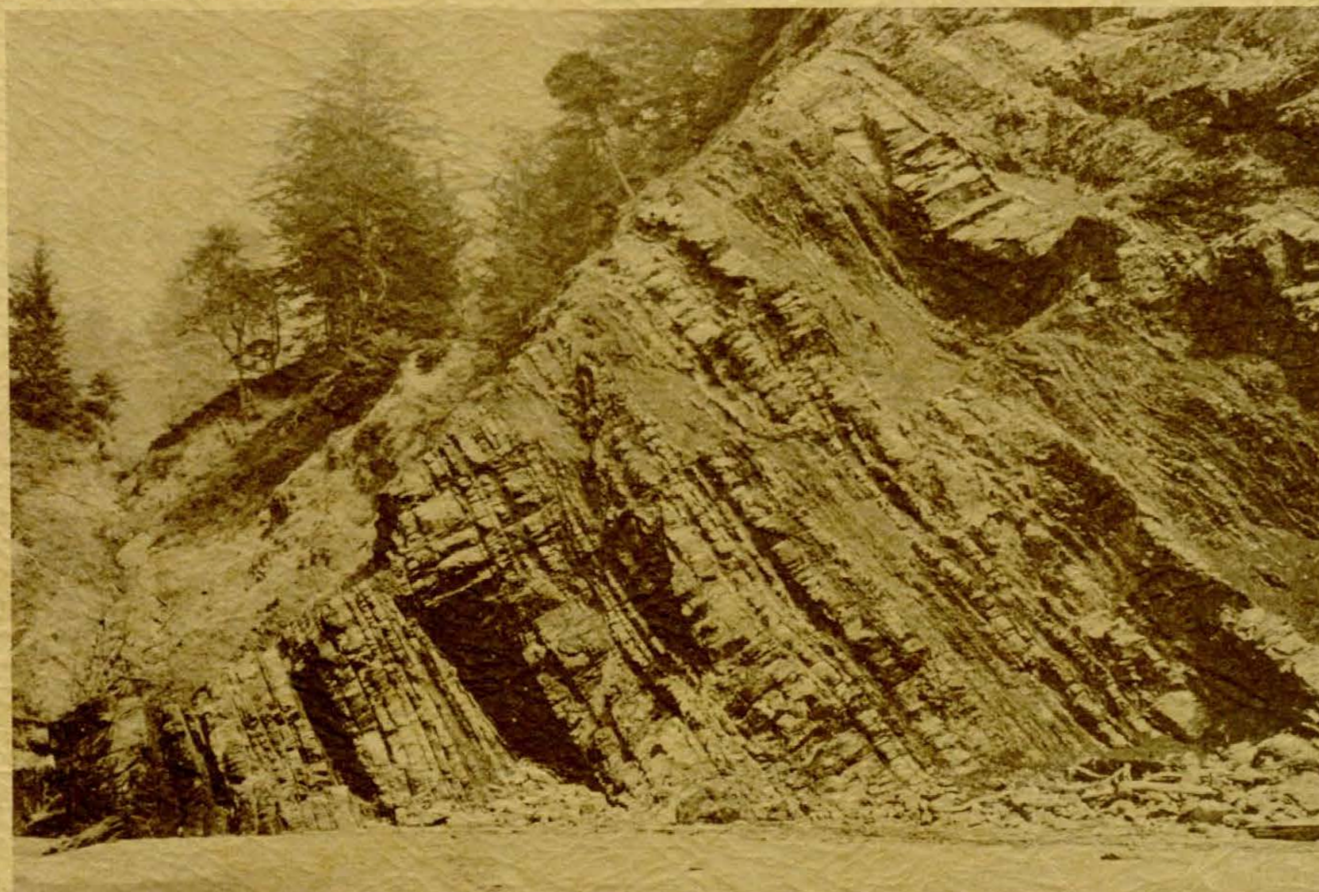
BULLETIN 70



GEOLOGIC FORMATIONS OF WESTERN OREGON

WEST OF LONGITUDE 121° 30'

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

1971

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1069 State Office Building
Portland, Oregon 97201

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CONTENTS

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INTRODUCTION

It is the purpose of this publication to provide a concise, yet comprehensive discussion of the formations of western Oregon. It is the further aim that the data for each of the formations be as current as possible. Consequently, the emphasis has been placed on the recent literature. Although this paper should not be viewed as a discussion of the historical development of each of the formations, the original reference for each of the units is given. Also, in cases where the historical development of the formation has a direct bearing on present-day problems it is included in the discussion.

A wide variety of published literature and unpublished reports, theses, and dissertations was consulted and several professional opinions regarding specific problems were solicited. In recent years research has been concentrated in the Klamath Mountains and the southern Coast Range and for these regions literature was voluminous. For other areas lacking recent study, it was sometimes necessary to consult older literature some of which dated back 20 years or more.

An attempt was made to emphasize the relationships between units as well as the lateral variations within units. Although much has undoubtedly escaped the author, it is hoped that this publication will provide the reader with an understanding of the units of particular interest to him. The bibliography is relatively complete with regard to recent literature and should be of value.

A total of 72 formations or units with a total of 92 names is treated in the text. The distribution, lithology, structure, and age of most of the units are treated under separate subheadings. In addition, the nature of the contacts of the units with the overlying and underlying units is discussed, as an appreciation of this feature is considered to be essential to the understanding of each of the units. Following the discussion of each unit is a list of references from which the information was extracted.

Correlation charts based on 15 localities in western Oregon are provided at the end of the text as aids in relating the units to one another and as a summary of the information presented in the text. The reader is reminded, however; that the actual relationships between units are often more complex and less well understood than the diagrams, taken by themselves, might imply.

An alphabetized list of the quadrangles of western Oregon with the accompanying references precedes the correlation charts. It is presented as an aid to the reader in finding recent literature for particular areas of interest about which the reader might not otherwise be aware.

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The author is indebted to several people throughout western Oregon for their assistance in the preparation of this publication. Special thanks are extended to Dr. E. M. Baldwin of the University of Oregon for his provocative discussions and helpful suggestions both in the office and in the field. Thanks are also extended to the rest of the geology faculty at the University of Oregon for their many and varied discussions and comments regarding the geology of Oregon during the academic year 1969-1970. Although their help was not directly intended for this publication, it nevertheless provided the author with valuable background.

Appreciation is also extended to the members of the State of Oregon Department of Geology and Mineral Industries for editing and typing the manuscript. Steve Renoud drafted the diagrams. R. E. Corcoran suggested the project and loaned the writer many of his personal notes. Field work and discussions with Len Ramp of the Grants Pass field office were helpful.

GEOLOGIC FORMATIONS

APPLEGATE GROUP

Original description: Wells, F. G., Hotz, P. E., and Cater, F. W., Jr., 1949, Preliminary description of the geology of the Kerby quadrangle, Oregon: Oregon Dept. Geol. and Mineral Indust. Bull. 40, 23 p.

Distribution: The Applegate Group is located in the Klamath Mountains of southwestern Oregon. The most prominent exposures and type section occur in the Ruch quadrangle along the Applegate River.

Lithology: The Applegate Group consists of a variety of eugeosynclinal metasediments and metavolcanics having an over-all thickness of possibly greater than 40,000 feet. The metavolcanics include flows, breccias, and basaltic and andesitic pyroclastic deposits and their albitized equivalents.

The metasediments include black platy argillite, tuffaceous feldspathic and lithic graywacke, micaceous quartzite, chert, and marble. The metasedimentary layers are grossly lenticular, exhibiting thicknesses of a few thousand feet and lateral extents seldom greater than a few miles.

The Applegate Group has undergone incomplete greenschist facies metamorphism so that aspects of the prehnite-pumpellyite metagraywacke facies are preserved locally in the clastics.

Structure: The structure is best characterized as a series of steep, easterly dipping anticlines and synclines probably accompanied by appreciable shearing and possible thrusting. The unit is intruded by Nevadan serpentinite and quartz diorite locally.

Contacts: The Applegate Group appears to be in high-angle reverse fault contact with older Paleozoic schists to the east and apparent fault contact with the younger Galice Formation to the west.

Age: A Late Triassic age is generally accepted for the unit. Ammonites recovered in lateral equivalents of the Applegate Group of northern California indicate a Karnian age for at least part of the unit.

References: Engelhardt, 1966
Heinrich, 1966
Silberling and others, 1962
Wells, 1956
Wells and others, 1949

ASTORIA FORMATION

Original description: Howe, H. V., 1926, Astoria: mid-Tertic type of Pacific Coast: Pan-American Geologist, vol. 45, no. 4, p. 295-306.

Distribution: Rocks assigned to the Astoria Formation are widespread in northwestern Oregon along the lower Columbia River and are exposed in sea cliffs along the coast. Notable exposures occur in the Yaquina, Cape Foulweather, Hebo, Euchre Mountain, Cannon Beach, Astoria, Svensen, and Tillamook quadrangles. The type locality is situated in the city of Astoria.

Lithology: Rocks assigned to the Astoria Formation characteristically consist of yellow to gray, massive to cross-bedded, medium- to fine- grained, feldspathic, locally tuffaceous or micaceous sandstone interbedded with varying amount of silty shale. Specific details vary with the individual author's concept of Astoria and the location of his study area. Occurrences of coal pebbles, concretions, fossiliferous horizons, gypsum, and interbedded volcanic rocks are reported locally.

At the type locality, sandstones fitting the above description (upper sandstone of Howe, 1926) are underlain by approximately 1,000 feet of mudstone and shale, which in turn are underlain by about

150 feet of sandstone. These strata are no longer available for study, but were included in the type Astoria by Howe (1926).

Structure: The Astoria Formation exhibits gentle westerly dips and is extensively faulted and locally intruded along the coast.

Contacts: In Astoria, the locality of the type section, the exact nature and stratigraphic relationships of the Astoria Formation are paradoxically uncertain. In the type description Howe (1926) designated a lower sandstone, a middle shale, and an upper sandstone. Subsequently Dodds (1963) assigned the upper sandstone to an overlying new unit, the post-Astoria sandstone. He points out that when the shales of the original Astoria Formation (middle mudstone of Howe, 1926) were lost to urbanization, geologists seeking new exposures settled upon sequences of predominately sandstone (upper sandstone of Howe, 1926; post-Astoria sandstone of Dodds, 1963), which overlay the shale in surrounding areas.

It has subsequently been proven that an unconformity underlies the upper sandstone in a regional sense and Dodds presents evidence that the unconformity extends into the type area between his Astoria Formation (lower sandstone and middle shale of Howe, 1926) and post-Astoria (upper sandstone of Howe, 1926) units. Apparently the type Astoria as originally defined contains an unconformity of regional dimensions. The presence of such an unconformity is sufficient grounds for subdividing the Astoria Formation, but unfortunately the type Astoria is no longer available for study.

In practice most beds assigned to the Astoria Formation are probably equivalent to the upper sandstone unit of Howe (1926) (post-Astoria of Dodds, 1963). In the Yaquina Bay area the Astoria Formation is unconformable over the Nye Mudstone and unconformable under the "basalt at Depoe Bay" (Snavely and others, 1969). To the north in the Hebo quadrangle the Astoria rests unconformably over the Keasey Formation. In the Tillamook quadrangle the Astoria Formation lies on tuffaceous marine deposits of Oligocene age.

Age: Rocks most commonly referred to the Astoria Formation contain a Temblor (mid-Miocene) megafauna and a Saucesian microfauna, and probably are equivalent to the upper sandstone unit of Howe (1926) and the post-Astoria sandstone of Dodds (1963). However, beds ranging in age from Oligocene to late Miocene are also included in the unit locally and there is considerable confusion concerning the exact age of the formation.

The Astoria Formation of Dodds (lower sandstone and middle shale of Howe, 1926) is Oligocene to early Miocene in age and contains a middle Refugian to Saucesian microfauna. Dodds assigns a late Miocene age to his overlying post-Astoria sandstone (upper sandstone of Howe, 1926). Stewart (1956 a), however, assigns a late Saucesian (mid-Miocene) age to part of the Astoria Formation of Howe (1926) on the basis of microfossils collected in Astoria. It follows that either the upper Astoria or lower post Astoria of Dodds is middle Miocene in age depending on where the samples were collected. Hence, the duration of the intervening unconformity of Dodds (which he designated as middle Miocene) is open to question.

In the vicinity of Clifton near the mouth of the Columbia River, Lowry and Baldwin (1952) describe friable sandstones overlying and interbedded with basalts assigned to the Columbia River Group of Miocene age. A late Miocene age was assigned to these beds on the basis of their stratigraphic position between the Columbia River Group and the overlying Troutdale equivalents of supposed early Pliocene age.

In Washington Pease and Hoover (1957) and Rau (1967) assign a middle Miocene age to beds which they correlate with the type Astoria Formation in their respective publications.

Remarks: Beds assigned to the Astoria Formation vary in age from Oligocene through the late Miocene, contain at least one regional unconformity, and are in part equivalent in age to or younger than the Columbia River Group. Clearly present usage of the term Astoria Formation is not in keeping with the formalities of stratigraphic nomenclature. The restriction of the term to a more meaningful definition will require the erection of an accessible type section and a careful re-evaluation of all beds assigned to the unit.

References: Dodds, 1963, 1969
Howe, 1926
Lowry and Baldwin, 1952
Pease and Hoover, 1957
Rau, 1967
Snavely and others, 1958
Snavely and others, 1964
Snavely and others, 1969
Snavely and Vokes, 1949
Stewart, 1956 a,b
Warren and others, 1945

BASTENDORFF FORMATION

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Calif. Univ. Pub. in Geol. Sci., vol. 16, no. 12, p. 449-460.

Distribution: The Bastendorff Formation has a relatively limited distribution, being restricted to the Coos Bay area of southwestern Oregon. The type locality is located at Bastendorff Beach.

Lithology: The unit consists of approximately 2,300 feet of thinly laminated, dark-gray siltstone and shale that weathers to light tan or almost white. Microfossils are locally abundant and the unit probably represents deposition during continued encroachment of the sea in post-Coaledo times.

Structure: The unit is intimately involved in the local folding of the Coos Bay area and locally dips to the east by as much as 75°.

Stratigraphy: The Bastendorff Formation is conformable over the Coaledo Formation and conformable under the Tunnel Point Formation.

Age: The age of the Bastendorff Formation is clearly late Eocene to early Oligocene. However, there has been some confusion surrounding the exact location of the Eocene-Oligocene boundary within the unit. Youngquist (1961) referring to Baldwin, (1959) and Baldwin 1964 referring to Stewart (1956), both specifically state that the upper two-thirds of the unit is Oligocene, whereas the lower third is late Eocene. Stewart (1956), however, in the cited article states that the upper 700 feet of the unit is early Oligocene, whereas the remainder (the lower 1,600 feet) is late Eocene. It would appear then, that the lower two-thirds of the Bastendorff is late Eocene and only the upper third is early Oligocene.

References: Baldwin, 1959
Baldwin, 1964
Ehlen, 1967
Stewart, 1956
Youngquist, 1961

BORING AGGLOMERATE

Original description: Treasher, R. C., 1942, Geologic map of the Portland area, Oregon: Oregon Dept. Geol. and Min. Ind. map.

Distribution: The Boring Agglomerate is a term sometimes applied to what probably is an equivalent of the Rhododendron Formation in the upper Clackamas Valley in northwestern Oregon near Portland.

Lithology: The unit consists of massive volcanic breccia and lesser amounts of interbedded lava. The breccia consists of angular fragments of basic andesite and boulders of basalt set in a tuffaceous matrix.

Age: The Boring Agglomerate is assigned an early Pliocene age in the literature on the basis of its interbedded relationship with the Molalla Formation, which was formerly thought to be of early Pliocene age. Because the Molalla Formation is now considered Miocene in age, a Miocene age is also assigned to the Boring Agglomerate (Rhododendron Formation). Volcanic rocks associated with the Pliocene Troutdale Formation, which are sometimes assigned to the Boring Agglomerate, probably belong to the Boring Lava.

References: Baldwin, 1964
Lowry and Baldwin, 1952
Treasher, 1942
Trimble, 1963

BORING LAVA

Original description: Treasher, R. G., 1942, Geologic Map of the Portland area, Oregon: Oregon Dept. Geol. Min. Ind. map.

Distribution : The Boring Lava is well exposed in the Portland area as a series of vents and related flows. The unit characteristically caps the more prominent topographic features such as Rocky Butte, Mount Tabor, Mount Scott, and Mount Sylvania. The westernmost occurrence is in the west Tualatin Mountains, where approximately 150 feet is exposed near Beaverton. The unit is more widespread to the east where it is included in parts of the Cascades Formation.

Although Lowry and Baldwin (1952) report the presence of Boring Lava as far south as the Molalla quadrangle, the exposures to which they refer are probably more appropriately included in the Rhododendron Formation. In the Portland area the Boring Lava was originally mapped as part of the Rhododendron Formation by Hodge (1938).

Lithology: The unit consists of light- to dark- gray diktytaxitic olivine basalt with subordinate amounts of pyroclastics, breccias, ash, and cinders locally around vents. Outcrops of basalt are characteristically blocky and seldom is columnar jointing developed.

Age and contacts: The Boring Lava is post-Rhododendron in age and most of the unit is probably middle Pliocene. That the lower part of the unit is early Pliocene, however, is suggested by the occurrence of basalts interbedded with beds assigned to the Troutdale by Lowry and Baldwin (1952) at Crown Point. A middle to late Pliocene age for most of the Boring Lava is most likely, because most of the unit rests disconformably over the Troutdale Formation. Isolated exposures of middle and late Pleistocene age to the south which Trimble (1963) assigns to the Boring Lava are perhaps better considered as part of the Cascades Formation.

References: Baldwin, 1964
Hodge, 1938
Lowry and Baldwin, 1952
Schlicker and others, 1967
Treasher, 1942
Trimble, 1963

BREITENBUSH TUFFS

Original description: Thayer, T. P., 1936, Structure of the North Santiam River section of the Cascade Mountains in Oregon: Jour. Geology, v. 44, no. 6, p. 704, 705, 709 (fig. 2), 713 (fig. 3).

Distribution: Rocks originally referred to this unit are now generally treated as part of the Little Butte Volcanic Series of Peck and others (1964). However, because the term sometimes undergoes sporadic present-day usage it is included here. The Breitenbush Tuffs are limited to those parts of the western Cascades situated east of Salem along the Breitenbush River.

Lithology: The unit consists of as much as 7,500 feet of water-worked land-laid tuffs, breccias, and conglomerates interlayered with lavas. Sandy and conglomeratic beds are most common high in the section, whereas massive, green, pumiceous breccias are common in the lower part of the unit. To the east the unit grades into pebbly sandstone, andesitic flows, and well-bedded ash lenses.

Age: The Breitenbush Tuffs are probably Oligocene to early Miocene in age. They are pre-Columbia River Basalt.

References: Baldwin, 1964
Peck and others, 1964
Thayer, 1936
Thayer, 1939

BURPEE FORMATION

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Calif. Univ. Pub. in Geol. Sci. Bull., vol. 16, no. 12, p. 455, 456.

(See: Tyee Formation)

CALAPOOYA FORMATION

Original description: Wells, F. G., and Waters, A. C., 1934, Quicksilver deposits of southwestern Oregon: U. S. Geol. Survey Bull. 850, 58 p.

(See: Fisher Formation)

CAPE SEBASTIAN SANDSTONE

Original description: Dott, R. H., Jr., (in press), Geology of the southwest Oregon Coast west of the 124th Meridian: Oregon Dept. Geol. and Min. Industries Bull. 69.

(See: Late Cretaceous sedimentary rocks)

CASCADES FORMATION (OR CASCADES ANDESITE)

Original description: Williams, I. A., 1916, The Columbia River Gorge; its geologic history interpreted from the Columbia River Highway: Oregon Bur. Mines and Geol., Mineral Res. of Oregon, vol. 2, no. 3, 77 p.

Distribution: The Cascades Formation makes up the crest and eastern slope of the Cascade Range in Oregon. Equivalent rocks appearing under different names extend north into Washington and south into California. Also included in the unit are numerous intracanyon flows that spilled onto the Western Cascades, and a few scattered cones in the Portland area. Rocks included in the Cascades Formation are also referred to in part or in full as the Cascade Andesite, Cascan Formation, Cascade Formation, Plio-Pleistocene lavas, and High Cascades Lavas.

Lithology: The Cascades Formation consists of porous and porphyritic flows of pyroxene andesite, basaltic andesite, and olivine basalt with subordinate amounts of capping pyroclastic rocks. Structurally the unit is an aggregate of coalescing shields and younger volcanic cones. In contrast to the lavas of the western Cascades, the lavas of the High Cascades are uniform in composition and are derived from cones rather than fissures. They are undeformed and modified by glaciation. Moreover, the topography is mainly constructional rather than erosional.

The Cascades Formation is subdivided by Williams(1957) into four units: the Pliocene-Pleistocene gray olivine basalt; the Pleistocene glaciated andesite; the Pleistocene-Holocene Icelandic andesitic lavas; and the Holocene unglaciated basalt flows. The Pliocene-Pleistocene gray olivine basalts occur as a series of coalescing olivine basalt and olivine-bearing basaltic andesite shields capped locally with the fragmental ejecta of the main cones of the Cascade Range. Included are Three Fingered Jack, Mount Washington, North Sister, Husband, Mount Yoran, Lakeview, Cowhorn, Sawtooth, Howlick Mountains, and Mount Thielsen. Other deeply dissected mountains belonging to this subdivision include Wife, Sphinx, Broken Top and Diamond Peak volcanoes. Less modified mountains also belonging to this group include Fuji Mountain, Mount Bailey, Maiden Peak, and Mount Hood.

