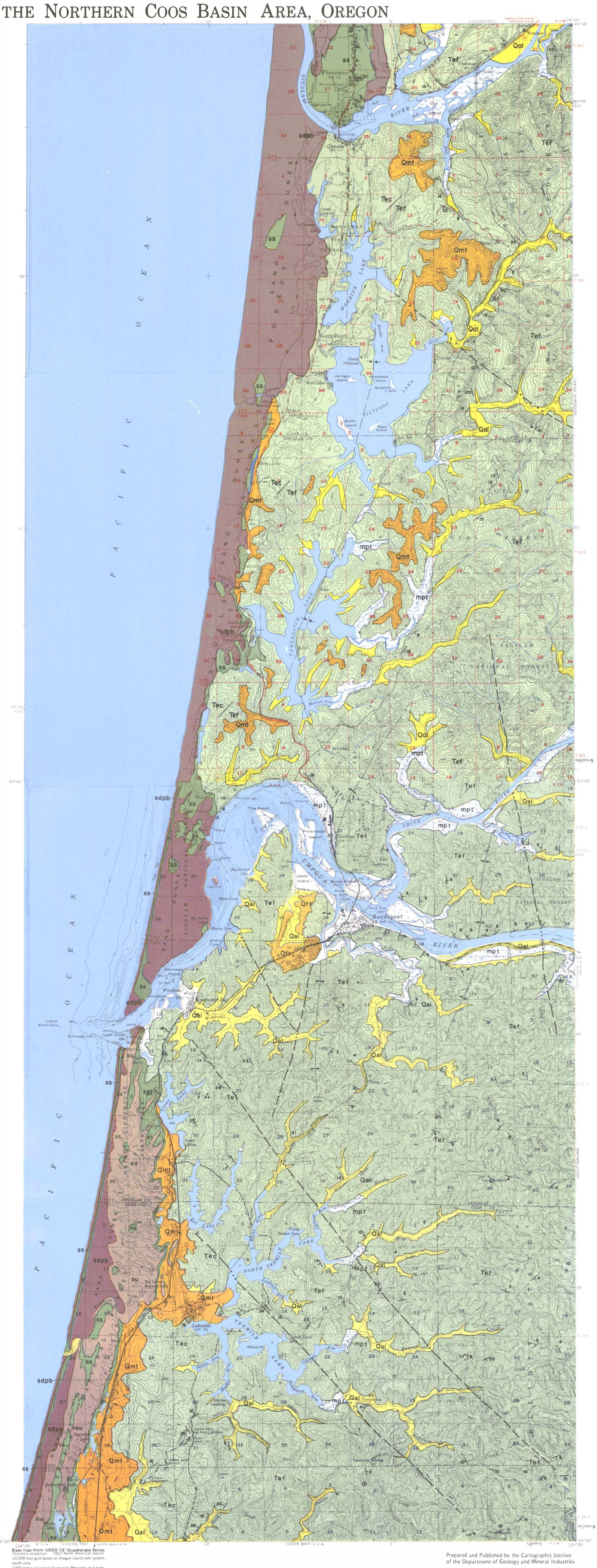
Contacts — Faults
Syncline — Anticline
Folds
Strike and dip — Horizontal bed
Attitudes

SCALE 1:62 500



Geology by E.M. Baldwin (1973), J.D. Beaulieu (1973) and V.C. Newton, Jr. (1979).

Geology of the Siltcoos Lake Quadrangle by V.C. Newton, Jr., 1979.



Base map from USGS 15' Quadrangle Series
Polyconic projection 1927 North American datum
10,000-foot grid based on Oregon coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks.

