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PRELIMINARY DATA ON COMPOSITIONAL VARIATIONS OF TERTIARY VOLCANIC ROCKS IN THE CENTRAL PART OF THE OREGON COAST RANGE*

By

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Basalt flows and breccias of early to middle Eocene, late Eocene to early Oligocene, and middle Miocene ages are important stratigraphic units within the sequence of Tertiary marine sedimentary rocks of the Coast Ranges of Oregon and Washington. Studies currently being conducted on samples from these three volcanic units (plate 1) in the central part of the Oregon Coast Range indicate that each unit has distinctive petrographic and chemical characteristics.

The purpose of this report, which briefly summarizes preliminary petrochemical data on these volcanic rocks, is to call to the attention of petroleum geologists a stratigraphic tool that may prove useful in determining the ages of volcanic units encountered in exploration drilling, particularly on the continental shelf off western Oregon. The writers are aware, however, of limitations attendant to correlation of volcanic rocks solely by petrochemical characteristics, since altered or highly zeolitized basalts and fragmental rocks provide little useful data. Also, differentiation in shallow magma chambers has produced small amounts of basaltic rocks of early middle Eocene age that are similar in composition to those of late Eocene age. Caution, therefore, must be exercised in utilizing petrochemical data alone to assign an individual basalt sample to a particular volcanic sequence.

The petrographic and chemical data in this report were determined for more than 100 samples of volcanic rocks collected in the central part of the Oregon Coast Range. A much smaller number of samples from Tertiary extrusive rocks in other parts of western Oregon and Washington has been studied. The available data indicate that volcanic rocks of corresponding

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ages throughout the Coast Ranges of western Oregon and Washington have similar petrochemical characteristics. These Coast Range volcanic rocks have a close affinity to the oceanic province, since they contain a high (2 to 3 percent) TiO_2 content (Chayes, 1964; Chayes and Metais, 1964).

Lower to Middle Eocene Volcanic Rocks

The oldest rocks exposed in the Coast Ranges of Oregon and Washington consist of a eugeosynclinal accumulation of basaltic pillow lavas and breccias with interbedded marine tuffaceous sedimentary rocks. In the central part of the Oregon Coast Range (pl. 1) this predominantly volcanic sequence was named the Siletz River Volcanic Series by Snavely and Baldwin (1948).

Based upon present knowledge, the Siletz River Volcanic Series is divided into two major petrochemical units: a lower Eocene tholeiitic suite, which is principally submarine in origin and forms the bulk of the series, and a lower middle Eocene alkalic suite, which apparently forms a thin veneer on the older unit and is both submarine and subaerial in origin. The relation of the tholeiitic and alkalic basalts * in the Siletz River Volcanic Series is similar to that described in the Hawaiian Islands by Powers (1935), Tilley (1950), and Macdonald and Katsura (1964) and in the northeast Pacific Ocean by Engel and Engel (1963; 1964), because in those areas thick shields of tholeiitic basalts are capped with alkalic basalt.

Lower unit

The lower unit consists of more than 6,000 feet of alternating sheets of basaltic pillow lava and breccia with thin interbeds of marine tuffaceous siltstone. These lower Eocene tholeiitic basalts form lenticular masses that are probably thickest, as much as 20,000 feet (Snavely and Wagner, 1964), along the former axis of the Tertiary eugeosyncline. This unit is interpreted as representing a shield-forming stage of early Eocene volcanism which was

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* As used in this report, tholeiitic basalt is a rock saturated in silica and containing normative quartz and(or) hypersthene; alkalic basalt is an undersaturated rock with abundant alkalis, and with nepheline in the norm

> Editor's Note: The Siletz River Volcanic Series was named prior to the 1961 Code of Stratigraphic Nomenclature, which recommends that "Series" be confined to time-stratigraphic use.

characterized by voluminous submarine eruption of basaltic magma along north-trending fissures. Broad submarine ridges constructed on the sea floor probably did not rise above sea level because the rate of subsidence kept pace with the rate of volcanism.

The lower unit consists predominantly of submarine lava which is composed of closely packed ellipsoidal pillows that are 3 to 4 feet in diameter and radially columnar-jointed. The pillows contain a chilled selvage up to half an inch thick which originally was a basaltic glass, but has altered to waxy, greenish-black clay minerals. Massive to rudely columnar-jointed basalt sills and flows(?) up to 50 feet thick occur locally in the pillow sequence. In places glassy tuff-breccias that contain broken pillows or small isolated pillows are interbedded with or grade laterally into pillow flows. The predominant rock type is an amygdaloidal dark greenish-gray aphanitic to fine-grained basalt. Zeolites and calcite commonly form the cementing material in breccias, fill interstices between pillows, and occur as amygdules in the basalt.

Microscopically, the basalt is holocrystalline to hypocrystalline. Some rocks are porphyritic to seriate, but more commonly they are equigranular. The most common texture is intersertal to subophitic or intergranular. Unaltered rims of pillows and basalt fragments in the breccia are vitrophyric. In the outer rims of some pillows the basalt is variolitic and amygdaloidal.

Plagioclase and clinopyroxene are the most abundant minerals; they occur in nearly equal proportions (clinopyroxene most commonly predominates) and form as much as 80 to 90 percent of the more crystalline rocks. Plagioclase phenocrysts, as well as crystals in the groundmass, are progressively zoned and range from calcic labradorite (An_{70}) in their cores to andesine (An_{40}) at their rims. The average composition of the zoned crystals is labradorite (An_{60}). The plagioclase is commonly altered in part to clay minerals. The clinopyroxene is augite with 2V ranging from 47° to 55° and refractive index (Ny) ranging from 1.689 to 1.707. Some augite has a pinkish cast and probably is titaniferous. Scattered phenocrysts in a few thin sections are much more calcic and somewhat more magnesian than coexisting augite in the groundmass. Olivine (Fo_{80}) or its alteration products is found in about half of the samples and composes as much as 10 percent of some rocks; it is commonly altered to yellowish-brown to green pleochroic montmorillonitic clay minerals, hematite, and magnetite. Euhedral to subhedral crystals of magnetite and less common elongate crystals of ilmenite form as much as 10 percent of the basalt. The mesostasis of the hypocrystalline basalt commonly consists of dark-brown glass which characteristically is devitrified to a green or brown, fibrous-appearing, montmorillonitic clay mineral. This clay mineral, which is probably nontronite, forms as much as 90 percent of some samples and is present in all the thin sections studied. Some samples contain a variolitic residuum consisting of radiating sheaves of augite and plagioclase. Small amounts (1 to 5 percent) of chlorophaeite or its alteration products are commonly associated with glass in the matrix. Amygdules, cavity fillings, and veinlets in the basalt consist most commonly of zeolitic minerals and calcite, and less commonly of clay minerals.