Postdating the Plio-Pleistocene olivine basalts and related rocks are the Pleistocene glaciated andesites and dacite lavas of Mount Mazama, South Sister, and Middle Sister. Dacite pumice is superficially widespread in the area surrounding Crater Lake.

Younger still are the relatively steep-sided, Pleistocene-Holocene andesitic lavas of Icelandic type which occur in the central and eastern High Cascades. Prominent mountains include Hamner, Ringo, and Gilchrist Buttes, and Cultus, Maklaks, Rogue, Lookout, Browns, and Davis Mountains.

Holocene unglaciated basalt flows and cinder cones are present north of Three Sisters in the region centered by Belknap Crater. Four-in-one cone, one of the more interesting of the numerous scattered cinder cones, expelled ash and flows as late as 2,600 years ago. Rocks belonging to this unit are more widespread to the south and east in Deschutes County in the area surrounding Newberry Crater, a Pleistocene-to-Holocene shield volcano.

Holocene pyroxene andesites are present at O'Dell Butte and Black Butte, and Holocene dacites occur at Broken Top. Dacite obsidians are present in the Three Sisters area.

Structure: The lavas of the Cascades Formation are undeformed and exhibit only primary dips.

Contacts: The Cascades Formation presumably overlies rocks of the western Cascade type at depth. To the east the lavas interfinger with the Dalles and the Madras Formations, and to the northwest lavas of similar age overlie and may intertongue with the Troutdale Formation.

Age: The Cascades Formation is early Pliocene to Holocene in age.

References:
Barlow, 1955
Dole, 1968
Halstead, 1955
Peck, 1960
Peck and others, 1964
Peterson and McIntyre, 1970
Schlicker, 1954
Schlicker and others, 1957
Walker and others, 1966
Wells and others, 1956
Williams, H., 1957
Williams, I., 1916

COALEDO FORMATION

Original description: Diller, J. S., 1899, The Coos Bay coalfield, Oregon: U. S. Geol. Survey 19th Ann. Rpt., Pt. 3, p. 309-370.

Distribution: The Coaledo Formation is restricted to the Coos Bay area of southwestern Oregon. The vicinity of Coaledo in the Coos Bay coal field is designated as the type locality.

Lithology: The Coaledo Formation consists of approximately 6,000 feet of coal-bearing lower and upper sandstone separated by a middle mudstone member of variable thickness that thins to the south and east. The whole sequence typifies a transgressive-regressive cycle in which the middle mudstone represents the deeper water conditions resulting from maximum transgression.

The lower sandstone consists of 400 feet of massive, buff sandstone and minor amounts of laminated siltstone and silty sandstone. The unit is coal-bearing locally, and the beautiful exposures of cross-bedding, flame structures, and sole markings at Sunset Bay are among the best in the world.

The middle unit is composed of fissile mudstone, siltstone, and medium-gray tuffaceous shale. The upper sandstone unit is a micaceous, medium- to fine-grained basaltic and tuffaceous sandstone much like the lower sandstone, with the exception that primary structures are not so well-developed.

The environment of deposition of the Coaledo is best characterized as deltaic with all the associated variations such as distributary channels, lagoons, tidal flats, barriers, beaches, shelves, marshes, and swamps. The sources lie to the southeast in the Klamath uplands as suggested by grain-size variations and primary structures. The unit was originally far greater in extent than is suggested by the present exposures. The impression one gets now of deposition in a narrow channel is probably the result of post-depositional deformation and erosion of the unit.

Structure: The Coaledo exhibits a northerly strike and dips gently to steeply to the east or west as a function of position on the various folds or of proximity to some of the major northerly faults of the area.

Contacts: The Coaledo Formation unconformably overlies the Tyee Formation and is conformable with the overlying Bastendorff Formation. There is no direct evidence pertaining to the exact stratigraphic relationship of the Coaledo Formation with the Coaledo (?) of Baldwin (1961).

Age: The Coaledo Formation is of late Eocene age. The lower, middle, and upper members correspond respectively to the A-2, A-1, and transitional R and A-1 zones of Laiming.

References: Baldwin, 1961
Baldwin, 1964
Baldwin, 1966
Dott, 1966
Ehlen, 1967
Stewart, 1956

COALEDO (?) FORMATION

Original description: Baldwin, E. M., 1961, Geologic Map of the lower Umpqua River area, Oregon: U. S. Geol. Survey Map OM-204.

Distribution: Beds assigned to this unit cap peaks in the Tyee, Ivers Peak, Elkton, and Scottsburg quadrangles. Baldwin intends to formalize the unit under the term Bateman Formation in a forthcoming publication (Baldwin, oral communication, 1970).

Lithology: The unit consists of micaceous, locally coal-bearing, deltaic sandstone. Poorly sorted, pebble-bearing, cross-bedded sandstone occupies the base of the section. Upsection, distinctly bedded sandstone gives way to tuffaceous sandstone, and to local coal beds and leaf-bearing beds high in the section. The total thickness of the unit is approximately 1,200 feet.

Contacts: The beds overlie the Elkton Siltstone Member of the Tyee Formation with slight angular discordance. Nowhere is the unit in direct contact with the Coaledo Formation.

Age: The Coaledo (?) contains specimens of *Venericardia hornii* subsp. *calafia* Stewart, a megafossil diagnostic of the Tyee Formation but unknown in the Coaledo Formation. Stratagraphic relationships, however, indicate that the beds are clearly post-Tyee in age.

The beds may represent a short-lived influx of the sea in pre-Coaledo-post-Tyee times. Specifically the unit is late Eocene post-Laiming's B-1A (upper Tyee) and pre-Laiming's A-2 (lower Coaledo). According to Stewart (1957), such an age is equivalent to Laiming's A-3 zone. The Coaledo (?) occupies approximately the same stratigraphic position as the upper Yamhill Formation.

References: Baldwin, 1961
Baldwin, 1966
Stewart, 1956
Stewart, 1957
Turner, 1938

COFFIN BUTTE VOLCANICS

Original description: Allison, I. S., 1953, Geology of the Albany quadrangle: Oregon Dept. Geol. Min. Ind. Bull. 37, p. 3-5.

(See: Siletz River Volcanics)

COLEBROOKE SCHIST

Original description: Diller, J. S., 1903, Description of the Port Orford quadrangle: U. S. Geol. Survey Geol. Atlas, Folio 89.

Distribution: The Colebrooke Schist occurs in the Mesozoic terrane of the Klamath Mountains in western Curry and Coos Counties as a series of sheets and slivers of various sizes and shapes.

Lithology: The Colebrooke Schist is a diverse assemblage of white quartz-mica phyllite and schist, well-foliated sandstone, stretched pebble conglomerate and metavolcanics (listed in order of decreasing abundance). The degree of schistosity is a function of composition and is characteristically developed as a series of segregation bands of lepidoblastic muscovite, sericite, biotite, chlorite, and granoblastic quartz. Epidote and stilpnomelane occur locally and glaucophane (indicative of high-pressure and low-temperature conditions) composes up to 15 per cent of the rock in places.

The unit is highly contorted, sheared, and cataclasized. Foliation surfaces generally dip inland at low to moderate angles and folds recumbent to the east have been described locally. Present thought is that the unit was derived from the Galice and possibly the Rogue Formations, but not from the Dothan or the Otter Point Formations.

Structure and origin: The occurrence of the Colebrooke Schist at its present locations within a post-Nevada terrain is attributable to large-scale thrusting, unroofing, or a combination of the two. The ultimate origin of the schists, however, is poorly understood and the rocks assigned to the unit may vary in manner of origin from place to place.

According to Blake and others (1967), the metamorphic grade of rocks equivalent to the Colebrooke Schist in California increases upsection towards a hypothetical thrust surface. They postulate that the unit was formed relatively near the surface under the simulated high-pressure low-temperature conditions which resulted from the cataclastic release of water beneath an overriding thrust plate.

If this mode of origin applies to the Colebrooke Schist of Oregon, it follows that associated low-grade metamorphic rocks such as the melanged Otter Point Formation, which apparently predates the blueschists, may have served as the overriding thrust sheet if it was actually thrust into the area. This theory, however, does not account for the exposures of Colebrooke Schist which overlie the Otter Point Formation. Moreover, Dott (in press) specifically states that no reverse metamorphic zoning is observable in the Colebrooke Schist of Oregon.

Coleman (1969; written communication, 1970) interprets the Colebrooke Schist to represent two poorly defined periods of deformation, the first of which produced the metamorphic minerals in the Early Cretaceous, and the second of which produced the recumbent folds as a result of regional thrusting to the east in the Late Cretaceous. According to him, much of the Colebrooke rests on "tectonic sheets" of serpentinite.

Possibly the blueschists and related metamorphic rocks of the Colebrooke Schist were formed according to a mechanism similar to that of Blake and others (1967) in a subduction zone environment in response to the stresses of sea-floor spreading. Possibly also, the Late Cretaceous thrusting which brought the Colebrooke Schist to its present location may have been related to sea-floor spreading in some way (Coleman, written communication, 1970).

Contacts: The nature of the contacts of the Colebrooke Schist with adjacent formation is poorly understood. Dott (in press) does not designate the nature of the contact with the Dothan Formation to the south, but he does suggest that the Colebrooke Schist has been thrust over the Otter Point Formation in the northwest. There Lent (1969) indicates thrusting of the Colebrooke over the Otter Point Formation. A short distance inland, however, in the Powers quadrangle Otter Point rests directly upon the Colebrooke Schist further complicating the picture (Baldwin and Lent, 1969; Baldwin and Hess, in press).

According to Coleman (written communication, 1970) much of the Colebrooke Schist rides on a sole of serpentine. In northern Curry County also, Rocky Point Formation appears to protrude through the Colebrooke Schist as a window.

Age: Radiometric age determinations for the Colebrooke Schist exhibit wide scatter, but are consistent with an age of approximately 130 million years (lower Early Cretaceous) (Coleman, 1969; written communication, 1970). Dott (1965) reports a radiometric age of 138 million years which he considers to be reliable, and he discards an age of 125 million years which he considers to be unreliable on the basis of contradictory field evidence.

The occurrence of the Colebrooke Schist above the Otter Point Formation indicates that it was not exposed at its present position prior to the Late Jurassic. The presence of blueschist clasts in the conglomerates of the early Tertiary Umpqua Formation indicate that the Colebrooke Schist was present at its present location no later than the Late Cretaceous. On the basis of this and other evidence, Coleman concludes that the Colebrooke Schist was thrust to its present position in the Late Cretaceous.

References:
Baldwin and Hess, in press
Baldwin and Lent, 1969
Blake and others, 1967
Coleman, 1969
Dott, in press
Kaiser, 1960
Koch, 1960
Koch, 1966
Lent, 1969

COLESTIN FORMATION

Original description: Wells, F. G., 1956, Geology of the Medford quadrangle, Oregon-California: U. S. Geol. Survey Map GQ-89.

Distribution: This unit is fairly widespread in the southern parts of the western Cascade Range and extends northward as far as the Eugene area where it is generally included in the lower Fisher Formation. Exposures in the Medford quadrangle are designated as the type locality.

Lithology: The Colestin Formation consists of 3,000 feet of primarily volcanic and pyroclastic rocks of intermediate composition. Massive, andesitic, greenish-gray, pumiceous lapilli tuffs are the most common rocks. Other rock types include crystal and lithic lapilli welded tuff, conglomerate, volcanic wacke, and lesser amounts of tuff breccias and flows of basaltic and pyroxene andesite.

Massive, well-bedded, tuffaceous sandstone with basal conglomerates of pre-Tertiary clasts are common low in the section. The massive lapilli tuffs make up the bulk of the middle of the section, and the various andesites and occasional dacites are the predominating rock types high in the section.

Structure: The Colestin Formation is only gently deformed and exhibits dips of generally less than 25° to the southeast and east.

Contacts: The Colestin Formation unconformably overlies the Umpqua and Tyee Formations and unconformably underlies the Little Butte Volcanics. It unconformably overlies the Spencer Formation south of Eugene.

Age: The Colestin Formation is late Eocene in age and correlates with the Nestucca Formation, the Cowlitz Formation, and the Goble Volcanics, and possibly with the upper Spencer Formation north of Eugene.

References: Baldwin, 1964
Champ, 1969
Elphic, 1969
Kays, 1970
Peck, 1960
Peck and others, 1964
Wells, 1956

COLUMBIA RIVER GROUP

Original description: Russell, I. C., 1893, A geological reconnaissance in central Washington: U. S. Geol. Survey Bull. 108, p. 20-22, map.

Distribution: In western Oregon scattered outcrops of basalt belonging to the Columbia River Group are preserved along the Columbia River to its mouth and south along the coast possibly as far as Yaquina Bay. In addition, exposures extend south into the Willamette Valley as far south as Brownsville. Included in the Columbia River Group are rocks previously referred to as Miocene basalts, Miocene volcanics, and Stayton lavas.

Lithology: Basalts belonging to the Columbia River Group of western Oregon are tholeiitic, fine-grained to aphnitic, and dark gray to black. The texture is intersertal to ophitic and occasionally porphyritic. The constituent minerals are commonly set in a groundmass of glass and chlorophaeite and consist of median plagioclase, augite, magnetite, and ilmenite listed in decreasing order of abundance. The composition conforms favorably to that of the Yakima Basalt described by Waters (1961) east of the Cascades.

Individual flows are noted for their columnar jointing and average approximately 50 feet in thickness. Aggregate thicknesses of 2,000 feet are developed in the Columbia River Gorge and thicknesses of as much as 1,000 feet are reported elsewhere.

Breccias and blocky jointing are developed locally, and marine-flow breccias and pillows are reported in the Svensen quadrangle where the flows evidently entered the sea. Coarse-grained basaltic agglomerates and flows extruded from local vents in the vicinity of Yaquina Bay are here included in the Columbia River Group.

Structure: The Columbia River Group is broadly upwarped in the Columbia River Gorge and broadly downwarped in the Willamette Valley. Relative vertical displacements are appreciable, however, as indicated by the occurrence of basalts 3,000 feet above sea level in Clatsop County as compared to the occurrence of basalts 1,500 feet below sea level beneath the surficial deposits of the Tualatin

Valley. In a local sense, however, outcrops are generally flat lying or gently dipping.

Contacts: The basalts of the Columbia River Group were extruded over an Oligocene erosion surface of moderate relief. The unit unconformably overlies the Scappoose Formation, the Pittsburg Bluff Formation, the Eugene Formation, the Little Butte Volcanic Series, and the Goble Volcanics. It intertongues to the west with rocks presently referred to as the Astoria Formation. According to Peck and others (1964), it underlies the Sardine Formation to the east in the northern West Cascades.

Age: Although the Columbia River Group is referred to as mid-Miocene in most of the literature, it probably varies in age from middle Miocene to lower Pliocene in places (Dodds, 1963; Thayer and Brown, 1966: Baldwin, oral communication, 1970). Rocks assigned to the unit in the Western Cascades and Willamette Valley, however, are probably restricted to the middle Miocene, because they consistently underlie the middle and late Miocene Sardine Formation.

References:

Baldwin and others, 1955
Barlow, 1955
Dodds, 1969
Halstead, 1955
Lowry and Baldwin, 1952
Peck, 1960
Peck and others, 1964
Schlicker and others, 1967
Thayer and Brown, 1966
Vokes and others, 1949
Warren and Norbisrath, 1946
Warren and others, 1945
Waters, 1961
Wilkinson and others, 1946

COMSTOCK FORMATION

Original description: Turner, F. E., 1938, Stratigraphy and mollusca of the Eocene of western Oregon: Geol. Soc. America Spec. Paper 10, 130 p.

Discussion: According to Hoover (1963), the Comstock Formation is more appropriately viewed as part of the Tyee, Spencer, and Fisher Formations and the term is no longer used. The unit is not to be confused with the Comstock flora of Diller (1900) or Sanborn (1937) which occurs in the lower Fisher Formation one mile northeast of Comstock.

COQUILLE FORMATION

Original description: Baldwin, E. M., 1945, Some revisions of the late Cenozoic stratigraphy of the Southern Oregon Coast: Jour. Geol., vol. 52, p. 35-46.

Distribution: The type section of the Coquille Formation is located at the mouth of the Coquille River immediately north of Bandon. The term is occasionally applied to similar late Pleistocene estuarine fill northward along the coast.

Lithology: The Coquille Formation is composed of semi-consolidated, poorly sorted, coarse sandstone and conglomerate with lesser amounts of carbonaceous shale, mudstone, and peat. It is locally cross-bedded and contains numerous large wood fragments, stumps, and logs.

Structure and contacts: The unit is flat lying and presumably overlies older formations unconformably at depth. The upper surface was planed to give a marine terrace prior to the deposition of the Elk River Beds.

Age: The Coquille Formation and similar deposits up the coast were deposited during the last interglacial stage (Sangamon) when a rise in sea level resulted in the development of numerous flooded river mouths. It correlates with the Portland Sand of the northern Willamette Valley.

References: Baldwin, 1945
Baldwin, 1964
Baldwin, 1966
Snavely and Vokes, 1949

COWLITZ FORMATION

Original description: Weaver, C. E., 1912, Washington Geol. Survey Bull. 15, p. 10-22.

Distribution: Although the type section of the Cowlitz Formation is in Washington, various late Eocene strata along the Columbia River in extreme northwest Oregon are also referred to by that name.

Lithology: The Cowlitz Formation consists of as much as 1,000 feet of conglomerate, sandstone, and siltstone. The base of the section consists of 0 to 200 feet of locally fossiliferous, will-indurated, rust-stained, basaltic conglomerate which passes upward into basaltic and arkosic, micaceous sandstone. Overlying the conglomerate and the sandstone is a sequence of dark, glauconitic, tuffaceous claystone and siltstone which make up the bulk of the formation. Thin, unmappable basalt flows are intercalated locally.

Structure: The unit dips gently to the east and probably underlies part of the northern Willamette Valley.

Contacts: The Cowlitz Formation rests unconformably on lavas and breccias of the Tillamook Volcanic Series and underlies the Keasey Formation (see Keasey Formation). The unit is interbedded with the Goble Volcanics.

Age: The Cowlitz Formation is late Eocene in age and correlates with the Tejon of California and the Coaledo of the Coos Bay area.

References: Baldwin, 1964
Deacon, 1953
Warren and others, 1945
Warren and others, 1946

DAYS CREEK FORMATION

Original description: Imlay, R. W., and others, 1959, Relations of certain Upper Jurassic and Lower Cretaceous formations of southwestern Oregon: Am. Assoc. Petroleum Geologists Bull., vol. 43, no. 12, pp. 2770-2785, 3 figs.

Distribution: The Days Creek Formation crops out as relatively isolated exposures in the Mesozoic terrane of the Klamath Mountains of southwestern Oregon. The Type section is located along the South Umpqua River in the Days Creek quadrangle.

Lithology: The Formation consists of a lower, relatively fine-grained clastic unit and an upper, coarser grained clastic unit. The lower unit is made up of dark-gray sandy siltstone with subordinate amounts of light-gray, fine-grained sandstone. The upper unit is made up of thick-to medium-bedded, fine- to medium-grained, gray sandstone.

The sandstone is lithic subgraywacke and in general is thicker bedded than that of the Riddle Formation. In addition, the Days Creek Formation contains a greater proportion of sandstone than does the underlying Riddle Formation.

Structure: The Days Creek Formation is steeply to moderately dipping.

Contacts: The mutual concordance of the Days Creek Formation with the underlying Riddle Formation suggests a conformable relationship, whereas the relative ages of the two units is generally interpreted to indicate an intervening unconformity. The lower Days Creek is middle Valanginian and the upper Riddle is Portlandian-Purbeckian and probably Berriasian in age (Imlay, written communication, 1970).

As an alternative interpretation it is sometimes suggested that faulting or incomplete sampling may account for the missing lower Valanginian strata.

Age: Pelecypods and ammonites indicate a middle Valanginian through Hauterivian and Barremian age for the Days Creek Formation.

References: Baldwin, 1964
Hicks, 1964
Imlay and others, 1959
Johnson, 1965

DOTHAN FORMATION

Original description: Diller, J. S., 1907, The Mesozoic sediments of southwestern Oregon: Am. Jour. Sci., 4th, vol. 23, p. 401-421.

Distribution: The Dothan Formation is fairly widespread in southwestern Oregon, forming a belt which averages approximately 10 miles in thickness and extends from the extreme southwestern corner of the state northeastward to a point immediately south of Roseburg. The type locality is located along Cow Creek in the Canyonville quadrangle.

Lithology: The predominate rock type is a massive, well-indurated, medium-grained, poorly to moderately sorted lithic graywacke. Interbeds of dark gray to black mudstone are developed locally, and intercalations of red and white chert and dense pillow lavas altered to greenstone are present in places. Though the scarce conglomerates which make up part of the formation are generally composed of clasts of greenstone and chert, a few conglomerates composed of quartz-rich granitic cobbles have been reported (Dott, 1962). The over-all thickness of the unit is unclear, but must be on the order of several miles.

Structure and contacts: In a regional sense the Dothan Formation is thought to be a large thrust sheet which has been thrust under the older Rogue Formation to the east. In a more local sense the unit is fractured, riddled with quartz veins, steeply dipping and locally sheared especially along contacts with other units such as the Rogue Formation.