Prepared and Published by the Cartographic Section
of the Department of Geology and Mineral Industries

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

GEOLOGIC MAP OF THE SOUTHERN COOS BASIN AREA, OREGON

EXPLANATION

SURFICIAL GEOLOGIC UNITS

- **fs** — **Fill and spoils:** Sand, silt, gravel, sawdust, wood chips, dredge spoils, and other material placed in wetland areas and on shoals for disposal or to provide space for development
- **ss** — **Stable sand:** Unconsolidated fine- to medium-grained dune sand; thickness up to 200 ft in large dune fields; much thinner south of Bandon; organic soils and incipient soil formation; does not include stable sand underlying Qmt
- **su** — **Unstable dune sand:** Unconsolidated fine- to medium-grained sand of large dunes
- **sdpb** — **Deflation plain and beach sand:** Unconsolidated fine- to medium-grained sand of beaches, flat-lying interdune areas, and transverse dune fields
- **tf** — **Tidal flat:** Unconsolidated mud, silt, clay, and sand in the tidal zone of estuaries and other coastal wetlands; sediments commonly high in organic material locally
- **mpt** — **Marsh and peat:** Unconsolidated organic soils of silt, clay, and sand in saltwater and fresh water wetland areas
- **Qal** — **Quaternary alluvium:** Unconsolidated deposits of sand, silt, clay, and mud in the flood plains of major streams draining sandstone and siltstone terrain, and gravel, sand, and silt along the middle and upper reaches of rivers draining pre-Tertiary or volcanic terrain
- **Qft** — **Quaternary fluvial terrace deposits:** Unconsolidated to well consolidated flat-lying and elevated deposits of river alluvium overlooking present stream valleys (Quaternary alluvium); includes fine-grained terrace deposits of estuarine origin
- **Qmt** — **Quaternary marine terrace deposits:** Unconsolidated to semiconsolidated flat-lying and elevated marine deposits of sand, silt, clay, and gravel locally; thickness varies from 10 to 50 ft but locally as little as 2 to 3 ft; elevations range from a few feet to several hundred feet near Coos Bay to as much as 2,000 ft farther inland

BEDROCK GEOLOGIC UNITS

- **Tpe** — **Empire Formation:** Massive marine sandstone with minor interbeds of siltstone; includes a fossiliferous conglomerate near Fossil Point
- **Tms** — **Miocene sedimentary rock:** Coarse-to, medium-grained gray sandstone exposed at Pigeon Point near Empire; presence of the unit in Coos Bay is inferred from dredgings
- **Totp** — **Tunnel Point Formation:** Coarse- to fine-grained reddish-brown sandstone and minor siltstone exposed only at Tunnel Point near the entrance to Coos Bay
- **Teob** — **Bastendorff Formation:** Thinly bedded gray to buff shale and minor sandstone
- **Tecl, Tecm, Tecu** — **Coaledo Formation:** Sequence has three members: lower and upper members (Tecl and Tecu) consist of coal-bearing, cross-bedded, tuffaceous sandstone; middle member (Tecm) consists of thin-bedded siltstone with minor sandstone
- **Tec** — **Coaledo Formation:** Undifferentiated
- **Tesb** — **Succhi Beach Beds:** Micaceous siltstone and thinly interbedded arkosic sandstone
- **Tef** — **Flaherty Formation:** Generally well indurated, rhythmically bedded microcrose sandstone passing upward into thin-bedded sandstone and siltstone
- **Telg** — **Lookingglass Formation:** Rhythmically bedded sandstone and siltstone; well indurated; basal beds are coal bearing and conglomeratic locally near the base of the section
- **Ter, Terv** — **Roseburg Formation:** Thick sequence of sandstone and siltstone; well indurated; rhythmically bedded locally; contains minor conglomerate and massive sandstone; pillowed and brecciated volcanic rock beds (Terv) are abundant locally
- **Jop, Jov, Js** — **Other Pelsic Formations:** Tectonically sheared marine sedimentary rocks; includes greywacke, some chert pebble conglomerate, and radiolarian chert. Also includes altered andesitic and hemipelagic breccias and pillows (Jov) and isolated blocks of limestone (Js)