Upper unit

In a few areas, such as in the vicinity of Ball Mountain (pl. 1), volcanic activity continued into earliest middle Eocene time, and a part of the basalt was extruded on land. This late stage of volcanism was sporadic and moderately explosive and is characterized by a differentiated alkalic suite consisting of flows of alkalic basalt, porphyritic augite basalt, feldsparphyric basalt, and picrite-basalt interbedded with tuffs and breccias. A few flows and numerous sills of tholeiitic basalt also occur in this part of the sequence. Massive beds of water-laid basaltic fragmental debris as much as 100 feet thick, and thick- to thin-bedded fine to lapilli tuff and tuffaceous siltstone are common in the upper unit. In places the beds of lapilli tuff contain abundant euhedral crystals of augite up to three-fourths of an inch in width.

The petrography and chemistry of the rocks in the differentiated upper part of the Siletz River Volcanic Series are rather complex, and more than a capsule discussion is beyond the scope of this report. The following discussion will serve only to call attention to the presence of rock types that doubtless are much less widely distributed in the geosyncline than the tholeiites in the lower unit of the Siletz River Volcanic Series.

Alkalic basalt occurs as pillow flows and breccia and as rudely jointed masses that form the lower parts of lava pods similar to those described from Unalaska Island, Alaska by Snyder and Fraser (1963). In the field the alkalic basalt cannot be distinguished from the tholeiitic basalt, except that individual pillows in the alkalic basalt are commonly peanut shaped or more elongate than pillows in the tholeiitic lavas. The alkalic basalt is dark greenish gray, is aphanitic to finely crystalline, and is generally amygdaloidal in the pillow flows.

Petrographically the alkalic basalt has a pilotaxitic texture with laths of plagioclase (andesine) and titaniferous augite (Ny 1.710, $2V = 48°$) set in an altered finely crystalline to cryptocrystalline matrix.

Porphyritic augite basalt is found in pillow flows and in the upper parts of some lava pods. In the lava pods the alkalic basalt at the base grades upward into porphyritic augite basalt within a single cooling unit. In hand sample, black equant phenocrysts of augite as much as 1 inch in width are conspicuous. In many samples the augite phenocrysts compose 15 to 25 percent of the rock, but make up as much as 40 percent of some specimens.

The large pyroxene phenocrysts in pillow flows are calcic augite to salite (Ny = 1.694 to 1.697, 2V = 58 to 60); in a lava lens, however, the phenocrysts are more iron rich (Ny = 1.707, 2V = 58), have a pinkish cast, and are titaniferous. The groundmass augite of both pillows and lenses is titaniferous.

Olivine phenocrysts probably composed 5 to 15 percent of many of these rocks, but have been completely replaced by clay minerals or calcite. Outlines of plagioclase laths in the groundmass are discernible, but the laths are now almost entirely altered to clay minerals. The remainder of the groundmass consists of clay and zeolite minerals and calcite.

Feldspar-phyric basalt occurs as massive subaerial flows and amygdaloidal submarine flows. Pillow structures have been found in only one outcrop, where a wedge-shaped pillow unit of feldspar-phyric basalt is intrusive into tuffaceous siltstone. This basalt is characterized by abundant light-gray stubby phenocrysts of plagioclase up to half an inch in length and averaging somewhat less than one-fourth of an inch in width.

The feldspar-phyric basalt has intergranular to subophitic textures with bytownite (An_{80}-An_{87}) phenocrysts composing 20 to 50 percent of the rock. Sodic labradorite (about An_{50}) makes up 35 to 60 percent of the groundmass; calcic, iron-rich augite (Ny = 1.705, 2V = 53) makes up 30 to 50 percent of the groundmass and in some specimens occurs as scattered phenocrysts. Olivine, which probably formed less than 1 percent of the basalt, has been entirely replaced by clay minerals. Opaque minerals make up an average of 7 percent of the rock. Basaltic glass that originally composed 2 to 20 percent of the rock has been completely altered.

Picrite-basalt is known only from one place in the Ball Mountain area where it occurs in pillow lavas and subaerial flows or sills. In fresh samples the picrite-basalt is a dark greenish-gray dense rock with conspicuous, water-clear, yellowish-green phenocrysts of olivine one-eighth to three-eighths of an inch in length.

A modal analysis of a typical thin section indicates that phenocrysts of olivine (Fo_{87}, Ny = 1.678) form 40 percent of the rock. The groundmass is extremely fine grained and is composed of abundant feather-shaped crystallites (predominantly pyroxene with lesser amounts of plagioclase) as well as opaques and olivine.

Tholeiitic basalt sills and dikes and a few pillow flows are associated with the flows and tuffs of the upper unit. The composition of this tholeiitic basalt is similar to that of the lower unit. The sills range in thickness from a few feet to more than 100 feet, are rudely columnar jointed, and have the appearance of massive subaerial flows. In hand sample the intrusive rocks are dark gray to black, are fine to medium grained, and have a sugary texture.

Microscopic textures range from intersertal to intergranular or subophitic. Commonly the basalt contains a few scattered plagioclase phenocrysts or glomerophenocrysts. Andesine (An_{40}) to labradorite (An_{65}) laths comprise 40 to 50 percent of a typical sample and commonly are partly altered to clay minerals. Augite (Ny = 1.70, 2V = 50) makes up about 30 to 40 percent, is very light brown, and in places shows uralitic overgrowths. Olivine or its alteration products are present in more than half of the specimens studied. Opaque minerals compose about 5 percent, and apatite less than 1 percent. Chlorophaeite is abundant in some samples, where it makes up as much as 5 percent of the rock. Very light brown to yellowish-brown glass, commonly altered, occurs with the chlorophaeite in interstitial areas and contains abundant crystallites of apatite, opaque minerals, and feldspar.

Chemical data

The flows that compose the lower unit of the Siletz River Volcanic Series are predominantly tholeiitic basalt which is saturated to oversaturated with respect to silica. Tholeiitic-olivine basalt flows are less common and contain both modal and normative olivine and normative hypersthene. The average composition of the lower unit, based on 10 widely distributed representative samples from the outcrop belt west of Corvallis, is shown in table 1, column 1. This composition is similar to both the correlative Crescent Formation of southwestern Washington (table 1, col. 2) and the tholeiitic basalts of the Hawaiian Islands (Macdonald and Katsura, 1964, p. 124, table 9).