Age: The recent discovery of *Buchia piochii* in the Dothan indicates a Tithonian, (Portlandian-lower Purbeckian) post-Nevadan age for the unit. Other evidence favoring a post-Nevadan age includes the absence of intrusions, the presence of granitic cobbles, and a fairly high potassium feldspar content in the unit. Dott's (1965) radiometric age assignment of 149 M.Y. for the unit is effectively called into question by Hotz (1969), who considers the Dothan to be younger, and a northward extension of the lower part of the Franciscan Assemblage of California.

References: Baldwin, 1969
Born, 1963
Dott, 1962
Dott, 1965
Hicks, 1964
Hixson, 1965
Hotz, 1969
Johnson, 1965
Ramp, 1969
Wells and others, 1949
Wells and others, 1953

ELK RIVER BEDS

Original description: Diller, J. S., 1902, Topographic development of the Klamath Mountains, U.S. Geol. Survey Bull. 196, 69 p.

Distribution: In southwestern Oregon a series of marine terraces is developed along the present-day coastline. Deposits upon the most widespread and lower-most terrace are referred to as the Elk River Beds.

Lithology: The Elk River Beds are composed of 10 to 90 feet of loose, gray basal sand and overlying rusty gravels, which were laid down upon the retreat of the sea from a newly cut marine bench. North of Coos Bay, where sand predominates, the beds are generally reworked as dunes.

Structure and contacts: The beds are flat lying and rest unconformably upon the truncated Port Orford and Coquille Formations.

Age: The Elk River Beds are very late Pleistocene to possibly Holocene in age.

References: Baldwin, 1945
Baldwin, 1964
Stewart, 1956

ELKTON SILTSTONE MEMBER (OF TYEE FORMATION)

Original description: Baldwin, E. M., 1961, Geologic map of the lower Umpqua River area, Oregon: U. S. Geol. Survey Map OM-204.

Discussion: Bird (1967) elevates the Elkton Siltstone, Sacchi Beach Siltstone, and the Loraine Siltstone members of the Tyee Formation to formational status under the term of Elkton Formation, and Lovell (1969) treats the units as a formation on his correlation chart. The member status of the units is retained here, however, because the thesis of Bird does not constitute adequate publication for establishing a formation. Moreover, the article of Lovell does not propose to establish a formation, nor does it provide a description or a type locality.

(See: Tyee Formation)

EMPIRE FORMATION

Original description: Diller, J. S., 1896, Geological reconnaissance in northwestern Oregon: U. S. Geol. Survey 17th Ann. Rpt. part I, p. 444-520.

Distribution: The Empire Formation is situated on the center of the South Slough syncline in the western Coos Bay area. The type section is located 3 miles southwest of Empire City, between Pigeon Point and Fossil Point.

Lithology: The unit is composed of as much as 3,000 feet of massive, friable poorly bedded, light-brown sandstone with minor interbedded siltstone. It is moderately to deeply weathered and iron-stained joints are common. Localized conglomeratic lenses are interpreted to be old channel deposits. Fossils are fairly abundant in places with remains of clams, gastropods, sea lions, seals, and whales being reported.

Structure and contacts: The unit occupies the center of a syncline and exhibits gentle dips. It rests unconformably on the Tunnel Point Formation.

Age: The Empire Formation is early to middle Pliocene in age.

References: Baldwin, 1966
Ehlen, 1967
Lent, 1969

ESTACADA FORMATION

Original description: Trimble, D. E., 1963, Geology of Portland, Oregon and adjacent areas: U. S. Geol. Survey Bull. 1119, p. 119.

(See: Pliocene-Pleistocene alluvium of the Portland area)

EUGENE FORMATION

Original description: Smith, W. D., 1924, Petroleum possibilities of western Oregon: Econ. Geol., vol. 19, p. 455-465.

Distribution: The Eugene Formation is restricted to the central and southern parts of the Willamette Valley. It is equivalent to the Illahee Formation of earlier usage. Exposures in the vicinity of Eugene are designated as the type locality.

Lithology: The Eugene Formation consists of as much as 8,000 feet (if thickness not effected by faulting) of neritic, yellowish-gray, arkosic and tuffaceous volcanic sandstone with subordinate amounts of vitric tuffs, vitric crystal tuffs, and conglomerate composed of pumiceous lapilli, basalt fragments, and andesitic fragments. The abundant fresh andesine in the sandstone is misleading in that it resembles quartz and is occasionally mistaken for that mineral. Most of the intercalated tuffs probably fell as showers into the Oligocene sea.

Similar-appearing beds of late Oligocene and possibly early Miocene age situated to the north near Scotts Mills in the Molalla quadrangle may represent strandline deposits laid down during the retreat of the Oligocene sea.

Structure: The Eugene Formation is characterized by homoclinal dips of less than 10° to the east and northeast over large areas of the southern Willamette Valley. Owing to the possibility of faulting on the east side of the Willamette Valley, however, it is possible that the stratigraphic thickness of the Eugene Formation is less than that suggested by the monoclinal dips alone.

Contacts: The Eugene Formation overlies the Fisher Formation south of Eugene and to the north is interbedded with nonmarine Oligocene tuffs herein considered to be part of the Fisher Formation (see Fisher Formation). Farther to the north the Eugene Formation is equivalent to the Illahee Formation of Thayer (1939) and interfingers with normarine Mehama Volcanics. In the northern Willamette Valley the Eugene Formation probably passes laterally into the marine Pittsburg Bluff Formation. Locally the unit is unconformably overlain by the Columbia River Group.

Age: The Eugene Formation is early and middle Oligocene in age. It correlates with the Lincoln Formation in Washington, the Mehama Volcanics, the upper Toledo Formation, and possibly part of the upper Keasey Formation.

References: Allison, 1953
Anderson, 1963
Baldwin, 1964
Barlow, 1955
Bristow, 1959
Halstead, 1955
Hickman, 1968
Hauck, 1962
Peck, 1960
Peck and others, 1964
Schlicker and others, 1957
Vokes and others, 1951

FERN RIDGE TUFFS

Original description: Thayer, T. P., 1933, Structural relations of the central Willamette Valley to Cascade Mountains (abst.): Pan-American Geologist, vol. 59, no. 4, p. 317.

Distribution: Tuffaceous sediments along the North Santiam River in the northeast part of the Willamette Valley are referred to as the Fern Ridge tuffs by Thayer (1933). The unit is included in the Sardine Formation of Peck and others, 1964.

Lithology: The Fern Ridge Tuffs consist of poorly bedded, poorly sorted, reworked eruptives. Tuffs, sandstones, and granule conglomerates predominate low in the section, whereas conglomerates made up of andesitic boulders set in a tuffaceous matrix are more common higher in the section. Apparently deposition occurred in a structural basin, because thicknesses of as much as 1,500 feet are developed locally.

Contacts: It is presently thought that the Fern Ridge Tuffs rest disconformably upon the Miocene Columbia River Group. Pebbles of laterite low in the section imply derivation from an upper Miocene lateritic weathering surface developed upon the Columbia River basalts.

Age: The Fern Ridge Tuffs are poorly dated, but are probably upper Miocene to Pliocene in age. They correlate roughly with the upper Molalla Formation, the Boring Agglomerate, the Rhododendron Formation, part of the Cascades Formation, and possibly part of the Boring Lava.

References: Baldwin, 1964
Lowry and Baldwin, 1952
Thayer, 1939
Youngquist, 1961

FISHER FORMATION

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Univ. Cal. Pub. in Geol. Sci. Bull., vol. 16, no. 12, p. 449-460.

Distribution: The Fisher Formation occurs in the southern and southeastern half of the Willamette Valley. Typical exposures crop out at Coyote Butte, 8 miles west of Eugene, and near Fisher Butte. In addition to beds traditionally referred to as Fisher Formation, the unit includes beds referred to as "Scio beds" and "Berlin volcanics" by Felts (1936). It also includes the non-marine Oligocene tuffs of the Western Cascades in the Eugene area (see Contacts below). The lower Fisher Formation is equivalent to the Calapooya Formation of Wells and Waters (1934) and the Colestin Formation of Wells (1956) in the Medford Quadrangle.

Lithology: The Fisher Formation consists of a maximum of 7,000 feet (1,500 feet at the type locality) of continental clastics including lapilli tuffs, sandstones, and breccias. Up to 50 feet of coarse, waterlaid andesitic boulder conglomerate occupies the base of the section. It is overlain by a series of sand-filled channels, one of which yielded the well-known Comstock flora (not to be confused with the Comstock formation) of late Eocene age. Higher in the section andesitic and pumiceous lamilli tuffs, pebbly feldspathic tuffaceous sandstone, arkosic sandstone, and siltstone predominate.

Fluvial aspects appear to be more dominant in the north where interfingering with the marine Eugene Formation is interpreted. To the south interbeds of welded tuff and flow rocks become more abundant towards the centers of Colestin volcanism.

Structure: Like the Little Butte Volcanics and the Eugene Formation, the Fisher Formation dips gently to the east with dips of about 10°.

Contacts: The stratigraphic relationships of the Fisher Formation are subject to debate. Baldwin (oral communication, 1970) restricts the Fisher Formation to exposures south of Eugene where Schenck (1927) interpreted a slight angular unconformity between the type Fisher Formation and the overlying Eugene Formation.

Vokes and others (1951) and Hoover (1963) demonstrate conformity between the Fisher and Eugene Formations and include most of the non-marine Oligocene tuffs of the western Willamette Valley into the Fisher. They further demonstrate that the Oligocene nonmarine tuffs are interbedded with the Eugene Formation.

Herein the Oligocene nonmarine tuffs are considered to be part of the Fisher Formation. Hence the upper Fisher Formation can best be viewed as the nonmarine lateral equivalent of the Eugene Formation.

Age: A late Eocene age for the lower Fisher Formation is indicated by the Comstock flora of Sanborn (1937) and similar fossil collections (Hoover, 1963). The age of the upper Fisher is less certain, but probably is early to middle Oligocene. The unit correlates with the Eugene Formation, the Mehama Volcanics, and the Little Butte Volcanics. According to Vokes and others, strata containing the late Oligocene flora at Goshen overlie the Fisher Formation and should not be included in the unit.

References: Baldwin, 1964
Bristow, 1959
Hoover, 1959
Hoover, 1963
Patterson, 1963
Schlicker and others, 1957
Vokes and others, 1951

GALICE FORMATION

Original description: Diller, J. S., 1907, The Mesozoic sediments of southwestern Oregon: Am. Jour. Sci., 4th, vol. 23, p. 401-421.

Distribution: The Galice Formation is situated in southwest Oregon where it forms a 10-mile-wide band which extends from the California border northeastward into the Days Creek quadrangle. It is bounded by the Rogue Formation to the west and the Applegate Group to the east. The name is derived from exposures in the vicinity of Galice Creek.

Lithology: The Galice Formation is composed primarily of dark-gray to black, fine-grained, thinly layered, slaty to phyllitic mudstones with minor amounts of interbedded dark gray or buff, medium-grained, lithic wackes. Also included in the unit are great thicknesses of andesitic flows and agglomerates altered to greenstone.

Structure: The Galice Formation strikes northeasterly and commonly dips to the southeast at angles in excess of 70°.

Contacts: Although shearing can be demonstrated locally along the contact of the Galice with the

Rogue Formation, the regional significance of these features is unclear. The abundance of volcanics in the Galice near the contact with the Rogue Formation makes accurate location of the contact difficult and may indicate conformity with that unit (Baldwin, oral communication, 1970).

The Galice Formation is in thrust contact with the Applegate Group to the east and is unconformable beneath the Humbug Mountain Conglomerate in western Curry County.

Age: The Galice Formation is Late Jurassic, but pre-Dothan in age. Koch (1966) reports the occurrence of *Buchia concentrica* of Late Oxfordian to middle Kimmeridgian age within the unit. Nevadan intrusives cut the Galice in places, and on the basis of radiometric age determinations Lanphere and others (1968) postulate that the Galice Formation was deposited between some of the later pulses of the Nevadan Orogeny.

References: Baldwin, 1964; Hess, 1967; Kaiser, 1962; Koch, 1960; Koch, 1966; Lanphere and others, 1968; Wells and others, 1949; Wells and others, 1953

GOBLE VOLCANICS

Original description: Warren, W. C., Norbisrath, Hans, and Grivetti, R. M., 1945, Geology of northwestern Oregon west of the Willamette River and north of latitude 45°15': U. S. Geol. Survey Oil and Gas Invest. Prelim. Map 42.

Distribution: The Goble Volcanics occur as isolated exposures about the highlands of northwestern Oregon. The type locality is located near Goble immediately north of the St. Helens quadrangle.

Lithology: The Goble Volcanics are composed of volcanic flows and breccias and minor intercalated tuffaceous siltstones. Basaltic flows predominate in the lower part of the section and consist of median plagioclase, augite, groundmass glass, olivine, and magnetite listed in order of decreasing abundance. Higher in the section pyroclastics are more common. Poor exposures preclude an accurate measurement of the total thickness of the formation, but a thickness of at least 5,000 feet seems likely.

Contacts: The Goble Volcanics unconformably overlie the older Eocene volcanics in the northern Coast Range and unconformably underlie strata containing fauna of middle Oligocene age in the St. Helens quadrangle. The lower part of the Goble Volcanics is interbedded with the Cowlitz Formation along the Columbia River.

Age: The Goble Volcanics are late Eocene and possibly partly early Oligocene in age. They correlate with the Eocene Volcanics of Baldwin (1956) in the Waldport quadrangle.

References: Baldwin, 1956; Baldwin, 1964; Baldwin and Roberts, 1952; Snavely and others, 1961; Warren and others, 1945; Wilkinson and others, 1946

GRESHAM FORMATION

Original description: Trimble, D. E., 1963, Geology of Portland, Oregon and adjacent areas: U. S. Geol. Survey Bull. 1119.

(See: Pliocene-Pleistocene alluvium of the Portland area)

HELVETIA FORMATION

Original description: Schlicker, H. G., and Deacon, R. J., 1967, Engineering geology of the Tualatin Valley Region, Oregon: Oregon Dept. Geol. Min. Ind. Bull. 60.

Distribution: The Helvetia Formation is exposed about the periphery of the Tualatin Valley in northwestern Oregon. In addition it is present locally in the subsurface of the Tualatin Valley as revealed by well logs.

Lithology: The unit consists of at least 25 feet and possibly 75 feet of poorly indurated, reddish-brown pebbly sands, silts, and clays. Mineralogically the unit consists of quartz, muscovite, feldspar, pyroxene, amphibole, zircon, tourmaline, opal, magnetite, and gibbsite. Boulders and pebbles of basalt, granite, and quartzite also occur in the unit. The Helvetia Formation was derived in part from the late Miocene lateritic weathering horizon which developed upon the Columbia River Group, but it was also derived in part from external sources as revealed by the mineralogy and the composition of some of the pebbles.

Structure: The Helvetia Formation exhibits gentle dips sympathetic with the major structures of the Tualatin Valley.

Contacts: The Helvetia Formation directly overlies the Columbia River Group and is overlain by various Pliocene-Pleistocene units such as the Willamette Silt and possibly sediments equivalent to the Troutdale Formation.

Age: The Helvetia Formation is correlated with the early Troutdale Formation and is probably early Pliocene in age.

References: Schlicker and others, 1967

HEPPSIE ANDESITE

Original description: Wells, F. G., 1956, Geologic map of the Medford quadrangle, Oregon-California: U. S. Geol. Survey, Map GQ-89.

Distribution: The Heppsie Andesite occurs in the Western Cascades of southern Oregon in the vicinity of Medford. It is occasionally considered as a southward extension of the Sardine Formation of Peck and others (1964).

Lithology: The unit consists of great thicknesses of characteristic Cascade andesite. It is a thickly bedded, locally platy, gray, porphyritic andesite with phenocrysts of pyroxene, hornblende, and feldspar.

Contacts: The Heppsie Andesite rests upon the red, agglomeratic andesite horizon of the Wasson Formation (upper Little Butte Volcanics) with probable unconformity, and is overlain by Pliocene basalts.

Age: A Miocene age is assigned to the unit on the basis of stratigraphic position.

References: Wells, 1956

HORNBROOK FORMATION

Original description: Peck, D. L., Imlay, R. W., and Popenoe, W. P., 1956, Upper Cretaceous rocks of parts of southwestern Oregon and northern California: Am. Assoc. Petroleum Geologists Bull., vol. 40, no. 8, p. 1968-1984, 4 figs.

(See: Late Cretaceous sedimentary rocks)

HUMBUG MOUNTAIN CONGLOMERATE

Original description: Koch, J. G., 1966, Late Mesozoic stratigraphy and tectonic history, Port Orford-Gold Beach area, southwestern Oregon coast: Am. Assoc. Petroleum Geol. Bull., Vol. 50, no. 1, p. 25-71.

Distribution: The Humbug Mountain Conglomerate occurs in the western Klamath Mountains of southwestern Oregon. Exposures are best developed at the type locality in the vicinity of Humbug Mountain in the Port Orford quadrangle.

Lithology: The unit consists of several thousand feet of massive to thickly bedded, well-indurated conglomerate which grades upsection into dark gray, veined sandstone. Clasts in the conglomerate consist of chert, schist, diorite, extrusive volcanic rocks altered to greenstone, sandstone, and quartz listed in order of decreasing abundance. Also present are clasts of argillite, phyllite, and dacite porphyry.

Structure: The Humbug Mountain Conglomerate is steeply dipping and locally overturned. The pebbles, however, are undeformed.

Contacts: The Humbug Mountain postdates the Otter Point Formation and grades upward into the Rocky Point Formation through a series of interbeds. In the Powers quadrangle it is overlain unconformably by the Umpqua Formation.

Age: Ammonites and pelecypods indicate a Berriasian through Valanginian age for the Humbug Mountain Conglomerate. The upper part of the formation correlates with the lower Days Creek Formation and the lower part of the unit may correlate with the Riddle Formation (see Riddle Formation).

References: Born, 1963
Hunter and others, 1970
Kaiser, 1962
Koch, 1960
Koch, 1966
Koch and others, 1961
Lent, 1969

HUNTER COVE FORMATION

Original description: Dott, R. H., Jr., (in press) Geology of the southwestern Oregon Coast west of the 124th meridian: Oregon Dept. Geol. Min. Ind. Bull. 69.

(See: Late Cretaceous sedimentary rocks)

ILLAHEE FORMATION

Original description: Thayer, T. P., 1939, Geology of the Salem Hills and North Santiam River Basin, Oregon: Oregon Dept. Geol. Min. Ind. Bull. 15, 40 p.

(See: Eugene Formation)

KEASEY FORMATION

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Calif. Univ., Pubs. in Geol. Sci., vol. 16, no. 12, p. 457, 459.

Distribution: The Keasey Formation occurs in northwestern Oregon as a series of outcrops which surround exposures belonging to the Siletz River Volcanics, the Goble Volcanics, the Cowlitz Formation, and the Nestucca Formation. Strata here included in the Keasey Formation are variously referred to in the literature as beds of Keasey age, Keasey Shale, and tuffaceous sediments of Keasey age, as well as Keasey Formation. The type section is located in the valley of Rock Creek in Columbia County.

Lithology: The Keasey Formation consists of massive, dark gray, tuffaceous mudstone, fine-grained sandstone, and siltstone. In the Vernonia area thin coarse sandstone grades upward into tuffaceous siltstone which was probably laid down under quiet-water conditions near shore in a sound rather than in the open sea.

Massive, tuffaceous mudstone and siltstone interrupted locally by ash layers and horizons of calcareous concretions predominate inland to the south in the Dallas-Valsetz and Sheridan-McMinnville areas.

Exposed farther to the south on Winkle and Oliver Buttes in the west-central Willamette Valley is as much as 200 feet of thick-bedded, medium- to coarse-grained, tuffaceous sandstone of lower to middle Keasey age. The beds are presumably extensive in the subsurface and their grain size suggests the presence of a lowermost Oligocene shoreline somewhere to the south.

Structure: The Keasey Formation dips gently to the south and east at angles of less than 10°.

Contacts: The contact of the Keasey Formation with the underlying Cowlitz Formation in the Vernonia quadrangle is poorly understood. Conformity is suggested by the similarity of rock type, difficulty of placing the contact in the field, and the apparent concordance of the individual outcrops. An unconformity, change of climate, or depositional discontinuity is suggested by the apparent change of fauna between the two formations.

A similar situation exists to the south where Snavely and Vokes (1949) interpret an unconformity overlying the Nestucca Formation north of Yaquina Bay, and Baldwin (1947) interprets a conformable relationship between the Nestucca and the Keasey Formations in the Dallas and Valsetz quadrangles. Baldwin and others (1955) also interpret a conformable relationship in the Sheridan and McMinnville quadrangles immediately to the north.

The exposure of coarse-grained Keasey-age beds at Winkle and Oliver buttes suggests that the Keasey Formation may grade southward into the lower Eugene or Fisher Formations. The relationship of the Keasey Formation with the overlying Pittsburg Bluff Formation of Oligocene age is poorly understood. (See Pittsburg Bluff Formation).

Age: The Keasey Formation is latest Eocene to early Oligocene in age.

References:
Baldwin, 1947
Baldwin, 1964
Baldwin and others, 1955
Deacon, 1953
Snavely and Vokes, 1949
Vokes and others, 1954
Warren and others, 1945
Warren and others, 1946
Youngquist, 1961

KINGS VALLEY SILTSTONE MEMBER (OF SILETZ RIVER VOLCANIC SERIES)

Original description: Vokes, H. E., and others, 1954, Geology of the west-central border area of the Willamette Valley, Oregon: U. S. Geol. Survey Map OM-150.

(See: Siletz River Volcanic Series)

LABISH LOWLAND SAND

Original description: Glenn, J. L., 1962, Gravel deposits in the Willamette Valley between Salem and Oregon City, Oregon: Ore Bin, vol. 24, no. 3.

