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AN ABSTRACT OF THE THESIS OF Richard Cortland Kent
for the Master of Science in the Department of Earth
Sciences presented June 10, 1972.

Title: The Geology of the Southeast Quarter of the Bone
Mountain Quadrangle, Oregon.

APPROVED BY MEMBERS OF THE THESIS COMMITTEE:

Robert O. VanAtta, Chairman

Ewart M. Baldwin

John D. Beaulieu

This thesis is a study of the geology of the southeast
quarter of the Bone Mountain Quadrangle. The bedrock
geology mapped includes about 56 square miles.

The Klamath Mountain and Coast Range Provinces of
southwestern Oregon are represented in the area. Rocks
in the area include the Rogue, Dothan Riddle, Days Creek,
upper member of the Umpqua, and Tyee Formations. The ages

of these rocks range from Late Jurassic to middle Eocene. Late Jurassic ultramafic and mafic intrusive rocks associated with the Rogue Formation occur in the Klamath Province.

The metavolcanics of the Rogue Formation and an associated linear belt of mafic intrusive rocks have been thrust northwestward over the Late Jurassic-Early Cretaceous Riddle Formation. Ultramafics occur along the fault.

Graywackes, siltstones, and conglomerate lenses of the Dothan Formation have been downfaulted relative to the Rogue Formation along a southeasterly dipping fault. The Dothan Formation is steeply dipping to the southeast and contains numerous folds inclined to the northwest. The genetic relationships of faulting are problematic.

The Myrtle Group conglomerates, siltstones and sandstones are greatly folded and dip to the northwest. Internal structures are intense and diagnostic fauna of Late Jurassic to Early Cretaceous age indicate separate lithologic units of shallow water deposition.

Tertiary sedimentary rocks include the upper member of the Umpqua and Tyee Formations of middle Eocene age. The formations are gently dipping to the northwest with coal beds and fauna indicating a near shore depositional environment.

THE GEOLOGY OF THE SOUTHEAST QUARTER OF
THE BONE MOUNTAIN QUADRANGLE, OREGON

by
RICHARD CORTLAND KENT

A thesis submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE
in
GEOLOGY

Portland State University
1972

TO THE OFFICE OF GRADUATE STUDIES:

The members of the Committee approve the thesis
of Richard Cortland Kent presented May 18, 1972.

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May 18, 1972

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INTRODUCTION

Location and Accessibility

The southeast quarter of the Bone Mountain quadrangle is located in southwestern Oregon, on the border of the Coast Range and Klamath Mountain physiographic divisions of Oregon. The thesis area is bounded by west longitudes $123^{\circ} 52' 30''$ and $123^{\circ} 45'$, and north latitudes $42^{\circ} 45'$ and $42^{\circ} 52' 30''$ (Figure 1). This area is approximately 56 square miles.

Bureau of Land Management roads provide access from the west near the town of Powers, and from the east via Riddle. Access is also obtained by private logging company roads as well as roads maintained by the U. S. Forest Service.

Climate and Vegetation

The mild, humid climate is typified by an average annual rainfall of 48 to 56 inches. Average temperatures range from 40° in January to 65° in July. The average snow depth for January is 20 inches, with only traces in December and February.

Figure 1. Index map of southwestern Oregon showing location mapped for this thesis (ruled).

Vegetation of the area includes the diseased Port Orford cedar, Douglas fir, red cedar, blue spruce, sugar pine, madrone, hemlock, oak, rhododendrons, manzanita, poison oak, white yarrow ("Queen Anne's Lace"), elderberry trees, Oregon grape, and blackberries.

Geomorphology

The Coast Range Tertiary sedimentary rocks and the Klamath Mountain pre-Tertiary rocks adjoin in the northwest part of the area. Maximum relief of approximately 3500 feet is found in the Klamath Province. The highest elevation is Mt. Bolivar (4319 feet), and the lowest point is where Mule Creek flows out of the mapped area (790 feet).

The area includes streams of three major drainage networks of southwest Oregon (Figure 2). Potential stream piracy of tributaries from the systems is evident in sec. 34, T. 31 S., R. 10 W. The South Fork Coquille River flows into the Coquille River drainage, and is the major stream in the northwestern part of the area. The West Fork Cow Creek and numerous tributaries drain the northern basin of the area and contribute to the Umpqua River drainage. Mule Creek, of the southern part of the area, flows into the Rogue River drainage.

Figure 2 . Stream pattern of study area.

The drainage of the area is rectangular to dendritic with a modified slightly angular to parallel subpattern. Following methods and analyses of Schmela (1971), the stream pattern of the area was projected by graphic methods onto a rose diagram (Figure 3). The stream tracings, from a 1:31,250 scale map, were divided into straight segments of at least 0.2 inches in length. Each segment was measured and the direction noted. A circle of arbitrary diameter was divided into several inscribed concentric circles representing increasing percentages from the center. The percentage represented by the outside circle was arbitrarily picked to allow for the largest percentage of stream orientation to approach the edge of the circle. This showed a larger rose diagram and therefore was easier to read.