The upper unit of the Siletz River Volcanic Series is composed of such diverse rock types that an average chemical composition would be of little significance. However, the composition of the alkalic basalt of the upper unit is given (table 1, col. 3) in order to demonstrate the chemical similarity between these alkali basalts and basalt of late Eocene to early Oligocene age.

Upper Eocene to Lower Oligocene Volcanic Rocks

A sequence of basalt flows, flow breccias, and massive to thick-bedded

TABLE 1. Average chemical analyses of Tertiary volcanic rocks in the central part of the Oregon Coast Range (recalculated to water-free basis).

	Lower to middle Eocene			Upper Eocene to lower Oligocene	Middle Miocene	
	1	2	3	4	5	6
SiO_2	48.5	49.1	49.6	50.3	55.8	51.8
Al_2O_3	14.4	14.9	17.5	17.2	14.1	13.9
Fe_2O_3	4.4	4.4	3.6	4.4	2.2	3.5
FeO	8.2	7.7	7.2	6.7	9.9	11.0
MgO	7.1	7.0	4.3	4.2	3.6	3.9
CaO	12.0	11.4	6.1	9.1	7.1	7.9
Na_2O	2.5	2.6	5.7	3.5	3.3	3.1
K_2O	0.20	0.22	2.0	1.0	1.3	1.0
TiO_2	2.2	2.1	3.0	2.9	2.0	3.0
P_2O_5	0.22	0.26	0.81	0.54	0.36	0.69
MnO	0.23	0.21	0.22	0.18	0.21	0.23
Number of analyses	10	10	4	19	8	11

Forty-four analyses used in the above averages were done by methods described in U.S. Geological Survey Bull. 1144-A by analysts Paul Elmore, Ivan Barlow, Samuel Botts, Gillison Chloe, Lowell Artis, and H. Smith, U.S. Geological Survey; 16 analyses were standard rock analyses by Dorothy Powers, June Goldsmith, Elaine Munson, and Christel Parker, U.S. Geological Survey; and 2 analyses were done using a combination of X-ray fluorescence and chemical methods by Leoniece Beatty and Albert Bettiga, U. S. Geological Survey.

1. Tholeiitic basalt; lower unit of Siletz River Volcanic Series, central part of Oregon Coast Range.
2. Tholeiitic basalt; Crescent Formation, southwest Washington.
3. Alkali basalt; upper unit of Siletz River Volcanic Series, central part of Oregon Coast Range.
4. Basalt; upper Eocene to lower Oligocene volcanic rocks, central part of Oregon Coast Range.
5. Tholeiitic basalt; lower unit of Miocene volcanic rocks, central part of Oregon Coast Range.
6. Tholeiitic basalt; upper unit of Miocene volcanic rocks, central part of Oregon Coast Range.

water-laid palagonitic lapilli tuffs forms precipitous sea cliffs between Heceta Head and Yachats and at Cascade Head along the central Oregon coast (pl. 1). These volcanic rocks intertongue with marine tuffaceous strata of late Eocene and early Oligocene age. Although these volcanic rocks originally extended into the central part of the Coast Range, erosion has removed them except on the west flank of the uplift in the central part of the range. The upper Eocene to lower Oligocene basaltic rocks attain a maximum thickness of 1,500 to 2,000 feet near former centers of volcanism, but thin rapidly away from these centers.

The flows are chiefly of subaerial origin and were erupted from numerous vents. However, in places basalt was extruded onto the sea floor, and the attendant rapid chilling of the magma by sea water produced glassy fragmental debris (commonly lapilli size) in which a few small pillows are enclosed locally. Much of the glass has been hydrated to palagonite, which later altered to clay minerals. The basalt flows are thin, averaging 10 to 20 feet thick, and in a few outcrops have a platy parting or well-developed columnar jointing. The upper parts of flows are commonly oxidized and contain brick-red scoriaceous fragments. Numerous basalt dikes, 1 to 8 feet in width, cut the volcanic sequence.

The basalt is dark gray to grayish black and is typically porphyritic. Tabular phenocrysts of plagioclase up to three-fourths of an inch long are easily recognized in hand samples and commonly make up 10 to 15 percent of the rock; fragmental basaltic debris usually contains many broken plagioclase crystals.

Microscopically the basalt is holocrystalline to hypocrystalline, porphyritic, or glomeroporphyritic; the groundmass texture is intergranular or pilotaxitic and vitrophyric where less crystalline. Phenocrysts of oscillatory zoned calcic labradorite (range An_{60}-An_{70}) generally compose 10 to 15 percent of the rock. Calcic andesine to sodic labradorite (An_{45}-An_{55}) in the groundmass makes up as much as 50 percent of the more crystalline samples. Sparse phenocrysts of calcic augite to ferroaugite ($2V = 50°$ to $58°$, $Ny = 1.705$ to 1.715) are found in about half of the samples. Granules of calcic augite to calcic ferroaugite ($2V = 50°$ to $55°$, Ny 1.70 to 1.71) in the groundmass average about 25 but form as much as 35 percent of the basalt. Olivine (Fo_{80}), both as phenocrysts and grains in the groundmass, is present in about half of the samples studied, and forms as much as 10 percent in a few sections. Opaque minerals, chiefly magnetite, compose 1 to 15 percent of the basalt. Interstitial areas between crystals consist of volcanic glass that is altered mainly to montmorillonite (nontronite[?]). Amygdules of montmorillonite (nontronite[?]) are common, but a few consist of calcite, apophyllite, and zeolite minerals.