Discussion: Deposits referred to by this term do not constitute a formation, but rather an informal unit. See Pleistocene alluvium of the upper and middle Willamette drainage.

LACOMB GRAVELS

Original description: Allison, I. S., 1953, Geology of the Albany Quadrangle: Ore. Dept. Geol. Min. Indus. Bull., 37.

(See: Pleistocene alluvium of the upper and middle Willamette drainage).

LATE CRETACEOUS SEDIMENTARY ROCKS

Distribution: Late Cretaceous sedimentary rocks occur as small isolated outcrops in the Klamath Mountains of southwestern Oregon. Campanian-Maestrichtian sediments along the coast at Cape Blanco and Cape Sebastian are referred to as the Cape Sebastian Sandstone and the overlying Hunters Cove Formation by Dott (in press), and are included in the lowermost Umpqua Formation to the north by Baldwin (1966). Older deposits (Cenomanian-Turonian) inland are generally referred to as the Hornbrook Formation.

Lithology: The Late Cretaceous sediments exposed inland consist of several thousand feet of conglomerate, conglomeratic sandstone, interbedded sandstone, mudstone and siltstone. The conglomeratic clasts consist of mafic volcanics, quartzite, argillite, felsite, gneiss, and diorite. The sandstone is a grayish-green to brown feldspathic wacke. Grain size decreases upsection.

The Late Cretaceous sediments along the coast consist of massive conglomeratic feldspathic wackes and overlying alternating sandstones and dark mudstones with a total thickness of approximately 1,500 feet. Oysters, calcareous nodules, and calcareous interbeds are reported locally and convolute bedding, cross stratification, and channel features characterize the sandstone in places.

Structure: The deposition of the Late Cretaceous sediments postdated the more prominent Mesozoic orogenies. Hence, the unit is only gently to moderately deformed. Along the coast folds trend N. 30° W.

Contacts: The Late Cretaceous sediments rest upon older units with angular unconformity. Along the coast the deposits may be continuous with the Umpqua Formation. To the south in California at the type locality of the Hornbrook Formation the lower Hornbrook (Turonian) may be separated from the upper Hornbrook (Campanian) by a Coniacian-Santonian unconformity.

Age: The Late Cretaceous sediments along the coast are Campanian, Maestrichtian and possible Santonian in age and correlate in part with the upper Hornbrook Formation of the type locality. Inland the Late Cretaceous sediments are of Cenomanian-Turonian and possibly Albian age and correlate in part with the lower Hornbrook of the type locality.

References:

Dott, 1962	Lent, 1969
Hicks, 1964	Peck and others, 1956
Howard, 1961	Popenoe and others, 1950
Howard and Dott, 1961	Wells and others, 1940
Hunter and others, 1970	Wells and others, 1956
Johnson, 1965	

LATE PLEISTOCENE LAKEBEDS

Distribution: Underlying the Willamette Silts presumably over wide areas of the Willamette Valley is a series of lacustrine deposits termed the late Pleistocene lakebeds by Baldwin (1964). The unit is not to be confused with the Willamette Silts from which it differs in age, lithology, stratigraphic position, and manner of origin.

The late Pleistocene lakebeds are probably equivalent in part to the Unit I of Glen (1965), which underlies his Willamette Silts and which contains middle Pleistocene interglacial pollen (Glenn, 1965, p. 185). Part of the Willamette Silts of Glenn are also probably equivalent to the late Pleistocene lakebeds of Baldwin.

Lithology: The deposits consist of homogeneous, buff silts of lacustrine origin and are totally lacking in glacial erratics. An average thickness of 50 to 100 feet is reported for the unit. The remains of elephants and mastodons are present locally. Gravel beds occupy the base of the section in places.

Structure: The unit is flat lying.

Contacts: According to Baldwin (oral communication, 1971) the Willamette Silts unconformably overlie the late Pleistocene lakebeds. Because the late Pleistocene lakebeds of Baldwin include part of the Willamette Silts of Glenn, however, there is still some confusion regarding the relationships of the two units. Reported paleosols throughout the Willamette Silts of Glenn suggest the possible presence of numerous unconformities of short duration within the late Pleistocene lakebeds of Baldwin (1964).

Age: Baldwin (1964) assigns a Sangamon (third interglacial) age to the late Pleistocene lakebeds and suggests correlation with the Coquille Formation along the coast. Both units were presumably formed when an interglacial rise in sea level resulted in the widespread alluviation of numerous rivers near their mouths.

References: Baldwin, 1964
Glenn, 1965

LEFFLER GRAVELS

Original description: Thayer, T. P., 1939, Geology of the Salem Hills and the North Santiam River basin: Oregon Dept. Geol. Min. Ind. Bull. 15, 40 p.

(See: Pleistocene alluvium of the upper and middle Willamette drainage)

LINN GRAVELS

Original description: Allison, I. S., 1953, Geology of the Albany quadrangle, Oregon: Oregon Dept. Geol. Min. Ind. Bull. 37.

(See: Pleistocene alluvium of the upper and middle Willamette drainage).

LITTLE BUTTE VOLCANIC SERIES

Original description: Wells, F. G., 1956, Geology of the Medford quadrangle, Oregon-California: U. S. Geol. Survey Map GQ-89.

Distribution: The term Little Butte Volcanics was originally used in reference to the post-Colestin volcanic rocks of Oligocene age exposed in the Medford quadrangle (Wells, 1956). Subsequently, the term Little Butte Volcanic Series was applied by Peck and others (1964) to all the Oligocene and early Miocene volcanic and related terrestrial rocks of the Western Cascades. As such, the unit includes the Mehama Volcanics, The Wasson Formation and the Heppsie andesite and makes up the bulk of the Western Cascades south of the McKenzie River. Also included are several isolated smaller exposures to the north with a variety of localized names, including: lower Breitenbush Series (Thayer, 1939), pre-Butte Creek beds (Harper, 1946), Eagle Creek Formation, and "Bull Creek beds." The Molalla Formation is also included in the unit by Peck and others (1964).

Lithology: The Little Butte Volcanic Series is composed of as much as 15,000 feet, but more commonly 5 to 10,000 feet, of volcanic rock of nonmarine origin. Flow rocks composed of olivine basalt, basaltic andesite, and pyroxene andesite make up 25 per cent of the unit and are most common low in the section.

Pyroclastic rocks make up the remainder of the unit and are composed of massive vitric lapilli tuff, vitric tuff, vitric-crystal tuff and water-laid tuff listed in order of decreasing abundance. Welding of the ash flows is common and all of the pyroclastic rocks are andesitic to dacitic in composition.

Generally speaking, the unit becomes more felsic and increasingly pyroclastic upsection and thicker to the south.

Structure: The Little Butte Volcanic Series is only gently deformed and dips at low angles in all directions. It is not known to what extent the dips are structural and to what extent they are depositional or initial. Low in the section, flows fill pre-Little Butte topographic lows in places.

Contacts: The unit is locally unconformable over the Colestin Formation and is overlain unconformably by the Columbia River Group.

Age: The Little Butte Volcanic Series varies in age from early Oligocene to early Miocene. As mapped by Peck and others (1964), the unit includes the Mehama Volcanics and the upper Fisher Formation. It interfingers with the fossiliferous marine Eugene Formation and correlates with the Pittsburg Bluff Formation, Tunnel Point Sandstone, upper Toledo Formation, and Yaquina Formation.

References: Anderson, 1963
Bristow, 1959
Champ, 1969
Hauck, 1962
Kays, 1970
Maddox, 1965
Peck, 1960
Peck and others, 1964
Wells, 1956

LORANE SILTSTONE MEMBER (OF THE TYEE FORMATION)

Original description: Vokes, H. E., and others, 1951, Geology of the southern and southwestern border areas of the Willamette Valley, Oregon: U. S. Geol. Survey Map OM-110.

Discussion: Although Vokes and others (1951) included the Lorane Siltstone member in the lower Spencer Formation, it is now considered to be part of the Tyee Formation. (See: Elkton Siltstone member and Tyee Formation).

MEHAMA VOLCANICS

Original description: Thayer, T. P., 1933, Structural relations of the central Willamette Valley to Cascade Mountains (abs.): Pan-American Geologist, vol. 59, no. 4, p. 317.

Distribution: Thayer (1933) applied the term Mehama Volcanics to a series of tuffs, breccias, and water-laid tuffaceous sediments exposed northeast of Mehama in Marion County. Subsequently the term was extended southward into the Marcola-Leaburg area by Schlicker and Dole (1957) and into the Lebanon quadrangle by Allison and Felts (1956) to include the "Berlin volcanics" and "Scio beds" of Felts (1936).

Lithology: The formation consists of a variety of mafic and intermediate volcanic and water-laid rocks. Dacitic and andesitic tuffs predominate and characteristically consist of coarse, indurated, pumice lapilli vitric tuff with crystals of quartz and glassy feldspar. Subordinate amounts of flow rock including olivine basalt, olivine andesite, pyroxene andesite, dacite, and rhyodacite are most abundant low in the section. Tuffaceous sediments of probable fluvial origin are included in the formation.

Structure: The unit dips gently easterly at angles of less than 10°. Locally dacite flows can be traced to dacite feeder dikes which cut the underlying flows.

Contacts: The nonmarine Mehama Volcanics unconformably underlie the Columbia River Group and grade laterally into the marine Eugene Formation about the eastern periphery of the Willamette Valley. The Mehama Volcanics correspond in age and stratigraphic position to the upper Fisher Formation of the Eugene area to the south.

Age: The bulk of the Mehama Volcanics is Oligocene in age, although the lower parts of the section may be as old as late Eocene. Again similarity with the Fisher Formation of the Eugene area is evident.

References:
Ashwill, 1951
Allison and Felts, 1956
Anderson, 1963
Bales, 1951
Bristow, 1959
Felts, 1936
Hauck, 1962
Maddox, 1965
Peck, 1960
Peck and others, 1964
Schlicker and others, 1957
Thayer, 1939
Wilkinson, 1959

MIOCENE BEDS OF SOUTHWESTERN OREGON

Distribution: The presence of Miocene exposures in southwestern Oregon was first indicated by the recovery of Miocene mollusks from dredgings taken from Coos Bay in 1948 and 1949. Armentrout (1967) subsequently described Miocene exposures at Sitka Dock in northern Coos Bay and Baldwin (1966) suggests that more Miocene beds are preserved at depth along the axis of the South Slough syncline.

To the south limited Miocene exposures are reported 1.5 miles southeast of Port Orford and in the lower "Empire" Formation, which crops out immediately southeast of Cape Blanco.

Lithology: The sediments of the Coos Bay dredgings consist primarily of concretionary sandstone, and the beds exposed along the coast consist of bluish-gray sandstone with subordinate amounts of conglomerate and shale.

Contacts: The coastal exposures of Miocene rocks lie unconformably on Mesozoic rocks and are unconformably overlain by Pliocene-Pleistocene marine gravels. Baldwin (1966) suggests that the beds from which the Coos Bay dredgings were derived are unconformable over the Tunnel Point Formation and unconformable under the Empire Formation.

Age: The faunas of the Miocene beds bear affinities to the faunas of both the Nye Formation and the Astoria Formation.

References: Armentrout, 1967; Dott, 1962; Ehlen, 1967; Koch, 1966; Moore, 1963

MOLALLA FORMATION

Original description: Lowry, W. D. and Baldwin, E. M., 1952, Late Cenozoic geology of the lower Columbia River Valley, Oregon and Washington: Geol. Soc. America Bull., vol. 63, no. 1, p. 1-24, 3 figs., 2 pls.

Distribution: The Molalla Formation of Harper (1946) is widespread in the eastern half of the Molalla quadrangle. Peck and others (1964) include part of the unit in their Troutdale Formation and part of the unit in their Little Butte Volcanic Series. The unit has yet to be adequately treated in the literature.

Lithology: The unit consists of terrestrial tuffaceous conglomerates, sandstones, and siltstones. Coarser grain sizes, torrential bedding, and leaf-bearing beds are common low in the section in beds mapped as Little Butte Volcanic Series by Peck and others (1964). High in the section tuffaceous, light-colored beds predominate. An interbed of reworked, massive, basic volcanic breccia occurs within the unit.

Contacts: The Molalla Formation rests with angular unconformity upon the "pre-Butte Creek beds" of Harper (1946) (part of the Little Butte Volcanic Series of Peck and others, 1964) and is overlain by rocks variously assigned to the Boring Lava by Lowry and Baldwin (1952) and the Rhododendron Formation by Trimble (1963). The mudflow aspect of the volcanic rocks favors assignment to the Rhododendron Formation. Lowry and Baldwin (1952) interpreted the contact to be conformable, whereas Trimble (1963) interpreted it to be unconformable on the basis of the weathered condition of the underlying Molalla Formation.

Age: The age of the Molalla Formation is poorly understood, but probably ranges from early Miocene to the middle or possibly late Miocene. An early Miocene age for the lower part of the unit is indicated by the presence of leaves of that age in the sandstone interbeds. An age possibly as young as late Miocene is suggested for the middle and upper parts of the section by the presence of interbedded mudflow breccias most appropriately assigned to the Rhododendron Formation. The Molalla Formation is overlain by volcanic rocks also considered to be part of the Rhododendron Formation (see contacts).

Some have suggested that the Molalla Formation correlates with the Troutdale Formation to the north and the Fern Ridge Tuffs to the south. Such a correlation is unlikely for the bulk of the Molalla Formation, but is possible for those parts of the Molalla of Harper (1946) which occur in the lower Molalla River and which have been subsequently mapped as Troutdale by Peck and others (1964).

References: Baldwin, 1964; Harper, 1946; Lowry and Baldwin, 1952; Peck and others, 1964; Trimble, 1963

MOODY SHALE

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Cal. Univ. Pub. in Geol. Sci. Bull., vol. 16, no. 12, p. 455,456,457,459.

(See: Toledo Formation)

NESTUCCA FORMATION

Original description: Snavely, P. D., Jr., and Vokes, H. E., 1949, Geology of the coastal area between Cape Kiwanda and Cape Foulweather, Oregon: U. S. Geol. Survey Oil and Gas Inv. Prelim. Map 97.

Distribution: The Nestucca Formation crops out in northwestern Oregon in an exposure which extends from the Siletz Bay-Nestucca Bay area along the coast inland 20 miles to Willamina. A short distance to the northeast, similar exposures near Yamhill are correlated with the upper Nestucca Formation. Typical exposures are located along the north bank of the Salmon River and in Road cuts north of Nestucca Bay in the Hebo quadrangle.

Lithology: The Nestucca Formation consists of interbedded tuffaceous shaly siltstones and claystones with subordinate amounts of relatively shallow water, locally cross-bedded and carbonaceous feldspathic sandstone low in the section. In addition, basaltic flows, pillows, breccias, and associated pyroclastic rocks are common in the northern part of the exposures, where a series of dikes suggests a local source for the volcanic part of the unit. Medium- to coarse-grained, massive basaltic sandstones, grits, and sandy tuffs are well-developed between the volcanic rocks and the mudstones as at Nestucca Bay.

In a general sense the Nestucca Formation can be viewed as a submarine volcanic and sedimentary accumulation deposited about the southern periphery of a then still-growing accumulation of Eocene volcanics in northwestern Oregon. As such, it is analogous to the Goble Volcanics-Cowlitz Formation complex deposited on the northern side of the volcanic high at about the same time.

Structure: The Nestucca Formation dips gently away from the upbowed center of Eocene volcanism. Dips are to the west along the coast, to the south in the Sheridan-McMinnville area, and to the east in the vicinity of Yamhill.

Contacts: The Nestucca Formation rests unconformably upon the Tyee Formation and is overlain by the Keasey Formation along a contact which is possibly conformable in some places and unconformable in others (see Keasey Formation).

Age: The Nestucca Formation is late Eocene in age and correlates with the Coaledo, Spencer, Cowlitz, and lower Keasey Formations, the Moody Shale, and the Goble Volcanics.

References: Baldwin, 1964; Baldwin and others, 1955; Baldwin and Roberts, 1952; Snavely and Vokes, 1949; Snavely and Wagner, 1964; Snavely and others, 1969; Youngquist, 1961

NYE MUDSTONE

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Calif. Univ. Pubs. in Geol. Sci. Bull., vol. 16, no. 12.

Distribution: The Nye Mudstone is exposed along the coast of northwestern Oregon in the vicinity of Yaquina Bay where the type section is located.

Lithology: The unit consists primarily of several thousand feet of dark gray to black, smooth fracturing mudstones with occasional siltstone layers. Calcareous material defines bedding locally and iron stains, gypsum, and jarosite commonly occur along the joints.

Lateral variations within the unit are relatively pronounced. Along the Yaquina River the mudstones pass into a section of predominately tuffaceous and micaceous sandstones. There cross bedding, pebbles, and coal seams are not uncommon low in the section, and massive, fine- to medium-grained monotonous sandstones make up the bulk of the section.

Contacts: Snavely and others (1969) report that the Nye Mudstone intertongues with the lower Yaquina Formation along the north shore of Yaquina Bay. The Nye Mudstone unconformably underlies beds assigned to the middle Miocene Astoria Formation of present-day usage.

Age: The Nye Mudstone is early Miocene in age and probably uppermost Oligocene in its lower portions. According to Dodds (1963) it correlates with the lower Astoria Formation at the type locality (see Astoria Formation).

References: Baldwin, 1964; Heacock, 1952; Snavely and others, 1964; Snavely and others, 1969; Stewart, 1956; Vokes and others, 1949; Youngquist, 1961

OTTER POINT FORMATION

Original description: Koch, J. G., 1966, Late Mesozoic stratigraphy and tectonic history Port Orford-Gold Beach area, southwestern Oregon Coast: Am. Assoc. Petroleum Geology Bull., vol. 50, no. 1, p. 25-71.

Distribution: The Otter Point Formation is exposed in the northern and western Klamath Mountains of southwestern Oregon and is reported in the Cape Ferrelo, Gold Beach, Collier Butte, Port Orford, Agness, Langlois, Powers, Bone Mountain, Coquille, and Sitkum quadrangles.

Lithology and structure: The Otter Point Formation consists of a highly sheared, diverse suite of eugeosynclinal rocks of undetermined stratigraphic thickness. The rock types include graywacke with subordinate amounts of chert-pebble conglomerate, lenticular radiolarian chert, andesitic and keratophyric breccias and pillows altered to greenstone, sheared argillite, mudstone, and isolated limestone lentils (see Whitsett limestone lentils). The graywacke is predominately a locally pebbly lithic graywacke, but feldspathic graywackes are common high in the structural section.

Also included in the Otter Point Formation are numerous detached garnetiferous blueschist blocks as much as several hundred feet in diameter which stand in marked relief above the irregular, undulating slide topography more characteristic of the sheared remainder of the formation. In addition, many of the volcanic and chert bodies are also monolithic in character, further accentuating the disordered condition of the unit. Metamorphism along shear zones in Otter Point has resulted in the albitization of plagioclase and the chloritization of mafic minerals. Other metamorphic minerals include laumontite, prehnite, and pumpellyite, indicative of the pumpellyite zone of Blake and others (1967).

The universal shearing, widespread occurrence of monoliths, and the absence of preserved bedding in the Otter Point Formation are features which conform favorably with the concept of melange as proposed by Hsu. Although the interpretation of the unit will no doubt be aided by the melange concept, the tendancy to map the unit on the basis of its superimposed structural features should be avoided. The unique lithology of the Otter Point Formation should be the main criterion in delimiting the extent of the unit in a stratigraphic sense. Structural modifications can cross stratigraphic boundaries and indeed they do in southwestern Oregon. South of Brookings the Dothan Formation is melanged and near Coos Bay the lower Umpqua displays several melange features.

Contacts: Although the age differentials between the Otter Point Formation and the predating and postdating formations suggest unconformities above and below Otter Point, all the observable contacts appear faulted. Hence, stratigraphic relationships cannot be directly observed. In the upper Sixes River drainage an exposure of Colebrooke Schist appears to either directly underlie the Otter Point Formation (Baldwin and Lent, 1969; Baldwin and Hess, 1971) or to be infaulted into the Otter Point Formation. Elsewhere, Colebrooke schist overlies the Otter Point Formation (Lent, 1969).

Age: The age of the Otter Point Formation is post-Nevadan late Jurassic (Portlandian-lower Purbeckian). Fossils taken from the unit include *Buchia piochii*, an ichthyosaur rostrum, belemnoids, perisphinctid ammonoids, and plant debris. It correlates with the Dothan Formation, the Franciscan Assemblage, and possibly the Riddle Formation (see Riddle Formation).

The blueschist pods within Otter Point have been radiometrically dated at 140 million years. This age may have no direct bearing on the age of Otter Point, however, because the pods are probably infaulted blocks belonging to a previously formed blueschist unit, perhaps the Colebrooke Schist. According to Hsu (1968) infaulting of this type is not at all uncommon in melanged units.

References:

Baldwin and Hess, 1971	Hsu, 1968
Baldwin and Lent, 1969	Hunter and others, 1970
Champ, 1969	Koch, 1966
Fairchild, 1966	Krans, 1970
Harms, 1957	Lent, 1969
Hess, 1967	Peterson, 1957

PALEOZOIC GRAPHITIC SCHISTS AND GREENSCHISTS

Distribution: These rocks are considered to be among the oldest in Oregon and are situated near the California border in the Ruch quadrangle of southwestern Oregon.