The rose diagram indicates linearities in the following directions: N. 40°-50° W., N. 10° E., N. 30° E., N. 55° E., N. 75° E. The N. 40°-50° W. orientation of streams includes those flowing in the Rogue, Dothan, and Riddle Formations. These streams probably follow structural weaknesses perpendicular to, and at various angles to, the major faulting of the area. Field observations could not be correlated due to poor exposures. The streams flowing in

Figure 3. Rose diagram of total stream orientation..

the N. 55° E., and N. 75° E. directions are located mainly in the Dothan Formation. The significance of the rose diagram is that it shows a major trend of streams flowing parallel to the major structural trends found in field observations. Those trends are N. 10° E., and N. 30° E. The streams follow weaknesses represented by a low angle thrust fault striking NE (Plate 1) that has been determined to have emplaced the pre-Nevadan, Jurassic Rogue Formation structurally above the post-Nevadan, Jurassic-Cretaceous Riddle Formation. The structure is discussed further in a following section.

A second major fault has been located between the Rogue and Dothan Formations that also strikes northeast. Numerous small scale faulting and jointing features are assumed to be associated with the major faults, but attitudes and directions could not be determined in field observations. The rose diagram is an aid to field structure studies, and indicates stream orientations.

The northernmost extension of Eden Ridge occupies the western topographic high in the area. A hogback formed by the resistant ridges of the Rogue Formation trends northeast through the central part of the area (Figure 4). Streams within the Rogue form steep walled valleys. A gorge

Figure 4. Saddle Peaks and Diamond Peak from Mt. Bolivar. Note the hogback ridge formed by the resistant Rogue Formation. View looking southwest.

exists in the northern area where the West Fork Cow Creek is believed to be a superposed stream cut down through the Rogue Formation. The walls are nearly vertical for a distance of $1\frac{1}{2}$ miles and are about 500 feet high. A four foot waterfall has been produced at the fault contact of the Rogue and Dothan Formations within the gorge.

Previous Work

The present thesis is an original detailed study of the area. Preliminary regional geology was done by Diller (1907), Wells (1955), and Wells and Peck (1961). Baldwin (1965, 1969), Baldwin and Hess (1971), and Baldwin and Rud (1972) have completed the regional and detailed geology of surrounding areas. Detailed geology of the southeast bordering Galice quadrangle was completed by Wells and Walker (1953). Other detailed geology of the bordering areas have been completed by University of Oregon graduate students. Krans (1970) mapped the northwest quarter of the quadrangle and Rud (1971) studied the geology of the adjacent western area in detail. Johannesen (1972) is mapping the northeast quarter of the Bone Mountain quadrangle.

Purpose of Study

The purpose of this study is to map, describe, and interpret the geology of the southeast quarter of the Bone Mountain quadrangle. A United States Geological Survey topographic map (1954) of the Bone Mountain quadrangle was enlarged from a scale of 1:62,500 to 1:31,250 for plotting of field data. Representative rock samples were collected and studied petrographically in order to classify and interpret the rock types. Fauna were collected for identification and correlation.

Field work was conducted during a nine week period in the summer of 1971. Return trips to the area were made during the winter and spring of 1972.

Regional Geologic Setting

The southeast quarter of the Bone Mountain quadrangle is underlain by rocks representing two geologic provinces of southwest Oregon, the pre-Tertiary Klamath Mountains Province and the overlying Coast Range Province of Tertiary age. In western Oregon, the Klamath Mountain Province occupies an elongate north-south area of about 12,000 square miles (Hotz, 1971). The Tertiary Province forms a linear basin about 400 miles long (Snively and Wagner, 1963).

Irwin (1964) was one of the earliest workers in the Klamath Mountains to recognize the importance of large thrust plates in Northern California and Southwestern Oregon. Davis (1969), Kays and Bruemmer (1964), and Hamilton (1969) further defined the geologic setting. Four major arcuate provincial belts were proposed by Irwin (1964) for the pre-Nevadan rocks of the Klamath and Sierra Nevada Complex: 1) the eastern Paleozoic belt; 2) the central metamorphic belt; 3) the western Paleozoic and Triassic belt; and 4) the western Jurassic belt. These westward thrust belts are termed subjacent rocks. The post-Nevadan strata in southwestern Oregon are divided into eugeosynclinal and noneugeosynclinal rocks, and are named superjacent rocks.

The subjacent rocks are altered eugeosynclinal units of greenstones, graywacke sandstones, mudstones, thin bedded cherts and minor limestones. The Rogue Formation of the present study is considered by Irwin (1964) to be part of the western Jurassic belt (subjacent). Included with the Rogue are the large ultramafic sheets that were recognized by Irwin (1964) to be nearly contemporaneous with the large scale thrusting. More recently Coleman (1971) interprets the large ultramafic sheets to have been

emplaced during subduction and obduction along previous continental margins. The thrust faults dividing the provincial belts of the Klamath Mountains Province are believed to steepen southeastward and to pass into high angle faults in the Sierra Nevada of California (Davis, 1969). The Nevadan Orogeny apparently effected much of what is now the western coast of the United States.