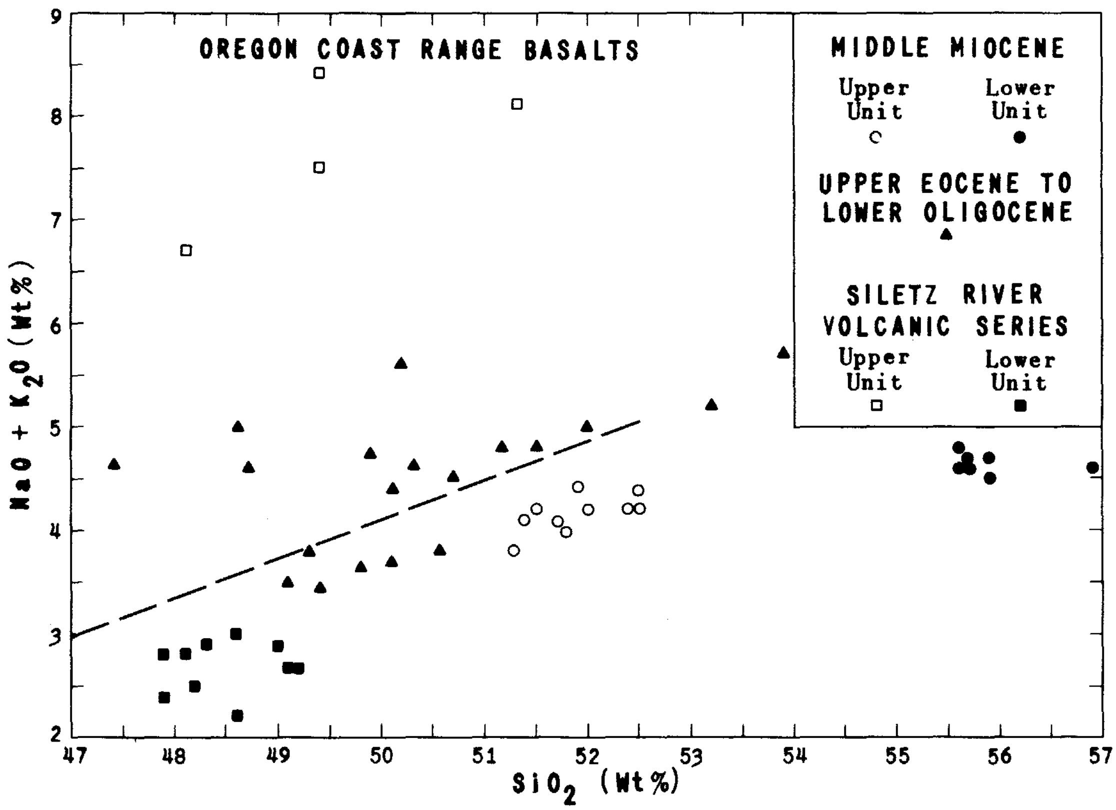
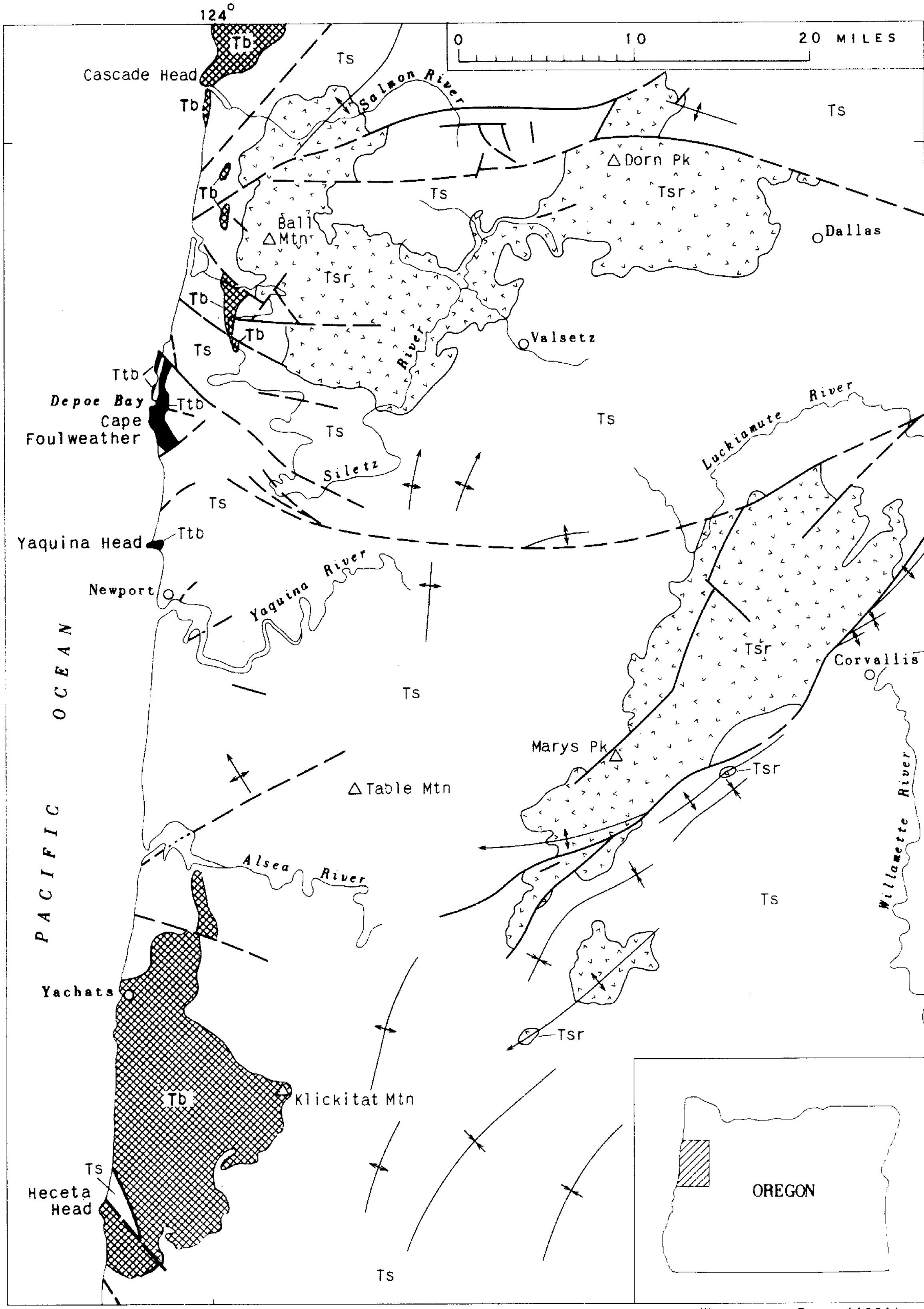


Figure 1. Alkali-silica diagram of Oregon Coast Range basaltic rocks. Analyses plotted are those used in averages given in table 1. Dashed line is boundary between tholeiitic and alkalic fields of Macdonald and Katsura (1964, p. 87).