Lithology: The predominate rock type is an albite-quartz-epidote schist that probably was derived from mafic volcanic rocks or related sediments with a high iron and magnesium content. Other rock types include dark-gray quartz-graphite schists and silver-white sericite schist with limonite pseudomorphs after pyrite. Schistosity, chevron folding, and faulting are well-developed and widespread.

Contacts: The contacts of the Paleozoic rocks with other units are obscure but undoubtedly involve faulting.

Age: In Oregon the schists are clearly pre-Applegate (Triassic) in age. They are correlated with the Abrams Schist and the Salmon Hornblende Schist in California to which Carboniferous metamorphic ages have been assigned on the basis of potassium argon dating, and Devonian metamorphic ages have been assigned on the basis of strontium-rubidium techniques. Lanphere and others (1968) consider the strontium-rubidium ages to be the more reliable. A pre-Silurian age is suggested for the original rocks on the basis of stratigraphy (Baldwin, 1964).

References:

Baldwin, 1964	Lanphere and others, 1968
Engelhardt, 1966	Wells, 1956
Lanphere and others, 1965	

PITTSBURG BLUFF FORMATION

Original description: Schenck, H. G., 1927, Marine Oligocene of Oregon: Calif. Univ. Publ. in Geol. Sci. Bull., vol. 16, no. 12.

Distribution: The Pittsburg Bluff Formation is exposed near Vernonia northwest of Portland and along the west side of the Willamette Valley as far south as the Sheridan-McMinnville area. The type section is located at Pittsburg Bluff along the Nehalem River in Columbia County, Oregon.

Lithology: The Pittsburg Bluff Formation consists of several hundred feet of highly variable, massive, arkosic, tuffaceous sandstone, shale, and conglomerate. Conglomerates and coarse-grained volcanic sandstones presumably derived from the Eocene volcanic accumulations to the west are common low in the section and coal-bearing interbeds are common high in the section. Much of the variation in the lithology of the unit can be explained in terms of a strandline environment. Most of the unit, however, can probably be characterized as a marine mudstone or siltstone.

Locally 500 feet of moderately indurated, marine and terrestrial, quartzose sandstone resembling part of the Cowlitz Formation occupies the base of the section. It is assigned to the Pittsburg Bluff Formation on the basis of stratigraphic position.

Structure: The unit dips gently eastward and is probably fairly extensive in the subsurface of the Willamette Valley.

Contacts: The relationship between the Pittsburg Bluff Formation and the underlying Keasey Formation is poorly understood. Although measured attitudes are consistant with a disconformable relationship, the variation in the attitudes between the two formations is no greater than the variation in the attitudes within either of the two formations (Van Atta, oral communication 1970).

Although local evidence supports a disconformable relationship between the Pittsburg Bluff Formation and the overlying Scappoose Formation (see Scappoose Formation), regional evidence provided by measured attitudes in no way demands a disconformity (Van Atta, oral communication 1970). Conformity within the Oligocene embayment in conjunction with local disconformities about the peripery is a possibility.

Age: The Pittsburg Bluff Formation is middle Oligocene in age and correlates with the Eugene Formation, the Mehama Volcanics of the northern West Cascades, the Oligocene tuffs of the Eugene area (here included in the Fisher Formation), and the upper Toledo Formation.

References: Baldwin, 1964
Baldwin and Roberts, 1952
Warren and others, 1945
Warren and others, 1946

PLEISTOCENE ALLUVIUM OF THE UPPER AND MIDDLE WILLAMETTE VALLEY

Distribution: Rocks referred to by this term occur as a series of weathered terraces and valley-fill deposits both north and south of the Salem Hills in the Willamette Valley. The age relationships assigned to the deposits are largely a matter of interpretation concerning manner of origin and, hence, are subject to revision (see age).

Lithology: Deeply weathered benches composed of poorly sorted gravel, pebbly sand, and clay occurring at elevations between 230 and 400 feet are included in the older parts of this unit. Allison (1953) refers to the highest terraces as the Lacomb Gravels in the Albany quadrangle and interpretes a Cascade provenance for them. He refers to the lower terrace (230 to 300 feet) as the Leffler Gravels.

Deeply weathered terrace gravels occurring at elevations between 350 and 450 feet in the Dallas and Valsetz quadrangles may be equivalent to the Leffler Gravels. Gravels on "Red Prairie" in the Sheridan quadrangle are possibly also equivalent to the Leffler Gravels of the Dallas quadrangle.

Younger deposits underlying the Willamette Silts along the Santiam River in the Albany quadrangle are termed the Linn Gravel by Allison and Felts (1956). Still younger deposits in the Mount Angel, Stayton, and Molalla quadrangles are referred to informally by Glenn (1962) as the modern stream deposits of the Silver, Abiqua, and Butte Creeks, the Labish lowland silt (possibly an abandoned channel of the Willamette River), the Willamette River deposits, the Salem-Santiam fan deposits and the Molalla River deposits (not to be confused with the Molalla Formation).

In the extreme southern portions of the Willamette Valley, Balster and Parsons (1969) treat the Linn Gravels and Willamette Silts in considerable detail, dividing them into a total of six members.

Age: Traditionally, terrace elevation and depth of weathering have been interpreted to be measures of the various ages of the Pleistocene alluvial deposits of the Willamette Valley. Hence, the Lacomb Gravels have been assigned a middle Pleistocene Kansan age, and the lower less-weathered deposits have been assigned successively younger ages.

An alternative interpretation is that all or part of the terraces are mere remnants of an originally much more extensive alluvial terrace which has been successively eroded throughout the Pleistocene to lower and lower levels exposing rocks successively deeper in the section. According to this theory the oldest Pleistocene alluvial rocks would be the most recently exposed and hence, would be the least weathered and would lie at the lowest elevations. It follows that the relative ages of the deposits as they are presented in the literature may be the reverse of what they should be.

The author tentatively concurs with Allison (1953) that the terraces represent successive deposits of glaciofluvial outwash delivered to the Willamette Vclley during glacial times, and that terracing was a phenomenon which occurred during the intervening interglacial periods. Accordingly the relative ages as presented in the literature are viewed as being basically correct. Concurrent progressive uplift has carried the oldest deposits to their relatively high elevations above the younger terraces.

It is emphasized, however, that the ages of the deposits are presently uncertain and it is further emphasized that correlations between terraces in different areas is difficult and possibly in need of revision.

References: Allison, 1953
Allison and Felts, 1956
Baldwin, 1947
Baldwin, 1955
Baldwin, 1957
Balster and Parsons, 1969
Glenn, 1962
Glenn, 1965
Vokes and others, 1954

PLIOCENE-PLEISTOCENE ALLUVIUM OF THE PORTLAND AREA

Introduction: The above term is applied to a wide variety of relatively localized fluvial deposits in the Portland area. Owing to the uncertain interrelationships of the numerous units, they are briefly considered here under one heading. More complete treatment of the Boring Lava, Rhododendron Formation, Troutdale Formation, Portland Hills Silt, Willamette Silts, and Portland Sand is provided under those headings.

Geology: Units belonging to the Pliocene-Pleistocene alluvium of the Portland area occur in both the Columbia River and the Clackamas River drainage systems. Volcanic rocks assigned to the Boring Lava occur locally low in the section.

In the Clackamas River drainage the Rhododendron Formation is successively overlain by the early Pliocene Sandy River Mudstone (lower Troutdale Formation of Hodge, 1933), the Troutdale Formation (with its distinctive quartzite boulders), the Pliocene Boring Lava, the early Pleistocene Springwater Formation (conglomerates), the middle Pleistocene Gresham Formation (gravels and mudflow deposits), and the late Pleistocene Estacada Formation (coarse gravels). Postdating these units is the late Pleistocene Willamette Silt.

Volcanic breccias interbedded with the Troutdale Formation have been referred to as the Boring Lava as well as the Rhododendron Formation, although Trimble (1963) emphasizes that the Troutdale (restricted) overlies the Rhododendron Formation. The confusion probably arises because the Rhododendron Formation of earlier authors included much of what is now called Boring Lava.

The term Portland Sand is applied to a series of estuarine deposits situated along the Columbia River near Portland. Most of the unit is probably third interglacial in age, but the bouldery veneer overlying the unit probably is a correlative of the Willamette Silts and postdates all the other aforementioned units (see Willamette Silts and Portland Sand).

References: Baldwin, 1964
Lowry and Baldwin, 1952
Schlicker and others, 1964
Schlicker and others, 1967
Trimble, 1963

PORTLAND HILLS SILT

Original description: Lowry, W. D., and Baldwin, E. M., 1952, Late Cenozoic geology of the lower Columbia River Valley, Oregon and Washington: Geol. Soc. America Bull., vol. 63, p. 1-24.

Distribution: The Portland Hills Silt is 25 to 100 feet thick on the south side of the Tualatin Mountains, where it reaches elevations of 1,200 feet. It occurs also in the lowlands bordering the Columbia River in the Portland area and to the north in Washington where it reaches elevations of 1,600 feet locally. The Portland Hills Silt is equivalent to the Upland Silt of Schlicker and others (1967), the Portland Hills Silt member of the Troutdale Formation of Lowry and Baldwin (1952) and the loess of Trimble (1963).

Lithology: The Portland Hills Silt consists of massive, structureless, yellow-brown to buff, micaceous silt. Mineralogically it is composed of quartz, muscovite, biotite, feldspar, augite, garnet, glass, spicules, diatoms, and clay minerals, primarily kaolinite and illite. Lithologically it is quite similar to the Palouse soil of eastern Washington.

Age: A post-Troutdale, middle Pliocene age is suggested for the Portland Hills Silt by the discovery of a rhinoceras tooth of that age along the crest of the Tualatin Hills (Baldwin, 1964). Admittedly, however, the exact stratigraphic position of the specimen has never been determined, and hence it may not have occurred in the Portland Hills Silt. The possibility also exists that the original tooth became inadvertently exchanged for another similar fossil between the time that it was first collected and the time that it was finally identified years later.

Loessal deposits assigned to the Portland Hills Silt by Trimble (1963) in the Clackamas drainage overlie the Springwater Formation of early Pleistocene age. Accordingly a mid Pleistocene, possible Kansan age is postulated for this part of the unit.

Origin: An eolian origin is postulated for the Portland Hills Silt in the Portland Hills. The rounded pebbles reported in the unit were probably introduced by localized mass wasting or stream action from above as the loess slowly accumulated on the leeward side of the mountains. If later study uncovers a relative abundance of pebbles near topographic highs, this view will be correspondingly enhanced.

Elsewhere at lower elevations the widespread, random occurrence of large pebbles in the silts is highly suggestive of ponding and rafting. Much debate in the literature regarding the origin of the Portland Hills Silt is a direct result of the ambiguous evidence available in the field. It is suggested here that the Portland Hills Silt is of both fluvial and eolian origin. Accordingly, the lowland silts are regarded as floodplain deposits, and the highland silts are viewed as loessal deposits that were laid down by dry glacial winds as they swept down the Columbia River Gorge over the flood plains and over the Portland Hills.

References: Baldwin, 1964; Howell, 1962; Lowry and Baldwin, 1952; Schlicker and others, 1967; Trimble, 1963; Youngquist, 1961

PORTLAND SAND

Original description: Buwalda, J. P., and Moore, B. N., 1930, Carnegie Inst. Washington Publ. 404, p. 21-22.

Distribution: The Portland Sand is situated along the Columbia River between the Sandy and Willamette Rivers. It has previously been referred to as Portland Delta Gravels and Portland Gravels. Baldwin (1964) favors the term Portland Sand.

Lithology: The unit consists of a dissected terrace with a maximum elevation of 365 feet and a total thickness of approximately 600 feet. With the exception of an overlying veneer of coarse gravels, the unit is composed of sand which was laid down during a ponding episode which accompanied the third interglacial epoch. The ensuing drop in sea level during Wisconsin times led to downcutting in the Columbia and Willamette Rivers, which in turn led to the development of terraces in the sand. The present post-glacial rise in sea level has partially flooded the river valleys once again.

The gravel veneer consists of coarse boulders of basalt and andesite derived from the Boring Lava, Rhododendron Formation, Cascades Formation and Columbia River Group. A few angular erratics are also reported in the veneer. One interpretation is that late Wisconsin floodwaters from Lake Missoula deposited the boulders as they swept southward to deposit the finer-grained Willamette Silts in the Willamette Valley.

Age: The bulk of the Portland Sand is probably of third interglacial post-Portland Hills Silt age and is thought to correlate with the Coquille Formation along the coast. Baldwin (1964) proposes that the Portland Sand was formed during interglacial alluviation which resulted from an eustatic rise in sea level. He further hypothesizes that related ponding to the south in the Willamette Valley resulted in the deposition of the late Pleistocene lakebeds.

The Willamette Silts and the gravelly veneer differ from the Portland Sand and the late Pleistocene lakebeds in that they were deposited by flood waters in late glacial times, whereas the Portland Sand and the late Pleistocene lakebeds were formed by ponding related to an eustatic rise in sea level during interglacial times.

References: Baldwin, 1964, 1957
Lowry and Baldwin, 1952
Treasher, 1942
Trimble, 1963

PORT ORFORD FORMATION

Original description: Baldwin, E. M., 1945, Some revisions of the late Cenozoic stratigraphy of the southern Oregon Coast: Jour. Geol., vol. 53, no. 1, p. 35-46.

Distribution: The Port Orford Formation is limited to an isolated exposure immediately southeast of Cape Blanco in southwest Oregon. Sea stacks to the west hint of a greater extent in Pleistocene times.

Lithology: The unit consists of approximately 200 feet of poorly indurated locally conglomeratic, uniform, light gray, massive, concretionary fossiliferous sandstone. Most of the unit was deposited under neritic conditions; however, some of the conglomerate appears to be of fluvial origin.

Structure: The Port Orford Formation dips gently to the east and is dissected locally by east-flowing streams.

Contacts: The Port Orford Formation rests unconformably upon the "Empire Formation" of Baldwin (1964) and beds assigned to the Miocene sedimentary rocks of southwestern Oregon.

Age: The Port Orford Formation is middle to late Pliocene.

References: Baldwin, 1945
Baldwin, 1964
Farooqui, 1969
Stewart, 1956
Youngquist, 1961

POST-ASTORIA SANDSTONE

Distribution: Dodds (1963) applies the term "post-Astoria sandstone" to sandstones in the Svensen quadrangle which are generally assigned to the Astoria Formation.

Lithology: The post-Astoria sandstone consists of approximately 1,200 feet of buff, medium-grained, micaceous, thick-bedded, arkosic, friable sandstone. Minor basalt flows are intercalated locally.

Structure: The unit is gently dipping and is cut locally by high-angle faults.

Contacts: The unit rests unconformably over mudstones and siltstones of the original type locality of the Astoria Formation (see Astoria Formation). The unit occupies the same stratigraphic position as strata elsewhere assigned to the Astoria Formation of present-day usage.

Age: According to Dodds (1963), the post-Astoria sandstone is late Miocene to early Pliocene in age and correlates with the Astoria Formation of authors; however the unit may be middle Miocene in part (see Astoria Formation). The post-Astoria sandstone is interbedded with lavas belonging to the Miocene Columbia River Group.

References: Dodds (1963)
Dodds (1969)

RHODODENDRON FORMATION

Original description: Hodge, E. T., 1933, Age of Columbia River and lower canyon [abs]: Geol. Soc. America Bull., vol. 44, p. 156-157.

Distribution: Rocks assigned to the Rhododendron Formation crop out on the northeast side of the Willamette Valley in the Molalla, Oregon City, and Portland quadrangles. Although the eastward extent of the Rhododendron Formation is poorly understood, it probably becomes thicker and more widespread in that direction.

In the Portland area much of the Rhododendron of Hodge (1938) is now recognized as Boring Lava. To the south in the Molalla quadrangle, however, rocks assigned to the Boring Lava by Lowry and Baldwin (1952) are here considered to be part of the Rhododendron Formation. The Boring Agglomerate of Treasher (1942) is here considered to be equivalent to the Rhododendron Formation.

Lithology: The Rhododendron Formation of the northeast Willamette Valley consists of a series of coalescing mudflow breccias of porphyritic hypersthene andesite. To the east the mudflows grade laterally into the dominant lava flows of the Cascade source areas. In the Molalla River drainage area breccias interbedded with the Molalla Formation and overlying the Molalla Formation are considered to be part of the Rhododendron Formation owing to their extremely poorly sorted and massive mudflow aspect.

The Rhododendron Formation can best be considered as a series of coalescing mudflow deposits derived from volcanic highs to the east and passing into interbedded fluvial deposits such as the Molalla Formation to the west.

Age: The Rhododendron Formation is late Miocene in age. In the Portland area a lateritic horizon representing an ancient weathering surface separates the Rhododendron Fromation from the overlying Sandy River Mudstone of lower Pliocene age.

References: Baldwin, 1964
Lowry and Baldwin, 1952
Peck and others, 1964
Trimble, 1963

RIDDLE FORMATION

Original description: Imlay, R. W., and others, 1959, Relations of certain upper Jurassic and lower

Cretaceous formations in southwestern Oregon: American Assoc. Petroleum Geol. Bull., vol. 43, no. 12, pp. 2770-2785, 3 figs.

Distribution: The Riddle Formation crops out in the upland Mesozoic terrane of the Klamath Mountains of southwestern Oregon. The type section is situated along the south Umpqua River in the Days Creek quadrangle.

Lithology: The Riddle Formation consists of massive chert-pebble conglomerate (with some greenstone clasts probably derived from the Rogue Formation) low in the section and thin to medium-bedded, alternating lithic subgraywacke, siltstone, and conglomerate high in the section.

Structure: The unit exhibits steep to moderate dips, is veined with quartz, and may be faulted to an extent greater than is presently recognized (Jones, 1969).

Contacts: Although the Riddle appears everywhere concordant with the overlying Days Creek Formation, the relationship between the two formations is uncertain (see age below).

Age: Pelecypods taken from the Riddle Formation have generally been identified as Buchia piochii. Accordingly paraconformity with the overlying Days Creek Formation of upper Valanginian-Barremian age has been inferred and the unit has been correlated with the Dothan and Otter Point Formations.

Recent studies, however, suggest that the contained fossils high in the section (unit 4 of Imlay and others, 1959) are probably Buchia uncitoides (Imlay, written communication, 1970) of Berriasian age. Accordingly the Riddle Formation is probably post-Dothan and post-Otter Point in part.

It follows that the paraconformity separating the Riddle and Days Creek Formation is lower Valanginian rather than lower Valanginian to Berriasian in age. Jones (1969) postulates that the missing record may be a result of faulting or sampling error instead of an unconformity.

References: Baldwin, 1964; Hixson, 1965; Imlay and others, 1959; Johnson, 1965; Jones, 1969

ROCKY POINT FORMATION

Original description: Koch, J. G., 1966, Late Mesozoic stratigraphy and tectonic history, Port Orford-Gold Beach area, southwestern Oregon coast: Am. Assoc. Petroleum Geologists Bull., vol. 50, no. 1, p. 25-71.

Distribution: The Rocky Point Formation is situated along the coast of southwestern Oregon and a short distance inland in the Langlois quadrangle.

Lithology: The unit consists of more than 8,000 feet of rhythmically bedded sandstone and dark gray to black mudstone. Graded bedding, coalified plant debris, and quartz and calcite veinlets are reported as occurring locally. Interbeds of conglomerate resemble the underlying Humbug Mountain Conglomerate, except that they are finer grained and contain a higher percentage of chert fragments.

Structure: The unit exhibits moderate to gentle dips.

Contacts: The Rocky Point Formation grades downward into the Humbug Mountain Conglomerate through a series of interbeds and is in fault contact with the Colebrooke Schist locally.

Age: The Rocky Point Formation is Valanginian and possibly part Berriasian in age and correlates in part with the upper Humbug Mountain Conglomerate and the lower Days Creek Formation.

References: Dott, (in press)
Koch, 1966
Lent, 1969

ROGUE FORMATION

Original description: Wells, F. G., and Walker, G. W., 1953, Geology of the Galice quadrangle, Oregon: U. S. Geol. Survey Map GQ-25.

Distribution: The Rogue Formation crops out as a northeasterly trending band extending from the center of the Klamath Mountains near the California border to a point east of Roseburg. It is bounded on the east by the Galice Formation and on the west by the Dothan Formation. Definitive exposures crop out along the Rogue River west of Galice in the Galice quadrangle.

Lithology: The Rogue Formation consists of an eugeosynclinal suite of volcanic rocks of intermediate to felsic composition incompletely adjusted to the greenschist facies of metamorphism. The various types of rocks, best differentiated where weathering and water erosion have accented the textures, include andesitic to dacitic agglomerates, tuffs, flows, flow breccias, and pillow lavas. The unit also includes some localized occurrences of pyroxene gneiss, reduced to tremolite-chlorite-calcite schist, and amphibole gneiss restricted to shear zones. The unit also contains some contemporaneous intrusive bodies.

Structure: The Rogue Formation is steeply dipping and intensely fractured. It contains hornblende diorite dikes locally.

Contacts: The Rogue Formation is thought to be thrust over the younger Dothan Formation to the west. To the east the relationship with the Galice is unclear. Shearing is evident locally along the contact (Wells and Walker, 1953), but in general the contact appears to be conformable (Baldwin, oral communication, 1970). Hence, the Rogue Formation is stratigraphically overlain by the Galice Formation to the east.

Age: The Rogue Formation is pre-Nevadan Late Jurassic in age. Imlay and others (1959) assign an early Oxfordian age to the unit.

References: Baldwin, 1964
Champ, 1969
Helming, 1966
Hixson, 1965
Imlay and others, 1959
Johnson, 1965
Lent, 1969
Wells and Walker, 1953

ROXY FORMATION

Original description: Wells, F. G., 1956, Geologic Map of the Medford quadrangle, Oregon-California: U. S. Geol. Survey Map GQ-89.