TIME ROCK CHART

GEOLOGIC SYMBOLS

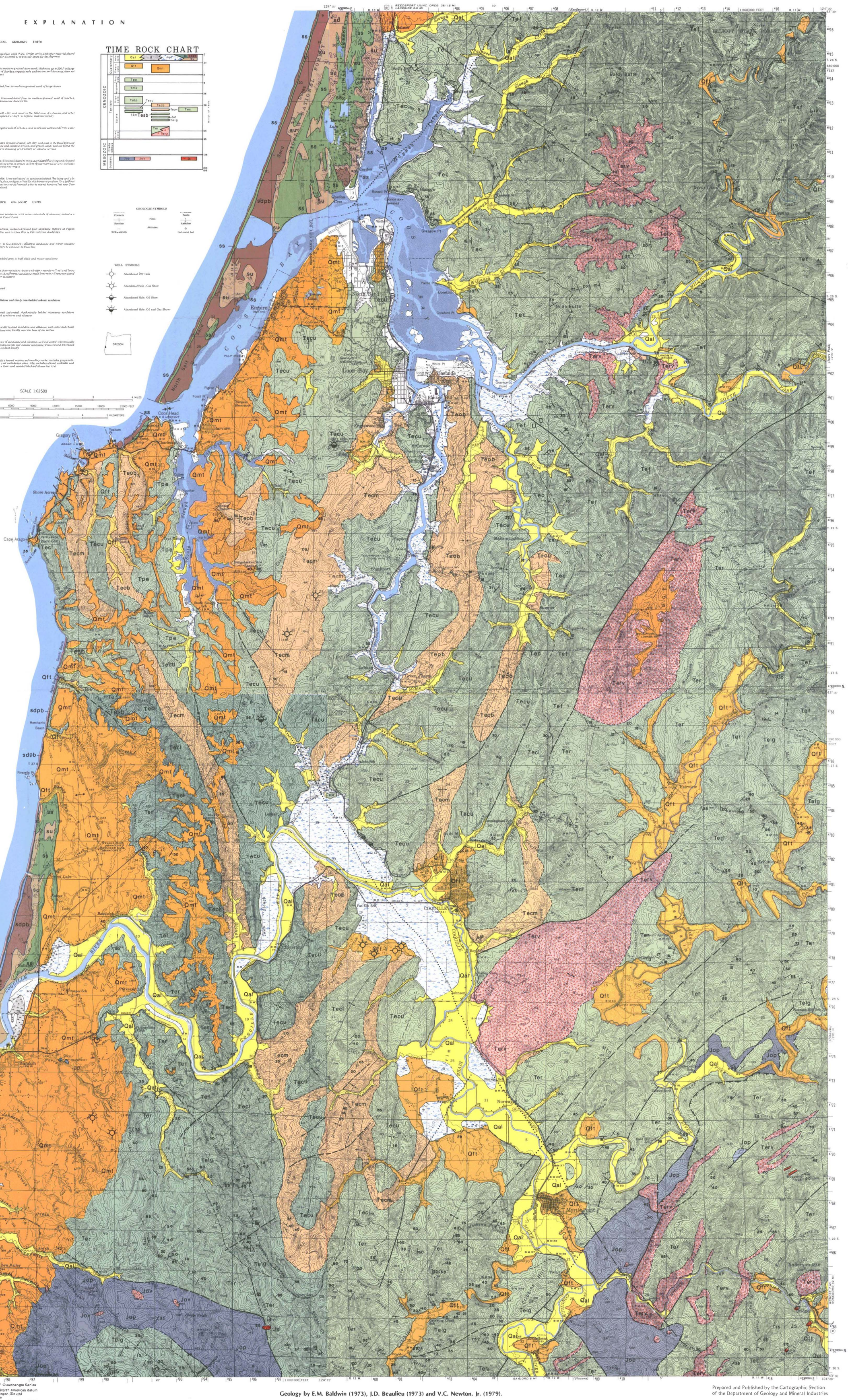
Contacts — Folds — Faults
Synclinal — Anticlinal
Strike and dip — Attitudes — Horizontal bed

WELL SYMBOLS

- Abandoned Dry Hole
- Abandoned Hole, Gas Show
- Abandoned Hole, Oil Show
- Abandoned Hole, Oil and Gas Shows

OREGON

SCALE 1:62500



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