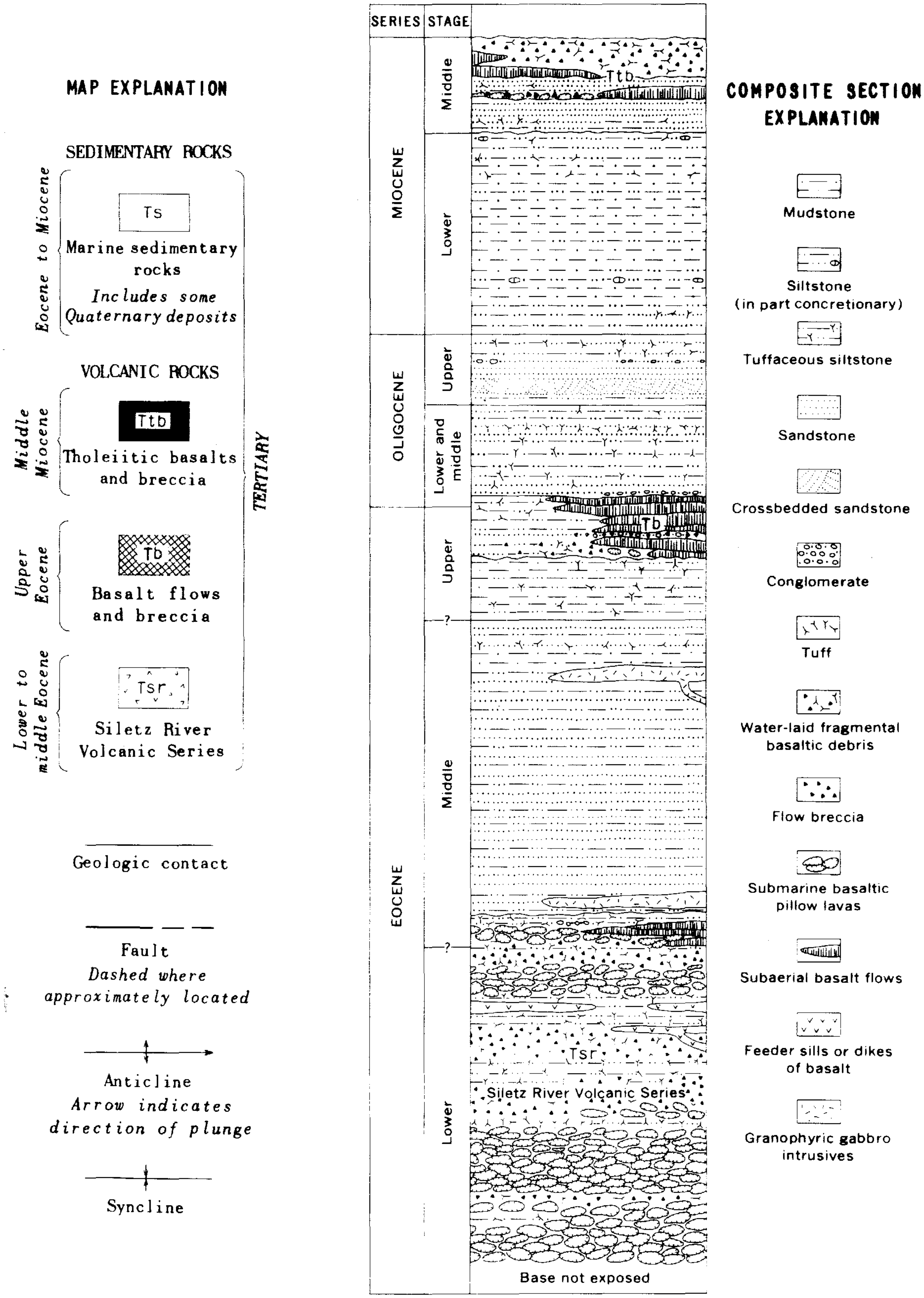
Chemical data

Chemical analyses of upper Eocene to lower Oligocene basalts indicate that this suite is intermediate in character between the alkalic and tholeiitic suites, since most of the basalts are over-saturated with respect to silica (tholeiitic affinity) but contain a total alkali content that averages 4.5 percent (alkalic affinity). These volcanic rocks typically have a rather high alumina and high total alkali content (table 1, col. 4) and are similar in total chemistry to the alkalic basalt of the upper unit of the Siletz River Volcanic Series (table 1, col. 3). They also have chemical affinities to typical andesites (Nockolds, 1954, p. 1019), but lack the characteristic mineralogy (hypersthene and/or hornblende and more sodic plagioclase) of the calc-alkaline andesites. The upper Eocene to lower Oligocene basalts have a rather wide range of silica content (47 to 54 percent) with a differentiation trend toward rocks of andesitic composition; the total alkali content increases as silica increases (fig. 1).



GENERALIZED FROM GEOLOGIC MAP OF OREGON WEST OF THE 121ST MERIDIAN BY WELLS AND PECK (1961). MODIFIED FROM FIELD WORK BY P.D. SNAVELY, JR., AND H.C. WAGNER, 1960-63. INTRUSIVE ROCKS NOT SHOWN

Plate 1. Generalized geologic map showing the distribution of Tertiary volcanic se
Oregon Coast Range.



ces, and composite section showing their stratigraphic positions, central part of

Middle Miocene Volcanic Rocks

Basalt flows, pillow lavas, and water-laid fragmental debris of middle Miocene age form precipitous headlands at Cape Foulweather and Yaquina Head in the map area (pl. 1) and farther north at Cape Lookout, Cape Meares, and Tillamook Head. These volcanic rocks were extruded from local centers near a middle Miocene strand and are of both subaerial and submarine origin.

Along coastal Oregon these basalts compose two mappable and petrochemically distinctive units, an older unit consisting of a subaerial flow and subaqueous palagonitic pillow lavas and breccias, and a younger unit consisting of subaerial basalt flows and subaqueous water-laid fragmental basaltic debris. These volcanic units are separated by nearshore to brackish water arkosic sandstone in the vicinity of Depoe Bay (Snavely and Vokes, 1949). Unconformities, in places marked by fossil soil zones, occur at the base of each unit; the upper unit overlaps the lower unit at Cape Foulweather and rests on older strata.

Lower unit

The lower unit is well exposed at Depoe Bay where pillow flows and palagonitic tuff-breccias 75 feet thick form the north-trending east shoreline of the outer bay. Immediately south of Depoe Bay these pillow lavas grade laterally into a rudely columnar-jointed subaerial flow approximately 50 feet thick.

The basalt in the lower unit is medium to dark gray, is aphanitic, and commonly contains patches of apple-green (on fresh breaks) to brownish-black chlorophaeite. In the complex of pillow lava and tuff breccia at Depoe Bay, ellipsoidal pillows are enclosed by a light-brown palagonite matrix in which fragments of black, glassy basalt occur in abundance.