Distribution: The Roxy Formation forms extensive exposures in the northeastern half of the old Medford 30 minute quadrangle (Gold Hill, Medford, and Talent 15' quadrangles) and in adjacent areas. It makes up the lower part of the Little Butte Volcanic series of Wells and others (1956).

Lithology: The unit consists of a series of vesicular to scoriaceous, felsitic to glassy, black to pink andesitic flows interbedded with local tuffs and volcanic breccias. Phenocrysts of augite and feldspar are common. Also included are localized occurrences of sandstone, volcanic shale, and sandy shale which contain leaf prints in places.

Contacts: The nature of the contact between this member of the Little Butte Volcanic Series and the underlying Colestin Formation is unclear. Because no discordance is detectable in the field, Wells and Walker (1956) concluded that the contact was conformable.

Age: An Oligocene age is assigned to the unit.

References: Wells, 1956

SACCHI BEACH MEMBER (OF TYEE FORMATION)

Original description: Bird, K. J., 1967, Biostratigraphy of the Tyee Formation: unpub. Univ. Wisconsin Ph. D. dissertation, 209 p.

(See: Tyee Formation and Elkton Siltstone member)

"SALEM-SANTIAM FAN DEPOSITS"

(See: Pleistocene alluvium of the middle and upper Willamette Valley)

SANDY RIVER MUDSTONE

Original description: Trimble, E. D., 1963, Geology of Portland, Oregon and adjacent areas: U. S. Geol. Survey Bull. 1119.

Discussion: This unit was included in the lower Troutdale Formation by Hodge (1938). In addition, it yielded the original lower Pliocene fossils upon which the lower Pliocene age of the Troutdale Formation was based (Baldwin, oral communication, 1970). (See Troutdale Formation)

(See: Pliocene-Pleistocene alluvium of the Portland area).

SARDINE FORMATION

Original description: Peck. D. L., Griggs, A. B., Schlicker, H. G., Wells, F. G., and Dole, H. M., 1964, Geology of the central and northern parts of the Western Cascade Range in Oregon: U. S., Geol. Survey Prof. Paper 449, 56 p.

Distribution: The Sardine Formation of Peck and others (1964) makes up the bulk of the Western Cascade Range in Oregon north of the North Santiam River. Continuing south to the McKenzie River, it occupies the center of the Sardine syncline and farther south still it crops out as isolated exposures. The Sardine Formation includes the Rhododendron Formation and Boring Agglomerate in the north. To the south it includes the Fern Ridge Tuffs, the upper Breitenbush Series of Thayer (1939), and the upper part of the Sardine Series of Thayer (1939). It probably also includes basalts and related rocks referred to as Miocene basalt by Patterson (1961) in the Glide quadrangle and Miocene and Pliocene Volcanics by Schlicker and Dole (1957) in the Marcola, Leaburg, and Lowell quadrangles.

In opposition to part of the distribution pattern outlined above, Wheeler and Mallory (1969) maintain that much of what is mapped as Sardine Formation in the interior of the western Cascades is actually part of the Little Butte Volcanic Series.

Lithology: The Sardine Formation consists of an average of 3,000 feet (10,000 feet maximum) of flows, tuff breccia, lapilli tuff and tuff of hypersthene andesite. Pyroclastic rocks are common low in the section particularly in the northern part of the exposures. In addition to the above lithologies, other rock types include olivine basalt, basaltic andesite, dacite, and aphyric silicic andesite.

The flows are platy and porphyritic with phenocrysts of calcic plagioclase and prismatic black hypersthene. The pyroclastic rocks include tuff breccias of mudflow origin which make up much of the Rhododendron Formation (see Rhododendron Formation).

Structure: The unit exhibits gently easterly and westerly dips in response to the poorly defined late Cenozoic structures of the western Cascades.

Contacts: The Sardine Formation rests with angular unconformity on the Little Butte Volcanic Series and fills an irregular pre-Sardine topography. In regions where a lateritic horizon is developed atop the underlying Columbia River Group an intervening unconformity is interpreted. Elsewhere conformity is interpreted in regions of low pre-Sardine relief, presumably where the intervening lateritic horizon is not developed. The Sardine Formation is unconformable beneath the Troutdale Formation along the Columbia River.

Age: A middle and late Miocene age is suggested for the Sardine Formation by numerous fossil-plant localities of that age within the unit. In addition, a late Miocene age is interpreted in the Portland area where its equivalent, the Rhododendron Formation, is unconformable beneath the Sandy River Mudstone.

References:

Barlow, 1955	Peck, 1960
Halstead, 1955	Peck and others, 1964
Kays, 1970	Pungrassami, 1969

SARDINE SERIES

Original description: Thayer, T. P., 1939, Structure of the North Santiam River section of the Cascade Mountains in Oregon: Jour. Geol., vol. 44, no. 6, p. 701-716.

Discussion: In tracing the Mehama Volcanics, Stayton Lavas, and Fern Ridge Tuffs eastward over the crest of the Mehama anticline Thayer (1939) found that the individual units lost their identity owing to the increase of volcanic flows throughout the section. To this pile of volcanic rocks he assigned the term Sardine Series.

Peck and others (1964) assigned the upper Sardine Series to their Sardine Formation and the lower Sardine Series to their Little Butte Volcanic Series in an attempt to further subdivide the section. The Sardine Series of Thayer (1939) should not be confused with the Sardine Formation of Peck and others (1964).

SCAPPOOSE FORMATION

Original description: Warren, W. C., and Norbisrath, Hans, 1946, Stratigraphy of the upper Nehalem River basin, northwestern Oregon: Am. Assoc. Petroleum Geologists Bull., vol. 30, p. 213-237.

Distribution: The Scappoose Formation is limited to the extreme northwest corner of the state and has been traced only short distances from the type locality near Scappoose in the St. Helens quadrangle. Rocks of similar age lithology north of Neahkahnie Mountain in the Cannon Beach quadrangle along the coast and in the Chehalem Hills in the Yamhill quadrangle of the northwestern Willamette Valley are tentatively correlated with the Scappoose Formation, as are sedimentary rocks on Butte Creek near Scotts Mills.

Lithology: The Scappoose Formation consists of as much as 1,500 feet of fossiliferous, buff, arkosic tuffaceous sandstone and shale quite similar to the underlying Pittsburg Bluff Formation. Lithic sandstone crops out locally and basaltic conglomerate occurs in places near the base. The unit is more tuffaceous, less massive, and younger than the Pittsburg Bluff Formation.

Contacts: On the basis of megafaunal content the Scappoose Formation is interpreted to rest disconformably upon the Pittsburg Bluff Formation. In addition, a basal conglomerate separates the unit locally. (See Pittsburg Bluff Formation) The Scappoose Formation is unconformably overlain by the Columbia River Group, and its correlatives presumably interfinger with the upper part of the Little Butte Volcanic Series to the east.

Age: The Scappoose Formation correlates with the Nye Mudstone and the Blakely stage of late Oligocene to lowermost Miocene age.

References: Baldwin, 1964; Peck, 1960; Peck and others, 1964; Schlicker, 1962; Warren and others, 1945; Warren and Norbisrath, 1946; Youngquist, 1961

SILETZ RIVER VOLCANIC SERIES (SILETZ RIVER VOLCANICS)

Original description: Snavely, P. D., Jr., and Baldwin, E. M., 1948, Siletz River Volcanic Series, northwestern Oregon: Am. Assoc. Petroleum Geologists Bull., vol. 32, no. 5, p. 805-812.

Distribution: The Siletz River Volcanic Series is situated in the central Coast Range and along the extreme western edge of the adjacent Willamette Valley. The type locality is between Valsetz mill dam and Lower Gorge in the Valsetz and Euchre Mountain quadrangles respectively. The term is sometimes applied to rocks of similar age and lithology exposed farther to the north and otherwise known as the lower Tillamook Volcanic Series (see Tillamook Volcanic Series). The Siletz River Volcanic Series is also equivalent to the Coffin Butte Volcanics of Allison (1953).

Lithology: The Siletz River Volcanic Series consists of several thousand feet of dominantly marine basaltic flows, pillows, flow breccias, and pyroclastics with minor amounts of water-laid tuffs. Dark greenish-gray, aphanitic to porphyritic basalt is the most common rock type and vesicular and amygdaloidal basalts are common. Mineralogically the basalts consist of labradorite, augite, and titaniferous magnetite with varying amounts of volcanic glass and secondary minerals including calcite, stilbite, natrolite, and mordenite. Chloritization is universal.

Minor interbedded tuffaceous siltstone is intercalated locally throughout the section. High in the section in the Corvallis quadrangle thin-bedded tuffaceous siltstone and water-laid tuff with a thickness of approximately 3,000 feet is termed the Kings Valley Siltstone member. It presumably represents a late pyroclastic phase in Siletz River volcanism.

The tholeiitic primitive pillow lavas of the Siletz River Volcanic Series in conjunction with the localized alkalic derivatives high in the section provide an Eocene analog to the Hawaiian shields of today. Snavely and others (1968) attribute the apparent differentiation to both crystal migration and volatile transfer.

Structure: The Siletz River Volcanic Series exhibits gentle to moderate dips. Thickness determinations may be slightly high owing to possible repetition of the section by unrecognized local faults.

Contacts: An unconformable relationship is interpreted between the Siletz River Volcanic Series and the overlying Tyee Formation and the Yamhill Formation in the Corvallis-Monroe and Sheridan-McMinnville areas respectively. The Siletz River Volcanic Series is unconformably overlain by the Goble

Volcanics and the Nestucca Formation to the north. The base of the unit is not exposed.

Age: The Siletz River Volcanic Series is largely of early Eocene (Capay) age and correlates with the lower part of the Tillamook Volcanic Series of Warren and others (1945) to the north. In addition, a Paleocene Meganos age is indicated for the lower part of the unit by Snavely and Vokes (1949). High in the section lower Eocene foraminifers belonging to the genera Discocyclina and Asterocyclina are reported. The unit is a correlative of the volcanics of the lower Umpqua Formation in the Roseburg area and may be continuous with them in the subsurface.

References:
Allison, 1953
Baldwin, 1964, 1955, 1947
Baldwin and others, 1955
Baldwin and Roberts, 1952
Snavely and Baldwin, 1948
Snavely and Vokes, 1949
Snavely and others, 1968, 1969
Vokes and others, 1954
Youngquist, 1961

SPENCER FORMATION

Original description: Turner, F. E., 1938, Stratigraphy and mollusca of the Eocene of western Oregon: Geol. Soc. America Sp. Paper 10, 130 p.

Distribution: The Spencer Formation crops out along the western edge of the Willamette Valley from the Yamhill area to the Eugene area where the type section is located. Outcrops continue farther to the south in the Drain quadrangle. Presumably the Spencer Formation is widespread beneath the younger deposits of the Willamette Valley. The unit includes the "upper Eocene sediments" of Baldwin (1947), but does not include the Lorane Shale member of Vokes and others (1951). In addition, the unit includes part of the Comstock Formation of Turner (1938).

Lithology: The Spencer Formation consists of a variety of micaceous and tuffaceous sandstones and siltstones. In the Drain quadrangle several hundred feet of massive, friable, arkosic sandstone thickens northward towards the Eugene area where approximately 2,000 feet of arkosic, micaceous, tuffaceous sandstone, and grit are assigned to the unit.

In the Corvallis area, coarse- to medium-grained basaltic and arkosic sandstone passes upsection into bedded dark shales and well-indurated basaltic and arkosic sandstone in a section which has a total thickness of about 4,500 feet. Lignite, coal, and carbonaceous material is present locally high in the section.

Approximately 2,500 feet of cross-bedded, friable, tuffaceous sandstone, and siltstone is present in the Dallas-Valsetz area, and farther to the north in the Yamhill quadrangle the Spencer Formation appears to wedge out between the finer grained siltstones and shales of the overlying Keasey-like beds and the underlying Nestucca-like beds.

The Spencer Formation was apparently derived from a wide variety of sources. The arkosic beds were probably derived from the Tyee Formation from which they are distinguished with difficulty. Intercalated basalt flows in the Dallas-Valsetz area indicate derivation in part from the Eocene volcanics of northwestern Oregon, and the occurrence of lenses of andesitic lapilli tuffs in the Corvallis area suggests derivation from the volcanic accumulations of the Western Cascades.

Structure: The Spencer Formation is gently deformed and dips easterly at angles of about 15°.

Contacts: The Spencer Formation rests unconformably over the Tyee and Yamhill Formations and is overlain by the Fisher Formation with slight angular unconformity in the Drain and Anlauf quadrangles.

Age: The Spencer Formation is late Eocene (Tejon) in age and correlates with the upper Nestucca Formation, the Cowlitz and Coaledo Formations, the Goble Volcanics, and the Moody Shale. Hoover (1963) correlates the unit with the upper part of the Yamhill Formation of the northern Willamette Valley.

References: Baldwin, 1964
Baldwin, 1947
Hoover, 1963
Hoover, 1949
Schlicker, 1962
Vokes and others, 1951
Vokes and others, 1954
Youngquist, 1961

SPRINGWATER FORMATION

Original description: Trimble, D. E., 1963, Geology of Portland, Oregon and adjacent areas: U. S. Geol. Survey Bull. 1119.

(See: Pliocene-Pleistocene alluvium of the Portland area)

STAYTON LAVAS

Original description: Thayer, T. P., 1933, Pan-American Geologist, vol. 59, no. 4, p. 317.

(See: Columbia River Group)

TILLAMOOK VOLCANIC SERIES

Original description: Warren, W. C., Norbisrath, Hans, and Grivetti, R. M., 1945, Geology of northwestern Oregon west of the Willamette River north of latitude 45°15': U. S. Geol. Survey Oil and Gas Inv. Prelim. Map 42.

Discussion: Warren and others (1945) assigned this term to the thick accumulation of Eocene volcanic rocks in northwestern Oregon. Subsequently the younger parts of the unit have been referred to the late Eocene Goble Volcanics and the Nestucca Formation. The older part of the unit, expecially in the southern part of the exposure, is commonly referred to indirectly as part of the Siletz River Volcanic Series. For further information see these formations.

TOLEDO FORMATION:

Original description: Harrison and Eaton (firm), 1920, Report on investigation of oil and gas possibilities of western Oregon: Oreg. Bur. Mines and Geol., Mineral Res. of Oregon, vol. 3, no. 1, p. 3-37.

Distribution: Exposures of the Toledo Formation are situated along the coast in the Yaquina, Waldport, and Heceta Head quadrangles of west-central Oregon. Snavely and others (1969) apply the informal term "siltstone of Alsea" to these beds.

Lithology: The Toledo Formation is subdivided into the Moody Shale and an overlying sandstone unit. The Moody Shale consists of approximately 1,500 feet of dark-gray clay shale and mudstone with minor interbeds of silty or glauconitic sandstone. It is interbedded to the south with approximately 2,000 feet of late Eocene and possibly early Oligocene basalts which make up the headlands at Heceta Head and Sea Lion Caves. The basalts probably represent a localized center of volcanism related to the contemporaneous Nestucca and Cowlitz volcanism to the north.

The upper sandstone member consists of approximately 1,000 feet of fine-grained, greenish gray, tuffaceous sandstone with subordinate amounts of siltstone and shale. Limy concretions occur locally high in the section.

The Toledo Formation is in need of further study and possible revision. Eventually the Moody Shale may be elevated to formational rank under the term Alsea Formation (Corcoran, written communication, 1970).

Contacts: The precise nature of the contact between the Moody Shale and the underlying Tyee Formation is not designated in the literature. The upper sandy member of the Toledo Formation is conformably overlain by the Yaquina Formation.

Age: The Moody Shale member of the Toledo contains fossils with Nestucca and Yamhill affinities and is late Eocene in age. The upper part of the overlying sandstone member has yielded fossils with Keasey, Pittsburg Bluff, and Lincoln affinities and is middle Oligocene in age. The apparent paraconformity between the two units is a result of widely spaced sampling. In the field the Moody Shale and overlying sandstone are concordant and very difficult to differentiate near the mutual contact.

References: Baldwin, 1964; Baldwin, 1956; Snavely and others, 1969; Stewart, 1956; Vokes and others, 1949; Youngquist, 1961

TROUTDALE FORMATION

Original description: Hodge, E. T., 1933, Age of Columbia River and lower canyon (abs.): Geol. Soc. America Bull., vol. 44, p. 156-157.

Distribution: The Troutdale Formation crops out intermittently along the lower Columbia River from the Columbia River Gorge westward to the coast. It is also mapped in the lower Clackamas and Sandy Rivers and is reported in thicknesses of as much as 1,500 feet in the subsurface of the Tualatin Valley. Farther to the south, beds mapped as Troutdale by Peck and others (1964) in the Molalla quadrangle are probably better considered as Troutdale equivalents only because they lack the distinctive quartzite pebbles characteristic of the Troutdale Formation (restricted).

Lithology: The Troutdale Formation consists primarily of lenticular vitric sandstone and quartz-boulder conglomerate with minor amounts of micaceous quartzose sandstone and leaf-bearing, fine-grained sandstone and siltstone. The vitric sandstone is coarse to very coarse- grained and consists primarily of basaltic glass.

Structure: The Troutdale Formation is relatively undeformed and flat-lying although local dips of 20° or more are common in the Columbia River Gorge.

Contacts: The Troutdale Formation rests unconformably on the Columbia River Group, the Sardine Formation, and the Sandy River Mudstone. It is overlain locally by the Cascades Formation.

Age: The Troutdale Formation is assigned an early Pliocene age on the basis of plant fossils recovered within the Troutdale (restricted) of Trimble (1963) in the Clackamas River area. Beds containing early Pliocene plant fossils upon which the unit was originally dated (Hodge, 1933) have subsequently been reassigned to the underlying Sandy River Mudstone (Trimble, 1963).

References: Baldwin, 1964; Lowry and Baldwin, 1952; Peck, 1960; Peck and others, 1964; Schlicker, 1964; Schlicker and others, 1967; Trimble, 1963; Wilkinson and others, 1946; Youngquist, 1961

TUNNEL POINT SANDSTONE

Original description: Dall, W. H., 1898, A table of the North American Tertiary horizons, correlated with one another and with those of western Europe, with annotations: U. S. Geol. Survey 18th Ann. Rpt., pt. 2, p. 323-348.

Distribution: Exposures of Tunnel Point Sandstone are limited to Tunnel Point situated about half a mile southwest of Coos Head adjacent to Coos Bay in southwestern Oregon. Original descriptions place the exposures immediately northeast of Bastendorff Beach.

Lithology: The unit consists of approximately 800 feet of fine-grained, massive, buff sandstone. The unit is commonly iron-stained and concretionary near the base and contains tuffaceous material, glauconite, and interbeds of brittle shale near the top.

Structure: The Tunnel Point Sandstone occupies part of the west limb of the South Slough syncline and is moderately to steeply dipping.

Contacts: The Tunnel Point Sandstone rests conformably upon the Bastendorff Formation and is unconformably overlain by the Empire Formation.

Age: The fauna of the Tunnel Point Sandstone bears affinities to the faunas of the Pittsburg Bluff and Eugene Formations. The unit is middle Oligocene and correlates with the upper Toledo Formation.

References: Baldwin, 1966
Baldwin, 1964
Ehlen, 1967
Youngquist, 1967

TYEE FORMATION

Original description: Diller, J. S., 1898, Description of the Roseburg quadrangle: U. S. Geol. Survey Geol. Atlas, Folio 49.

Distribution: The Tyee Formation forms the bulk of the exposures of the central Coast Range of Oregon from the latitude of Salem southward to the latitude of Myrtle Point. South of Myrtle Point isolated outcrops occupying the axis of a major syncline cap various ridge tops. The unit includes the Burpee Formation of older publications and the Lorane Shale member of the Spencer Formation of Vokes and others (1951).

Lithology: The Tyee Formation is composed of rhythmically bedded, cliff-forming, buff to greenish-gray sandstone and dark mudstone. The sandstone is composed of medium- to coarse-grained, micaceous, arkosic and lithic wacke. The over-all thickness of the unit is approximately 7,000 feet.

Numerous lateral variations within the Tyee Formation are evident. In the south cross-bedded sandstone, conglomerates of andesite, quartzite, chert, and basalt and local coal beds comprise significant parts of the section. In the north the Tyee is composed entirely of alternating sandstone and siltstone in which graded bedding is developed.

Compositionally the sandstones in the south are most appropriately referred to as litho-feldspathic sandstones. In the north the relative abundance of the feldspar is apparently greater and the sandstone is most frequently referred to as arkosic in composition.

According to Snavely and Vokes (1949) the Tyee Formation (Burpee) is locally tuffaceous and is interbedded with volcanic flows and breccias in the Hebo quadrangle. The flows are probably local in extent and are post-Siletz River and pre-Nestucca in age.

High in the section several thousand feet of siltstone dominates locally. To these strata the terms Elkton Siltstone member, Sacchi Beach Siltstone member, and Lorane Siltstone member have been applied in the vicinities of Elkton, Sacchi Beach, and Eugene respectively.

Structure: The Tyee Formation exhibits northerly strikes and dips only gently in contrast to steep dips of the underlying Umpqua Formation.

Contacts: The Tyee Formation is unconformable over all three members of the Umpqua Formation in the southern Coast Range. In the Coos Bay area it is unconformably overlain by the Coaledo Formation and beds referred to the Coaledo (?) by Baldwin (1965). The Spencer and Colestin Formations unconformably overlie the Tyee in the central Coast Ranges and the Nestucca Formation unconformably overlies the unit in the northern Coast Ranges. The Tyee Formation grades laterally to the north into the lower Yamhill Formation.

Age: On the basis of stratigraphic position and megafaunal content the Tyee Formation is assigned a middle Eocene (probably upper middle Eocene) age and is correlated with the Domengine State of California. Microfossils taken from the Sacchi Beach member correspond in age with the upper middle Eocene B-IA zone of Laiming and correlate with part of the Yamhill Formation to the north.

References:
Allison, 1953
Baldwin, 1966, 1964, 1956, 1955, 1947
Baldwin and Roberts, 1952
Bird, 1967
Born, 1963
Ehlen, 1967
Elphic, 1969
Hess, 1967
Hoover, 1959
Krans, 1970
Lovell, 1969
Magoon, 1966
Nelson, 1966
Patterson, 1961
Payton, 1961
Peck, 1960
Snavely and Vokes, 1949
Trigger, 1966
Vokes and others, 1954
Vokes and others, 1951
Vokes and others, 1949
Westhusing, 1959

UMPQUA FORMATION

Original description: Diller, J. S., 1898, Description of the Roseburg Quadrangle: U. S. Geol. Survey Geol. Atlas, Folio 49.

Definition: The Umpqua Formation is a thick body of possibly lower middle Eocene and older Tertiary sandstone, mudstone, and basalt exposed in the southern Coast Ranges of Oregon. On the basis of excellent exposures such as those in the Camas Valley and Tyee quadrangles the unit has been subdivided in recent years to give three unconformity-bounded sequences. In a forthcoming article Baldwin (oral communication, 1970) intends to elevate the three units to formational status. In this publication as in other recent publications, however, the units are referred to informally as lower Umpqua Formation, middle Umpqua Formation, and upper Umpqua Formation and are discussed under those headings below.

LOWER UMPQUA FORMATION

Distribution: The lower Umpqua Formation is exposed in the southern Coast Ranges and crops out as a discontinuous series of exposures which extends southward from the Coos Bay area to the vicinity of Coquille and Powers. From there it extends northeastward through the Dutchman Butte and Roseburg quadrangles to terminate in the Glide and Dixonville quadrangles.

Lithology: The lower Umpqua Formation consists of approximately 7,000 feet of submarine basalt, sandstone, and siltstone. The basalt occupies the base of the section and is dark gray and aphanitic to porphyritic, as is the Siletz River Volcanic Series of similar age to the north.

Overlying and interbedded with the basalt is several thousand feet of rhythmically-bedded olive-green to gray sandstone and shale. The sandstone is well-indurated, fine- to medium-grained, lithic to feldspathic wacke and locally contains cobble conglomerates with clasts of basalt, quartzite, sandstone, and chert.

Baldwin (1965) notes the lithologic and structural similarity of the Umpqua Formation to late Cretaceous beds exposed in the Bandon-Cape Blanco area along the coast to the south and suggests that the Cretaceous beds be included in the lower Umpqua Formation. Such a revision would greatly increase the thickness of the lower Umpqua Formation and would shift the basaltic flows to the middle of the unit rather than the base which they now occupy.

Structure: The lower Umpqua Formation is moderately to greatly deformed and dips at angles approaching vertical in several places (for example beneath Bushnell Rock). In the Sutherlin and Glide areas the unit is thrust over the upper Umpqua Formation along the Bonanza fault and the middle Umpqua member is absent.

Contacts: The contact of the lower Umpqua Formation with older formations is rarely observed and is probably faulted. The contact with the overlying middle Umpqua Formation is marked by a pronounced angular unconformity which is well exposed beneath Bushnell Rock. The unconformity probably becomes less intense to the north in deeper parts of the paleobasin.

Age: The bulk of the lower Umpqua is early Eocene in age and correlates with the Siletz River Volcanic Series to the north. Early Eocene faunas with some Paleocene affinities have been recovered from the outcrop, and well drillings have yielded late Cretaceous and Paleocene faunas from rocks thought to belong to the Umpqua Formation. Inclusion of Late Cretaceous beds exposed at Bandon into the unit would, of course, affect the total range of the unit.

References: Baldwin, 1966, 1965, 1964; Champ, 1969; Elphic, 1969; Hess, 1967; Magoon, 1966; Nelson, 1966; Trigger, 1966; Youngquist, 1961

MIDDLE UMPQUA FORMATION

Distribution: The middle Umpqua Formation crops out in the southern Coast Range as a discontinuous series of exposures which extends from the Coquille quadrangle on the west southward through the Powers and Bone Mountain quadrangles. From there it extends eastward and northeastward through the Dutchman Butte, Canyonville, and Roseburg quadrangles. Isolated exposures also occur in the Langlois, Agness, Sitkum, and Sutherlin quadrangles. The unit includes the lower Umpqua Formation of Krans (1970) in the Bone Mountain quadrangle (Baldwin, oral communication, 1970).

Lithology: The middle Umpqua Formation consists of a maximum of 7,000 feet of basal conglomerate and overlying rhythmically bedded sandstone and siltstone. The basal conglomerate consists of pebbles of quartzite, chert, basalt, metamorphic rocks, and granite set in a sandstone matrix and varies in thickness from 0 to 700 feet.

Overlying the conglomerate, medium- to coarse-grained lithic and feldspathic wackes grade upsection into rhythmically bedded sandstone and mudstone, and high in the section siltstone is the dominant rock type. Cut-and-fill structures and coal-bearing beds are present locally low in the section.

Structure: The middle Umpqua Formation is moderately to gently deformed and exhibits dips of generally less than 30°, except near major faults such as the Sixes River fault in the Langlois quadrangle.

Contacts: The middle Umpqua Formation rests unconformably upon the lower Umpqua Formation and older rocks such as the Days Creek Formation. It is unconformably overlain by the upper Umpqua Formation and the Tyee Formation. The intensity of the unconformities between the various members of the Umpqua Formation probably decreases to the north.

Age: A middle Eocene age is most commonly assigned to the unit on the basis of microfossils and megafossils. The fact that several microfossil samples are suggestive of an early Eocene age emphasizes the fact that regional stratigraphic relationships provide us with a more refined dating tool for this unit than do the relatively imprecise foraminifers that are available. The middle Umpqua clearly cannot be older than the lower Umpqua, which it overlies with marked angular unconformity.

References:

Baldwin, 1964	Lent, 1969
Baldwin, 1965	Magoon, 1966
Baldwin, 1966	Nelson, 1966
Elphic, 1969	Trigger, 1966
Hess, 1967	Westhusing, 1959
Krans, 1970	Youngquist, 1961

UPPER UMPQUA FORMATION

Distribution: The upper Umpqua Formation is situated in the southern part of the Oregon Coast Ranges and occurs in two sets of exposures. The first is centered in the Bone Mountain, Powers, Agness, Martial, and southern Sitkum quadrangles. The second set of exposures is located to the northeast in the Sutherlin, Glide, and Dixonville quadrangles.

Lithology: The upper Umpqua Formation consists of a maximum of 3,900 feet of olive-green, well-indurated, micaceous, fine- to coarse-grained lithic and feldspathic wacke and overlying gray siltstone with minor interbedded sandstone. Low in the section the sandstone contains quartzite and basalt pebbles and displays cross-bedding, ripple marks, and mud cracks locally. Although the sandstone is micaceous, it is not as micaceous as the overlying Tyee Formation.

Structure: The upper Umpqua Formation exhibits northerly strikes and gentle dips.

Contacts: The upper Umpqua Formation rests unconformably upon the middle and lower members of the Umpqua Formation, the Otter Point Formation, the Humbug Mountain Formation, and the Rocky Point Formation. It is overlain by the Tyee Formation with slight angular unconformity. In the Glide-Dixonville area lower Umpqua is thrust over upper Umpqua along the northwesterly-trending Bonanza fault.

Age: A middle Eocene age is assigned to the upper Umpqua Formation on the basis of microfossils and stratigraphic position.

References:

Baldwin, 1964	Krans, 1970
Baldwin, 1965	Lent, 1969
Champ, 1969	Trigger, 1966
Elphic, 1969	Westhusing, 1959

WASSON FORMATION

Original description: Wells, F. G., 1956, Geology of the Medford quadrangle, Oregon-California: U. S. Geol. Survey Map GQ-89.

Distribution: The term Wasson Formation refers to the upper part of the Little Butte Volcanic Series in the Medford area.

Lithology: The Wasson Formation is a thick, distinctive, and persistent series of rhyolitic to dacitic pyroclastics, flow agglomerates, flow breccias, and tuffs. The most distinctive bed is a thick, white, chalky tuff with occasional leaf prints and platy fracture. The top of the unit is marked by a flow of red agglomeratic andesite.

Contacts: The Wasson Formation rests conformably upon the Roxy Formation and is overlain by the Heppsie Andesite of Miocene age with probable unconformity.

Age: An Oligocene age is assigned to the Wasson Formation.

References: Wells, 1956

WHITSETT LIMESTONE LENTILS

Original description: Diller, J. S., 1898, Description of the Roseburg quadrangle: U. S. Geol. Survey Geol. Atlas, Folio 49.

Distribution: Whitsett Limestone Lentils occur in the Otter Point and Riddle Formations of authors (Dothan Formation of Wells and Peck, 1961) in the Klamath Mountains of southwestern Oregon. The term does not refer to a single stratigraphic entity, but rather to a particular rock type having a wide range of stratigraphic occurrences.

Lithology, age and contacts: Exposures of gray, bioclastic limestone consisting largely of *Inoceramus* and echinoid fragments crop out along Deer Creek in the Roseburg-Dixonville area and are assigned to the Whitsett Limestone Lentils. The limestone occurs in beds mapped as Riddle by Imlay and others (1959) and as Otter Point Formation by Champ (1969).

A Portlandian age is suggested for the limestone by the occurrence of *Durangites* and *Buchia piochii* in the adjacent strata. However, the additional occurrence of the Valanginian pelecypod, *Buchia crassicollis*, in the associated strata adds confusion to the age of the unit. Final clarification must await possible redefinition of the *Buchia* species, systematic sampling of the inland late Mesozoic section, and more accurate mapping.

Microfossils in thinly bedded, pink to white, fine-grained limestone in the Roberts Creek area reveal a Cenomanian-Turonian age for the Whitsett Limestone Lentils in that area. Johnson (1965) indicates that the lentils are interbedded with late Cretaceous strata, whereas Champ (1969) suggests that similar beds a short distance to the east are either faulted into the Otter Point Formation or are unconformable over the Otter Point (Riddle Formation of Imlay and others, 1959).

References: Champ, 1969
Imlay and others, 1959
Johnson, 1965

WILLAMETTE SILTS

Original description: Allison, I. S., 1953, Geology of the Albany quadrangle: Oregon Dept. Geol. Min. Indus. Bull. 37.

Distribution: The Willamette Silts mantle older units over wide areas in the Willamette Valley below an elevation of approximately 400 feet. The specific distribution and nature of the unit are, however, poorly understood. Allison (1953) maps extensive lowland deposits in the Albany quadrangle as Willamette Silts, and Glenn (1965) extends the unit northward to include similar and contiguous deposits. Baldwin (oral communication, 1970) believes the unit should be restricted to include only the thin, glacially-derived upper deposits and not the thicker underlying lacustrine deposits with which they are sometimes confused (see late Pleistocene lakebeds).

Lithology: The Willamette Silts consist of light brown, mottled, homogeneous silt having a composition indicative of a source up the Columbia River. The remarkably uniform texture is interrupted locally with cross-beds, basaltic gravels and indistinct thin- to medium- parallel bedding. The Willamette Silts are associated with scattered glacial erratics and probably were derived from the late Wisconsin Missoula Flood (see Portland Sand for further discussion).

Structure: The Willamette Silts are flat-lying in the lower parts of the Willamette Valley and conform to local topography at elevations of about 400 feet. At the higher elevations the unit is sometimes not distinguished from the underlying older formations.

Contacts: The Willamette Silts are unconformable over the older units.

Age: Baldwin (1964) assigns a late Wisconsin age to the Willamette Silts and Glenn (1965) demonstrates that the unit is younger than 34,000 years old on the basis of radiometric evidence. The Willamette Silts may grade laterally to the north into the gravelly veneer which overlies the Portland Sand in the Portland area.

References: Allison, 1953; Baldwin, 1957; Baldwin, 1964; Baldwin and others, 1955; Glenn, 1965; Trimble, 1963

YAMHILL FORMATION

Original description: Baldwin, E. M., Brown, R. D., Jr., Gair, J. E., and Pease, M. H., Jr., 1955, Geology of the Sheridan and McMinnville quadrangles, Oregon: U. S. Geol. Survey Map OM 155.

Distribution: The Yamhill Formation is exposed along the eastern edge of the northern Coast Ranges in the Sheridan, Yamhill, and Dallas quadrangles. The unit also includes the "middle Eocene volcanic and sedimentary rocks" of Baldwin and Roberts (1952) in the Grand Ronde quadrangle (their Spirit Mountain quadrangle) to the west (Baldwin and others, 1955).

Lithology: The Yamhill Formation consists of up to 5,000 feet of faintly bedded, medium to dark gray, micaceous siltstone and sandstone. The lowermost part of the section in the northern part of the Dallas quadrangle is composed of 500 feet of dark-gray shale with lime-cemented sandstone interbeds overlain by an equal thickness of gray-green basaltic sandstone presumably derived from nearby islands of Siletz River volcanics.

The base of the section is occupied locally by shallow-water limestone beds (Rickreall Limestone member, Baldwin, 1964) where the sequence laps against the Siletz River Volcanic Series. The limestone consists of abraded shell fragments, foraminifers, calcareous algae, and tuffaceous material derived from the underlying volcanic rocks. The limestone is quarried for agricultural purposes.

Contacts: The Yamhill Formation unconformably overlies the Siletz River Volcanic Series in the Dallas quadrangle and is overlain unconformably by the Nestucca Formation in the Sheridan-McMinnville region. The lower Yamhill Formation passes laterally to the south into the Tyee Formation.

Age: The Yamhill Formation is upper middle to lower late Eocene in age. It correlates in part with the upper Domengine and lower Tejon States of California, the B-IA zone of Laiming, and the Elkton, Sacchi Beach, and Lorane Siltstone members of the Tyee Formation.

References: Baldwin, 1947 (1964 revision); Baldwin, 1964; Baldwin and others, 1952; Schlicker, 1962; Stewart, 1957; Youngquist, 1962

YAQUINA FORMATION

Original description: Harrison and Eaton (firm), 1920, Report on investigation of oil and gas possibilities of western Oregon: Oreg. Bur. Mines and Geol., Mineral Res. of Oreg., vol. 3, no. 1, p. 3-37.

Distribution: The Yaquina Formation is of rather limited distribution, being restricted to the coast of northwestern Oregon between Newport and Yachats. The type locality is at Yaquina Bay.

Lithology: The Yaquina Formation consists of approximately 2,700 feet of deltaic, shallow-water, light-gray to brown, poorly consolidated, fine- to medium-grained tuffaceous sandstone and mudstone. Locally fossiliferous sandstones rich in calcareous concretions low in the section pass upward into gritty, cross-bedded brackish and near-shore marine sandstone and siltstone.

The unit also exhibits marked lateral variations with coal-bearing beds, conglomerates, and coarse-grained sandstone developed locally. In the vicinity of Heceta Head thick-bedded basaltic conglomerates and grits overlying the volcanic sediments of the Toledo Formation are tentatively assigned to the Yaquina Formation by Vokes and others (1949).

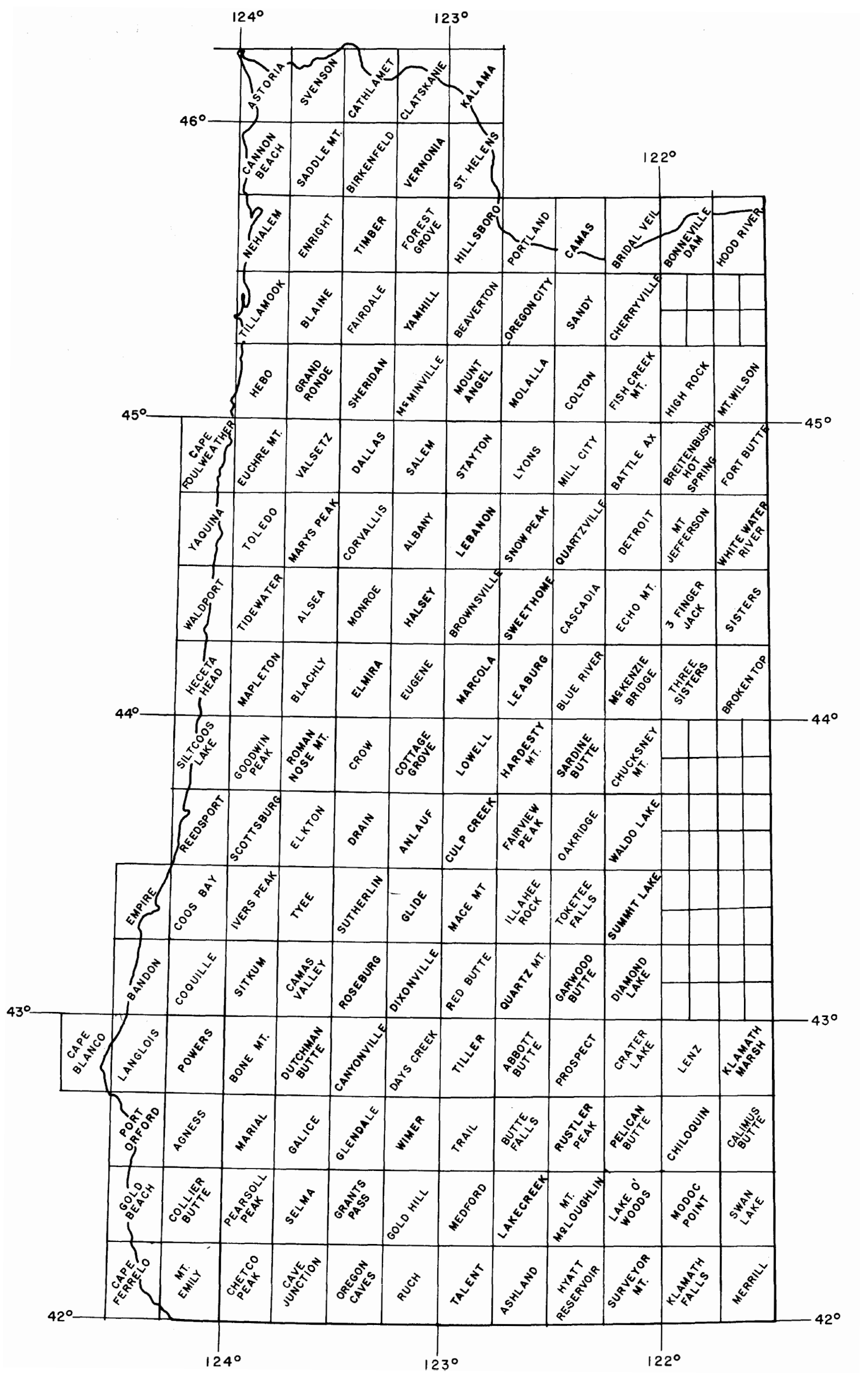
Structure: The Yaquina Formation is gently dipping to moderately dipping in the north.

Contacts: Most recent evidence indicates that the Yaquina Formation is conformable on the Toledo Formation and interfingers with the lower Nye Formation.

Age: The Yaquina Formation is late Oligocene in age.

References: Baldwin, 1964; Snavely and others, 1969; Snavely and Vokes, 1949; Stewart, 1956; Vokes and others, 1949; Youngquist, 1961

INDEX OF 15' TOPOGRARHIC MAPS OF WESTERN OREGON



QUADRANGLES

The following alphabetized list of quadrangles is presented as an aid to the geologist in tracing down the recent literature for various areas throughout western Oregon. After each quadrangle name are one or more citations referring to publications, theses, and reports which are listed in the bibliography and which contain a geologic map of part or all of the particular quadrangle. The accompanying map will aid the reader in determining the names of the quadrangles of interest to him. The reader is referred to Youngquist (1961) for an excellent bibliography of much of the older literature which is not cited here.