Petrographically the basalt is hypocrystalline and equigranular with intersertal to intergranular or subophitic textures. The glassy breccias and chilled margins on pillows exhibit vitrophyric to hyalo-ophitic textures. Calcic andesine to sodic labradorite (An_{40}-An_{60}) forms 5 to 50 percent of the sections studied. Augite to subcalcic augite (2V = 27 to 45, Ny 1.704 to 1.711) and pigeonite form 5 to 40 percent. Opaque minerals, largely magnetite, average about 2 percent but range from less than 1 to nearly 10 percent of the rock; apatite is present only in the most crystalline rocks, where it composes 1 percent or less. Dark- to light-brown basaltic glass forms 5 to 90 percent of the rock. In the fragmental rocks and in the outer-most rims of pillows, the most common basaltic glass is a clear pale-brown variety with refractive index greater than balsam (sideromelane); interior to the outer rims of pillows and as occasional fragments in the breccias, the glass is a dark-brown to nearly opaque variety that is minutely dusted with opaque minerals (tachylyte). The glass is generally fresh, but the outer rims of some fragments are altered to yellow palagonite which has a refractive index less than balsam. Chlorophaeite, commonly olive green to orange brown with index less than balsam, makes up as much as 10 percent of some samples. A glassy silicic residuum occurs in the more crystalline samples; cryptocrystalline quartz and calcite occur in amygdules, in veinlets, and as the cementing material of some breccias.

Upper unit

The upper unit of the middle Miocene volcanic sequence is typically exposed in sea cliffs at Yaquina Head and Cape Foulweather. The volcanic sequence in these headlands is cut by swarms of feeder dikes and volcanic necks, thus indicating that these basalts were erupted from numerous vents and fissures located near the present coast. The upper unit consists predominantly of basalt breccias and water-laid fragmental debris with lesser amounts of massive flows and pillow lavas. Much of the basaltic magma was extruded onto the ocean floor, and rapid chilling by sea water caused this extensive fragmentation.

In hand sample, yellowish phenocrysts of plagioclase, as much as three-fourths of an inch in length, serve to distinguish this sparsely porphyritic younger unit from the nonporphyritic basalt of the older unit.

Thin-section studies show that the basalt is hypocrystalline with intersertal to subophitic textures the most common. The less crystalline samples have vitrophyric to hyalo-ophitic textures. Sparse phenocrysts (less than 1 percent) of calcic labradorite (An_{63}-An_{65}) and laths of sodic labradorite (An_{55}) form 5 to 40 (commonly 20) percent of the basalt. Augite ($2V = 42$ to 50, $Ny = 1.699$ to 1.709) and pigeonite (less common) comprise 1 to 25 percent; olivine, which is generally altered, forms 1 to 5 percent; opaque minerals make up 1 to 10 percent of the samples studied. Basaltic glass is present as both sideromelane and tachylyte and composes up to 95 percent of individual fragments in the breccias; sideromelane is commonly partially palagonitized. In the more crystalline basalt a glassy silicic residuum ($N < 1.54$) makes up about 20 percent of the rock. Chlorophaeite is common and forms as much as 10 percent of some samples. Analcite, calcite, apophyllite, cryptocrystalline quartz, and celadonite occur in amygdules and veinlets.

Chemical data

Both the lower and upper volcanic units of middle Miocene age in coastal Oregon are tholeiitic basalts that are over-saturated with respect to silica. These Coast Range Miocene basalts bear a marked similarity to the Yakima Basalt of the Columbia River Group of Waters (1961, p. 607). The lower unit (table 1, col. 5) is remarkably close chemically to the Yakima petrographic type (Waters, 1961, p. 593); the upper unit (table 1, col. 6) is strikingly similar to the Late Yakima type of the Columbia River Basalt (Waters, 1961, p. 594). The lower unit is characterized by a higher silica and lower TiO_2 and P_2O_5 content than the upper unit.

Summary

The three basalt sequences that comprise the Oregon Coast Range petrographic province generally can be distinguished from one another on the basis of either their petrographic or chemical characteristics. The principal

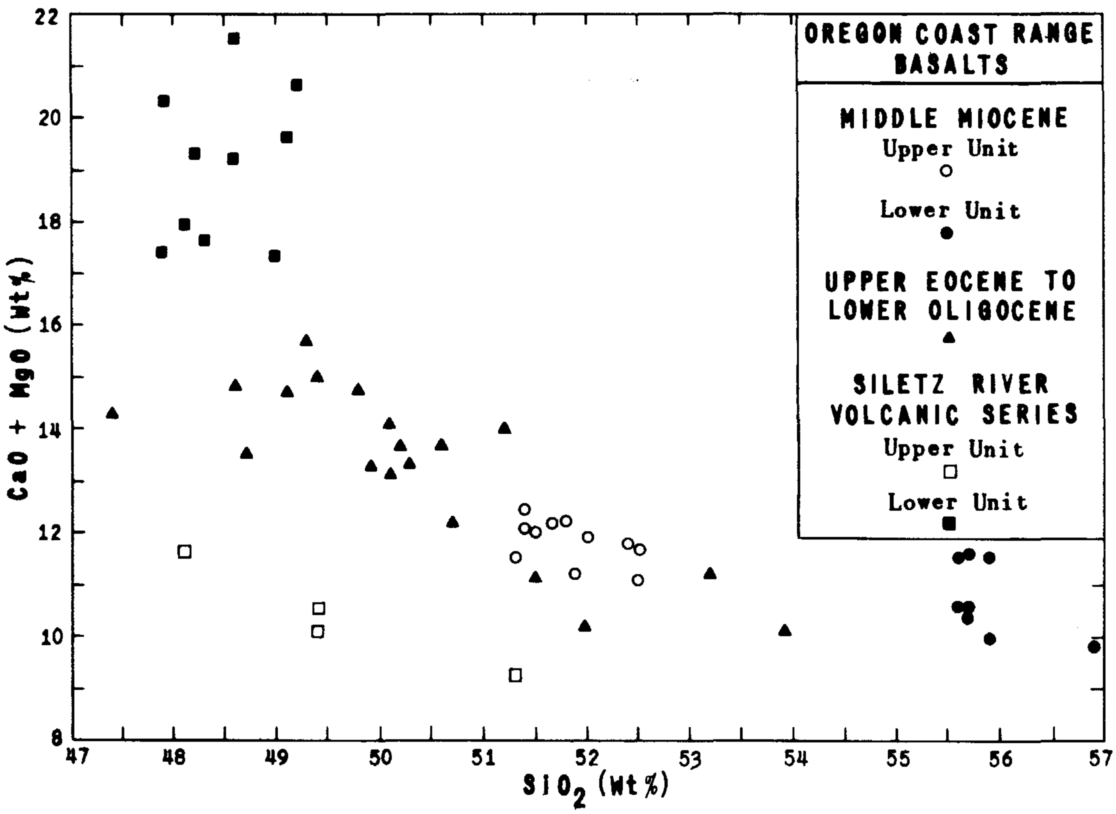


Figure 2. Diagram showing the relation of CaO+MgO to SiO_2 in Oregon Coast Range basaltic rocks. Analyses plotted are those used in averages given in table 1.