Agness

Baldwin, 1965
Dott (in press)

Albany

Allison, 1953
Allison and Felts, 1956
Vokes and others, 1954

Alsea

Baldwin, 1955

Anlauf

Hoover, 1963

Ashland

Wells, 1956

Astoria

Warren and others, 1945

Bandon

Baldwin, 1966

Battle Ax

Peck and others, 1964

Beaverton

Glenn, 1965
Hart and Newcomb, 1965
Schlicker and others, 1967
Warren and others, 1945

Birkenfeld

Deacon, 1953
Warren and others, 1945

Blachly

Baldwin, 1956

Blaine

Warren and others, 1945

Blue River

Peck and others, 1964
Taylor, 1968
Williams, 1957

Bone Mountain

Baldwin, 1965
Imlay and others, 1959
Krans, 1970

Breitenbush Hotsprings

Peck and others, 1969

Broken Top

Williams, 1957

Brownsville

Anderson, 1963
Hauck, 1962
Peck and others, 1964

Calimus Butte

Peterson and McIntyre, 1970

Camas

Trimble, 1963

Camas Valley

Harms, 1957
Moore, 1957
Peterson, 1957

Cannon Beach

Warren and others, 1945

Canyonville

Imlay and others, 1959

Cape Blanco

Baldwin, 1964
Dott, 1962
Hunter, 1970

Cape Ferrelo

Dott (in press)
Howard and Dott, 1961
Hunter and others, 1970

Cape Foulweather

Snavely and Baldwin, 1948
Snavely and others, 1969
Snavely and Vokes, 1949

Cascadia

Peck and others, 1964
Taylor, 1968
Williams, 1957

Cathlamet

Warren and others, 1945

Cave Junction

Imlay and others, 1959
Wells and others, 1949

Chemult 30' quadrangle

Williams, 1957

Cherryville

Peck and others, 1964

Chetco Peak

Wells and others, 1949

Chiloquin

Peterson and McIntyre, 1970

Chucksney Mountain

Peck and others, 1964
Williams, 1957

Clatskamie

Warren and others, 1945

Collier Butte

Dott (in press)

Colton

Peck and others, 1964

Coos Bay

Baldwin, 1966

Coquille

Baldwin, 1966
Baldwin, 1969
Fairchild, 1966
Magoon, 1966
Nelson, 1966

Corvallis

Vokes and others, 1954

Cottage Grove

Vokes and others, 1951

Crater Lake

Williams, 1957

Crow

Vokes and others, 1951

Culp Creek

Peck and others, 1964
Schlicker and Dole, 1957

Dallas

Baldwin, 1947 (revised 1964)

Days Creek

Imlay and others, 1959

Detroit

Peck and others, 1964
Pungrassami, 1969
Williams, 1957

Diamond Lake

Williams, 1957

Dixonville

Champ, 1969
Hixson, 1965

Drain

Hoover, 1963

Dutchman Butte

Baldwin, 1965
Imlay and others, 1959

Echo Mountain

Peck and others, 1964
Taylor, 1968
Williams, 1957

Elkton

Baldwin, 1961

Elmira

Vokes and others, 1951

Empire

Armentrout, 1967
Baldwin, 1966
Ehlen, 1967

Enright

Warren and others, 1945

Euchre Mountain

MacLeod, 1969
Snavely and Baldwin, 1948
Snavely and others, 1969
Snavely and Vokes, 1949

Eugene

Vokes and others, 1951
Lewis, 1950

Fairdale

Warren and others, 1945

Fairview Peak

Schlicker and Dole, 1957
Peck and others, 1964

Fish Creek Mountain

Peck and others, 1964

Forest Grove

Glenn, 1965
Hart and Newcomb, 1965
Schlicker and Deacon, 1967
Warren and others, 1945

Galice

Helming, 1966
Wells and Walker, 1953

Garwood Butte

Peck and others, 1964
Williams, 1957

Glide

Elphic, 1969
Patterson, 1961

Gold Beach

Dott (in press)
Howard and Dott, 1961
Hunter and others, 1970

Gold Hill

Wells, 1940

Goodwin Peak

Baldwin, 1956

Grande Ronde

Baldwin and Roberts, 1952
MacLeod, 1969

Grants Pass

Wells, 1940

Halsey

Vokes and others, 1954

Hardesty Mountain

Peck and others, 1964
Schlicker and Dole, 1957

Hebo

MacLeod, 1969
Snavely and Vokes, 1949

Heceta Head

Baldwin, 1956
Bray, 1958
Snavely and others, 1969

High Rock

Peck and others, 1964

Hillsboro

Glenn, 1965
Hart and Newcomb, 1965
Schlicker and Deacon, 1967
Warren and others, 1945

Illahee Rock

Peck and others, 1964

Kalama

Warren and others, 1945

Klamath Falls

Peterson and McIntyre, 1970

Klamath Marsh

Peterson and McIntyre, 1970

Lake Creek

Wells, 1956

Langlois

Baldwin, 1965
Lent, 1969

Leaburg

Peck and others, 1964
Schlicker and Dole, 1957

Lebanon

Allison and Felts, 1956
Felts, 1936
Peck and others, 1964

Lenz

Peterson and McIntyre, 1970
Williams, 1957

Lowell

Peck and others, 1964
Schlicker and Dole, 1957

Lyons

Barlow, 1955
Halstead, 1955
Peck and others, 1964
Thayer, 1939

Mace Mountain

Peck and others, 1964

Maiden Peak

Williams, 1957

Mapleton

Baldwin, 1956
Bray, 1958
Snavely and others, 1969

Marcola

Bristow, 1959
Maddox, 1965
Peck and others, 1964
Schlicker and Dole, 1957

Marial

Baldwin, 1965

Mary's Peak

Baldwin, 1955

McKenzie Bridge

Peck and others, 1964
Taylor, 1968
Williams, 1957

McMinnville

Baldwin and others, 1955
Brown, 1951
Glenn, 1965

Medford

Wells, 1956

Merrill

Peterson and McIntyre, 1970

Mill City

Peck and others, 1964

Modoc Point

Peterson and McIntyre, 1970

Molalla

Glenn, 1962,1965
Harper, 1946
Lowry and Baldwin, 1952
Peck and others, 1964

Monroe

Vokes and others, 1954

Mount Angel

Glenn, 1962, 1965
Wells and Walker, 1953

Mount Emily

Dott (in press)

Mount Hood 1

Wise, 1968

Mount Hood 2

Wise, 1968

Mount Jefferson

Walker and others, 1966
Williams, 1957

Nehalem

Warren and others, 1945

Oak Ridge

Peck and others, 1964
Williams, 1957

Oregon Caves

Wells, 1940

Oregon City

Glenn, 1964
Hart and Newcomb, 1965
Trimble, 1963

Pearsoll Peak

Wells and others, 1949

Portland

Dehlinger and others, 1963
Glenn, 1964
Hart and Newcomb, 1965
Schlicker and others, 1964
Trimble, 1963

Port Orford

Dott (in press)
Hunter and others, 1970
Imlay and others, 1959
Koch and others, 1961

Powers

Baldwin, 1965
Baldwin and Hess (in press)
Born, 1963
Hess, 1967

Prospect

Williams, 1957

Quartz Mountain

Kays, 1970
Peck and others, 1964

Quartzville

Peck and others, 1964
Pungrassami, 1969
Williams, 1957

Red Butte

Peck and others, 1964

Reedsport

Baldwin, 1961

Roman Nose Mountain

Baldwin, 1956

Roseburg

Hicks, 1964
Imlay and others, 1959
Johnson, 1965

Ruch

Engelhardt, 1966
Heinrich, 1966
Wells, 1940

Saddle Mountain

Warren and others, 1945

Salem

Glenn, 1964
Thayer, 1939

Sandy

Peck and others, 1964
Trimble, 1963

Sardine Butte

Peck and others, 1964
Williams, 1957

Scottsburg

Baldwin, 1961

Selma

Wells and others, 1949

Sheridan

Baldwin and others, 1955

Siltcoos Lake

Baldwin, 1956

Sisters

Taylor, 1968
Williams, 1957

Sitkum

Fairchild, 1966
Magoon, 1966
Trigger, 1966

Snow Peak

Peck and others, 1964

Stayton

Glenn, 1962, 1965
Thayer, 1939

St. Helens

Warren and others, 1945
Wilkinson and others, 1946

Summit Lake

Peck and others, 1964
Williams, 1957

Sutherlin

Westhusing, 1959

Svensen

Dodds, 1963
Warren and others, 1945

Swan Lake

Peterson and McIntyre, 1970

Sweet Home

Peck and others, 1964

Talent

Wells, 1956

Three Finger Jack

Taylor, 1968
Williams, 1957

Three Sisters

Taylor, 1968
Williams, 1957

Tidewater

Snavely and others, 1969
Vokes and others, 1949

Tillamook

Mangum, 1967
Warren and others, 1945

Timber

Deacon, 1953
Warren and others, 1945

Toketee Falls

Peck and others, 1964
Williams, 1957

Toledo

Snavely and others, 1969
Vokes and others, 1949

Valsetz

Baldwin, 1947 (revised 1964)
MacLeod, 1969
Snavely and Baldwin, 1948

Vernonia

Deacon, 1953
Warren and others, 1945

Waldo Lake

Peck and others, 1964
Williams, 1957

Waldport

Baldwin, 1956
Snavely and others, 1969
Vokes and others, 1949

White Water River

Williams, 1957

Yamhill

Glenn, 1964
Hart and Newcomb, 1965
Schlicker, 1962
Schlicker and others, 1967
Warren and others, 1945

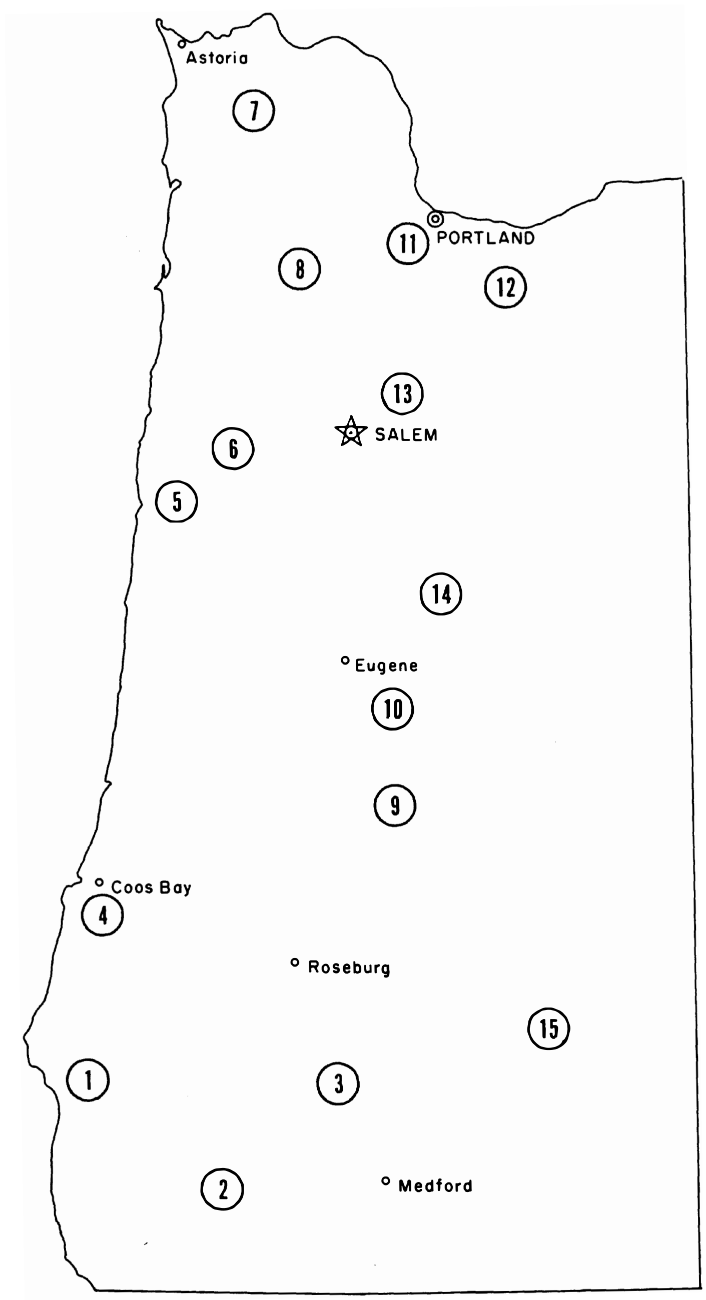
Yaquina

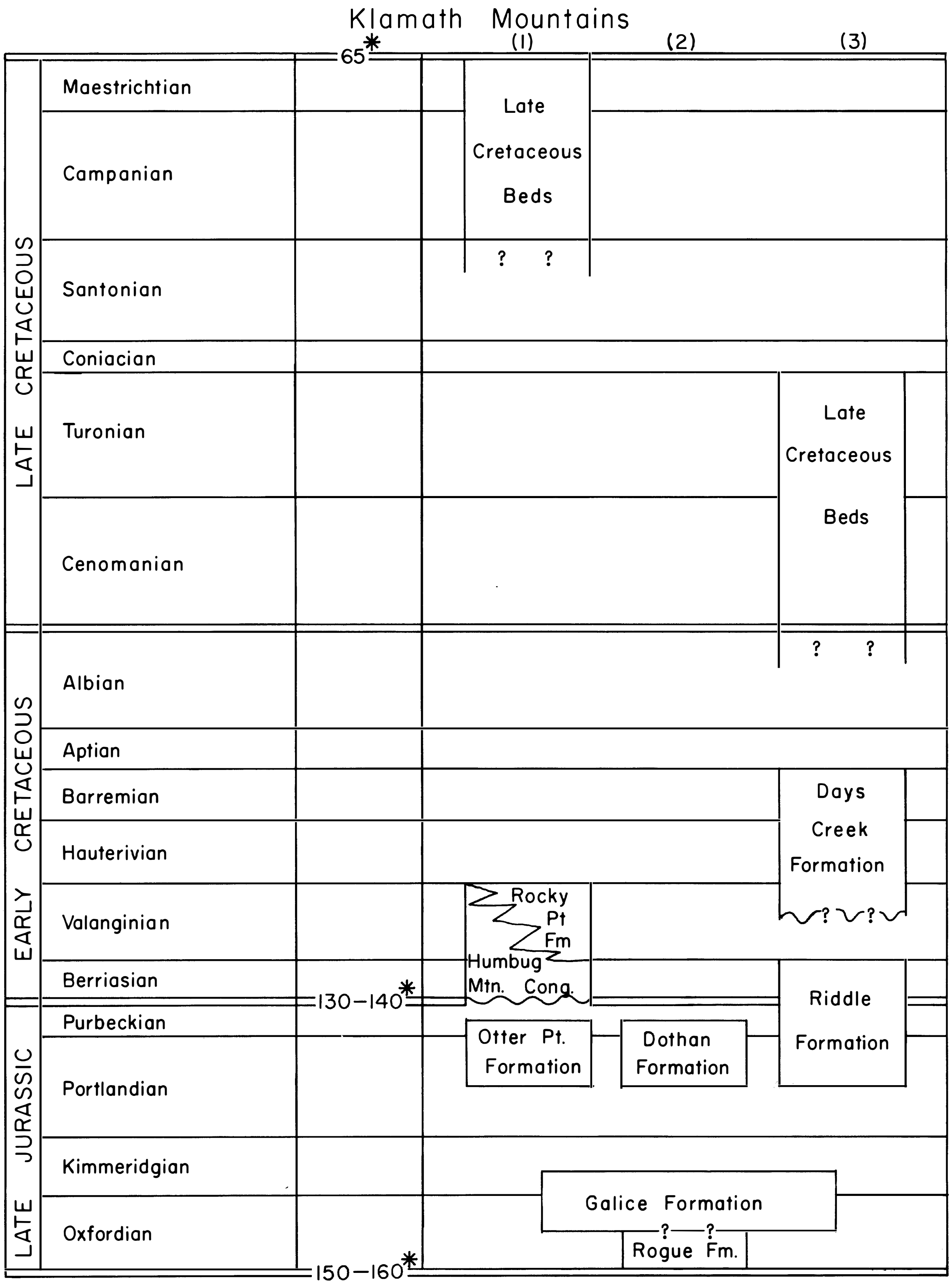
Heacock, 1952
Snavely and others, 1964, 1969
Vokes and others, 1949

CORRELATION CHARTS

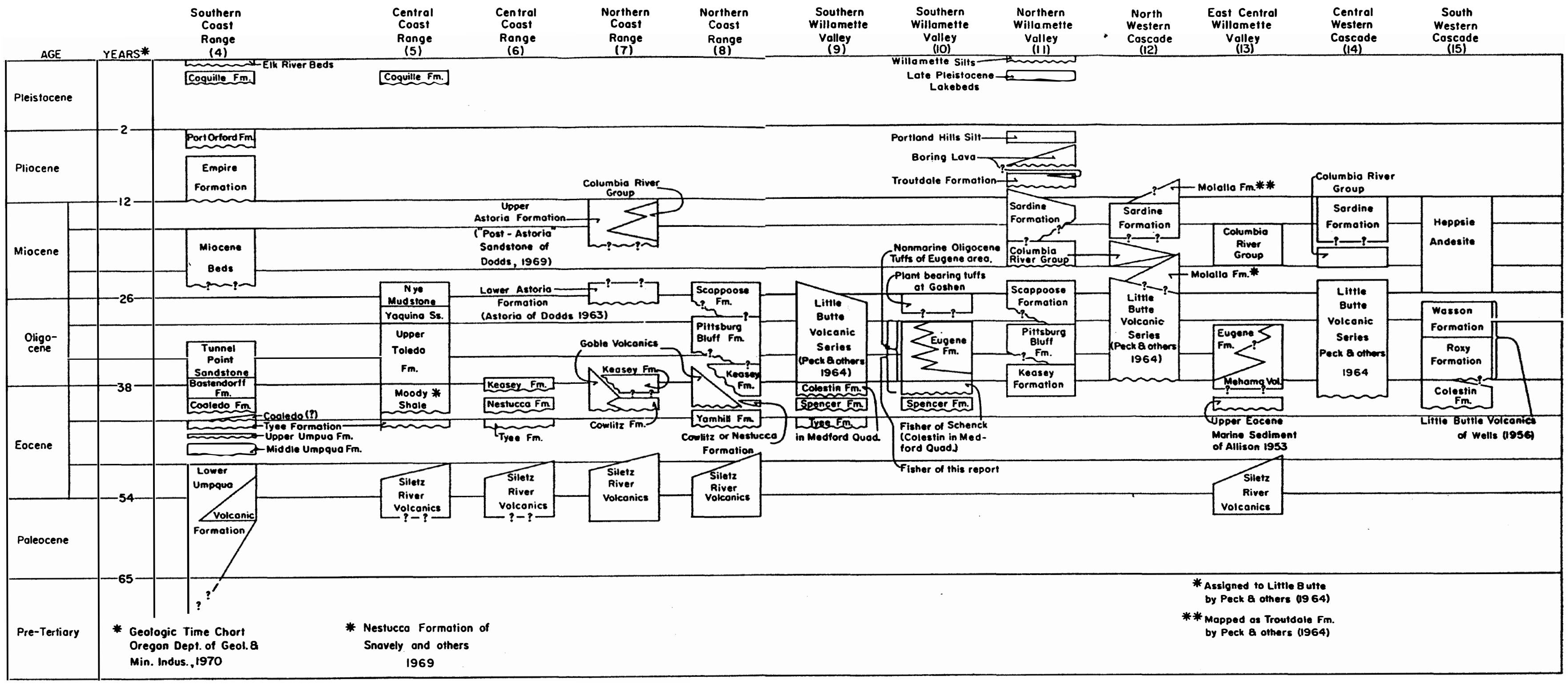
The correlation charts are outgrowths of the interpretations presented in the text. As such, they incorporate much of the recent information and many of the more recent interpretations regarding the formations of western Oregon. Because the correlation charts are not merely collections of previously published columnar sections, but rather the interpretations of one particular writer, however, they will probably not meet with the complete satisfaction of the readers. It is emphasized that the charts are not intended as the final word, but merely as an interpretation which is subject to change. It is hoped that the correlation charts as well as the text will prompt much discussion, criticism, and critical thought, and in so doing will contribute to our understanding of the geology of western Oregon.

Locality Map for Correlation Chart





* Absolute ages: Suppe, John (1969), Imlay, Ralph E. (1970), Lanphere, Marvin A., and others (1965).



AGE
YEARS*
Southern Coast Range (4)
Central Coast Range (5)
Central Coast Range (6)
Northern Coast Range (7)
Northern Coast Range (8)
Southern Willamette Valley (9)
Southern Willamette Valley (10)
Northern Willamette Valley (11)
North Western Cascade (12)
East Central Willamette Valley (13)
Central Western Cascade (14)
South Western Cascade (15)
Pleistocene
Pliocene
Miocene
Oligo-cene
Eocene
Paleocene
Pre-Tertiary
2
12
26
38
54
65
Elk River Beds
Coquille Fm.
Port Orford Fm.
Empire Formation
Miocene Beds
Tunnel Point Sandstone
Bastendorff Fm.
Coaledo Fm.
Coaledo (?)
Tyee Formation
Upper Umpqua Fm.
Middle Umpqua Fm.
Lower Umpqua Volcanic Formation
Nye Mudstone
Yaquina Ss.
Upper Toledo Fm.
Moody * Shale
Siletz River Volcanics
Upper Astoria Formation
("Post - Astoria" Sandstone of Dodds, 1969)
Lower Astoria Formation (Astoria of Dodds 1963)
Keasey Fm.
Nestucca Fm.
Tyee Fm.
Columbia River Group
Goble Volcanics
Cowlitz Fm.
Scappoose Fm.
Pittsburg Bluff Fm.
Yamhill Fm.
Cowlitz or Nestucca Formation
Little Butte Volcanic Series (Peck & others 1964)
Colestin Fm.
Spencer Fm.
Tyee Fm. in Medford Quad.
Willamette Silts
Late Pleistocene Lakebeds
Portland Hills Silt
Boring Lava
Troutdale Formation
Nonmarine Oligocene Tuffs of Eugene area.
Plant bearing tuffs at Goshen
Eugene Fm.
Fisher of Schenck (Colestin in Medford Quad.)
Fisher of this report
Sardine Formation
Columbia River Group
Scappoose Formation
Keasey Formation
Molalla Fm.**
Molalla Fm.*
Mehama Vol.
Upper Eocene Marine Sediment of Allison 1953
Heppsie Andesite
Wasson Formation
Roxy Formation
Little Butte Volcanics of Wells (1956)
* Geologic Time Chart Oregon Dept. of Geol. & Min. Indus., 1970
* Nestucca Formation of Snavely and others 1969
* Assigned to Little Butte by Peck & others (1964)
** Mapped as Troutdale Fm. by Peck & others (1964)

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