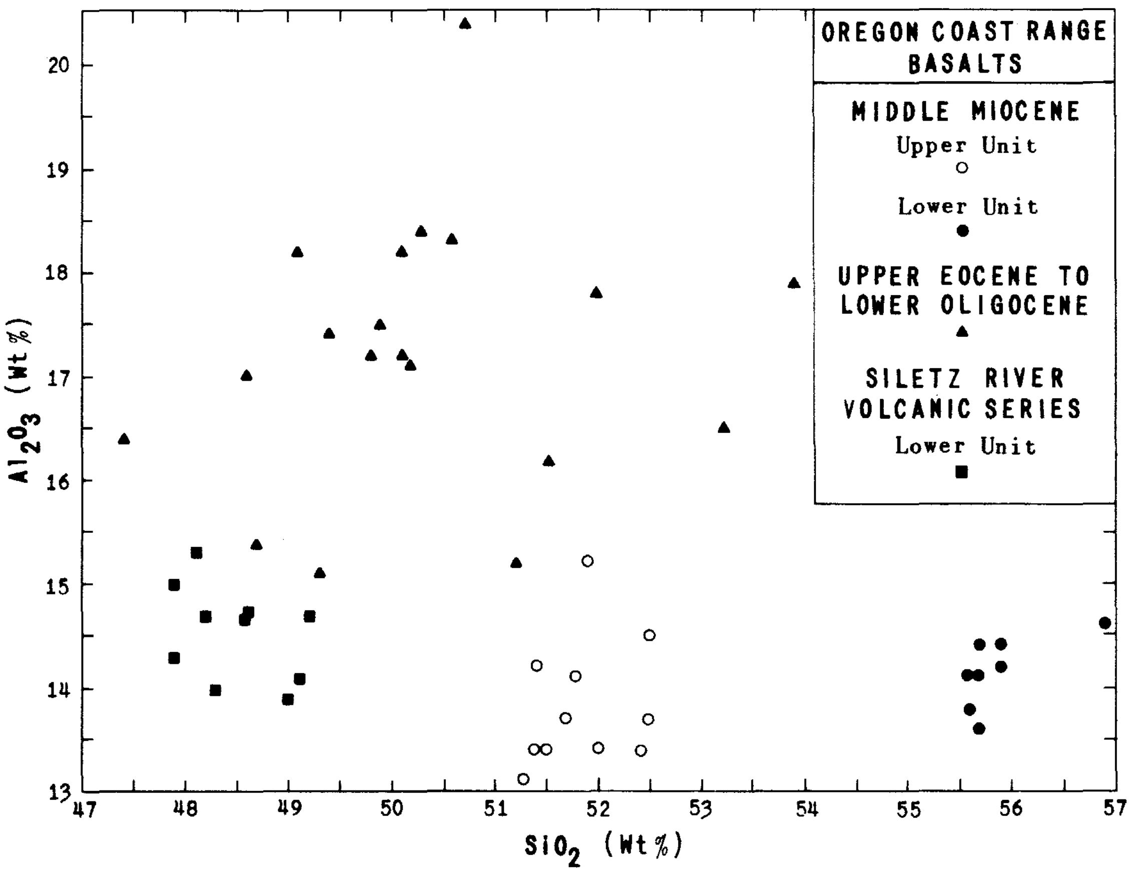


Figure 3. Alumina-silica diagram of Oregon Coast Range basaltic rocks. Analyses plotted are those used in averages given in table 1.

characteristics are:

1. The widespread tholeiitic basalt in the lower unit of the Siletz River Volcanic Series has a lower silica content, a lower content of total alkalis, and a higher content of CaO and MgO than is present in either the upper Eocene to lower Oligocene basalt or the Miocene basalts (figs. 1 and 2). The original basaltic glass in the Siletz River Volcanic Series is typically altered to montmorillonitic clay minerals.
2. The upper Eocene to lower Oligocene basalt has a higher alumina content than most of the other volcanic units (fig. 3), with the exception of the alkalic and feldspar-phyric basalts in the upper unit of the Siletz River Volcanic Series. However,
   a. the upper Eocene to lower Oligocene basalt has a lower content of total alkalis (fig. 1) and a higher content of CaO plus MgO for a given silica content (fig. 2) than is present in the alkalic basalt of the upper unit of the

Siletz River; also,

b. the pyroxenes of the upper Eocene to lower Oligocene basalt are typically more iron-rich (higher Ny) than those of the alkalic basalt; and

c. the upper Eocene to lower Oligocene basalt can generally be distinguished from the feldspar-phyric basalt (upper unit, Siletz River Volcanic Series) on the basis of plagioclase composition, since the plagioclase phenocrysts are considerably more calcic in the feldspar-phyric basalt.

3. The middle Miocene tholeiitic basalts have lower contents of CaO and MgO than most older lavas (fig. 2). Also,

a. the lower unit of Miocene age is richer in silica than other volcanics in this area (approaching an andesite in composition);

b. the upper unit of Miocene age can be distinguished from the lower unit of Miocene age by its higher contents of TiO_2 and P_2O_5 and lower content of silica (table 1); and

c. the upper unit commonly contains a few plagioclase phenocrysts and olivine grains in the groundmass, whereas the lower unit contains neither.

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OIL RECORDS RELEASED

The Department released records of the E. M. Warren "Coos County 1-7" well on June 5, 1965, after holding them in confidential file for the two-year period prescribed by law. The drilling was located in the SW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 7, T. 27 S., R. 13 W., Coos County, 7 miles south of Coos Bay. Total depth of the Warren well was 6,337 feet. No volcanic rocks were logged in the drilling, as contrasted with the Phillips Petroleum Co. "Dobbyns 1" 4 miles to the north, which encountered volcanic rocks between 2,300 and 5,700 feet.

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MINERS TO LOSE RIGHTS ON 57 PARCELS OF LAND

The latest in a long and continuing series of proposed withdrawals of public lands from mineral entry has been announced by the U.S. Bureau of Land Management. Total acreage involved in the current withdrawals amounts to nearly 4,800 acres, scattered widely over the state. Most of the withdrawals are designed to provide or protect recreation areas. One area involves 440 acres on Sugarloaf Mountain near Myrtle Point in Coos County, where the Bureau wishes to withdraw a hardrock deposit from application by individuals. The quarry site is adjacent to Oregon State Highway 42 and not far from the Myrtle Point-Powers road. Both of these roads were damaged in the winter high water, and large quantities of crushed rock are needed for their rebuilding and repair.

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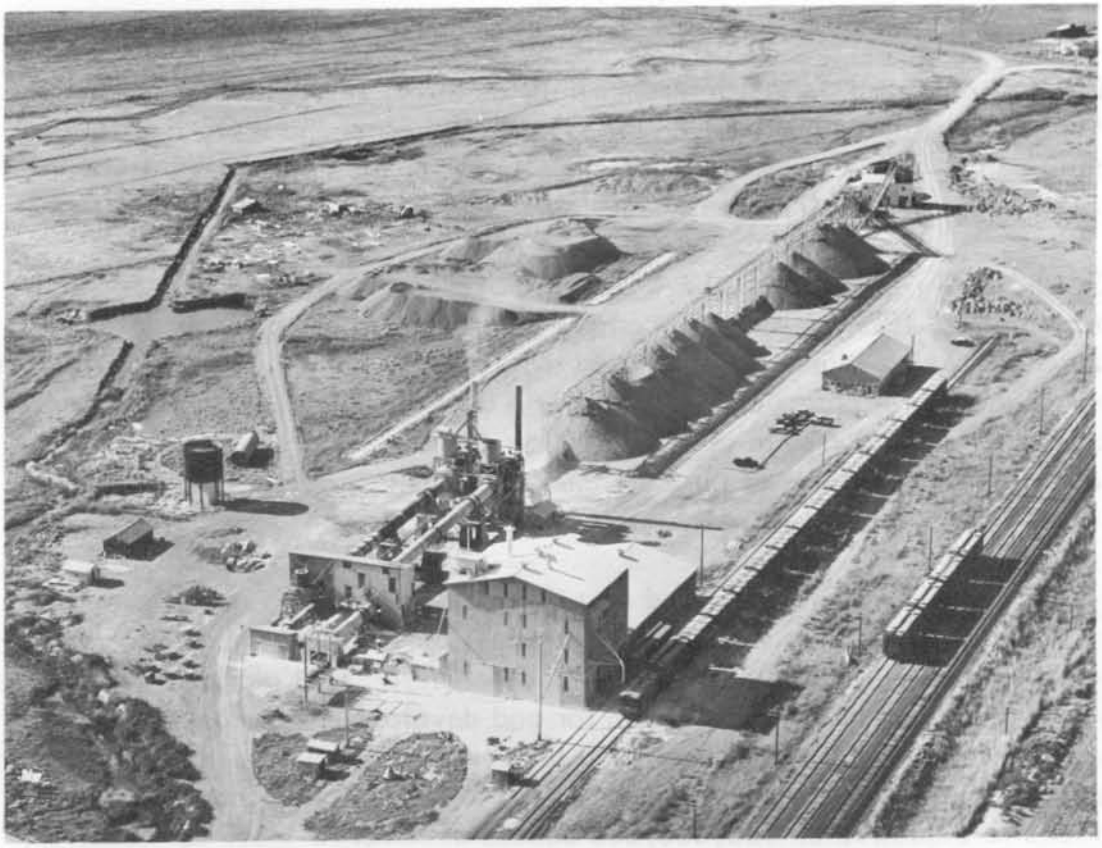
Chemical Lime Co. quarry on Baboon Creek, Baker County.

Road from Marble Creek over the summit of Elkhorn Ridge.



Chemical Lime Co. Processing Plant

What a resource-based industry does for the welfare of the Baker community is evident in the facts about Chemical Lime Co., Baker County, Oregon.

Chemical Lime operates a quarry just over the "hump" of Elkhorn Ridge west of Baker on Baboon Creek, sec. 20, T. 9 S., R. 38 E. By an access road developed by the company, raw lime rock is trucked to a plant at Wing Siding, where gas-fired kilns and other equipment convert the quality limestone into lime of chemical grade for the industries of the Pacific Northwest (see photograph above).

Chemical Lime Co. employs full or part time from 35 to 40 men. The annual payroll is from $257,000 to $300,000. The operation generates 700 to 750 rail cars of freight, shipping to all points in the Northwest, entailing freight costs in excess of $200,000. Lime and limestone shipped are valued at $850,000 to $950,000 annually.

Natural gas consumed and supplies purchased locally exceed $400,000 annually. Construction of plant, building of the road, and completion of the power line provided major additional employment. In the haul between the quarry and the plant, four trucks of Reed's Truck firm operate two shifts six days a week for approximately six months a year. Chemical Lime's general manager is Ned Thomas. The auditor is Leo Case, the quarry foreman Bert Farrar, and the chemist Raymond Fenn.

(All photographs courtesy of Chemical Lime Co.)

MINING CONCERNS WESTERN GOVERNORS

The Western Governors' Conference held its three-day session at the Hilton Hotel in Portland June 10-13, 1965, with Governor Mark O. Hatfield as chairman. A number of resolutions dealing with the mining industry were recommended, as follows:

Gold: It was resolved that the Western Governors' Conference endorse in principle S. 1377 for direct incentive payments to our domestic gold producers or similar legislation designed to reactivate our gold mines and increase our domestic gold production; recommend adoption of tax incentives to encourage greater domestic gold production; and urge the Federal Government in evaluating solutions of the balance of payments problem to study the desirability of multilateral revaluation of gold.

Silver: The Conference resolved that Congress be urged to reject moves to eliminate silver from our coinage and that it provide for retention of silver in reduced amounts in all coins now made of silver; that affirmative programs be adopted to increase exploration for and development of domestic silver supplies, and that silver be permitted to seek its own price in the market place; and that the Administration be commended for its action in setting a national stockpile objective of 165,000,000 ounces of silver to meet our security requirements, a move which the Conference has urged for many years.

Public lands: It was resolved by the Conference that all actions proposed by the Bureau of Land Management which substantially affect the administration of the public lands be openly and publicly considered with representatives of the localities affected prior to implementation.

Mineral taxation: It was resolved that the Conference urge that adequate depletion allowances for minerals be provided and that mining exploration expenditures be made fully deductible on a basis comparable to the research expenditures of other businesses.

Import controls: It was resolved that the Conference recommend the imposition of import controls, where necessary, with provision for adjustments to assure the maintenance of sound and vital domestic natural resource industries.

Oil shale: It was resolved that the Governors of the western states urge prompt action to establish and implement a leasing policy with private enterprise to develop western oil shale deposits.

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