The Nevadan Orogeny is a major tectonic marker and provides a division for lithologies recognized by Irwin (1964). The post-Nevadan rocks consist of eugeosynclinal rocks that are thick sequences of graywacke, mudstone, pillow lavas, and radiolarian chert, and are represented by the Dothan Formation and the Myrtle Group in the thesis area. As defined by Irwin (1964) the eugeosynclinal superjacent rocks were deposited offshore on the west side of the continent. They were not deposited on subjacent rocks, but on oceanic crust.

The noneugeosynclinal rocks of the superjacent sequence are considered by Irwin (1964) to have been deposited on subjacent rocks and formed the continental shelf and slope. The rocks consist of graywacke, mudstone, and conglomerate; structural features include cross bedding and sole markings. In contrast to the eugeosynclinal

suite, the noneugeosynclinal rocks are typically fossiliferous. The Myrtle Group is considered to be part of this geologic setting.

Both types of superjacent rocks are considered by Irwin (1964) to be laid down concurrently during the Late Jurassic and Cretaceous and are in part lateral equivalents, or facies, of one another. However, the contacts of the superjacent rocks near the thesis area are due to tectonic activity.

Eastward underthrusting of the oceanic crust (Dott, 1971) is presumed to have continued during the Cretaceous, resulting in broad folding and faulting of the Cretaceous strata. Presumably during or shortly following orogenic pulses, the subjacent (Rogue Formation) was thrust over the superjacent strata (Myrtle Group).

Regionally, the Coast Range rock types extend from Vancouver Island, Washington, to the area southeast of Agness, Oregon. Eugeosynclinal basining developed in this area by early Eocene times, and by the middle Eocene the basin was filled largely with basaltic pillow lavas, breccias, tuffaceous material, and marine sediments (Umpqua Formation). The sources for the volcanics may have included island arcs and various other forms of

submarine volcanism (Snively and Wagner, 1963). During the middle Eocene the geosynclinal basin sank and received up to 20,000 feet of sediments along the axis, now included in the Umpqua and Tyee Formations in Oregon and equivalent units in Washington.

STRATIGRAPHY

Introduction

The rocks in the thesis area range in age from Late Jurassic to middle Eocene. The Rogue, Dothan, and Riddle Formations are the oldest stratigraphic units exposed. Exposures here assigned to the Rogue Formation were called the volcanic rocks of the Dothan Formation by Wells and Peck (1961). Baldwin (1969) however states that the unit is a part of the Rogue Formation. Descriptions of the rock closely resemble those of the Rogue by Wells and Walker (1953) and Helming (1966), further suggesting that the metavolcanic rocks are the Rogue.

The Dothan is considered to be younger than the Rogue on the basis of a Late Jurassic fossil discovered by Ramp (1969) and the lack of intrusive rocks in the unit. The Riddle Formation, part of the Myrtle Group, has been paleontologically dated from Late Jurassic to Early Cretaceous. The Days Creek Formation, also of the Myrtle Group, contains fossils that indicate an Early Cretaceous age. The Myrtle Group contains a basal conglomerate that

grades into siltstones (Riddle Formation). Sandstones and siltstones dominate the uppermost section (Days Creek Formation).

The Tertiary is represented by the Umpqua and Tyee Formations. The upper member of the Umpqua is middle Eocene (Baldwin, 1965). Also of middle Eocene age, but lying with a slight angular discordance on the Umpqua, is the Tyee Formation. The Umpqua is mainly siltstone and the Tyee is largely sandstones.

A sequence of Late Jurassic intrusive rocks, including peridotite, hornblende diorite, and diorite intrude the Rogue Formation. The peridotite is now largely serpentinite and has been remobilized and deformed during succeeding orogenic events. The stratigraphic correlations are shown in Figure 5.

Rogue Formation

Introduction

The Rogue Formation was named by Wells and Walker (1953) for a sequence of metavolcanic and related intrusive rocks that are almost continuously exposed along the Rogue River from the confluence of Whiskey Creek to the Almeda mine. The type section along the Rogue River consists of

Series	European Stages (in part)	Standard West Coast Section (in part) Weaver et al. (1944) Baldwin (1964)	SE/4 Bone Mtn. Quad. Baldwin, 1964, 1965 Imlay et al. (1959)	
Eocene		Tejon		
		"Transition Beds"		
		Domengine	Tyee Formation	
		Capay	U. Umpqua Member	
Paleocene		Meganos		
		Martinez		
Upper Cretaceous	Maastrichtian			
	Campanian			
	Santonian			
	Coniacian			
	Turonian			
	Cenomanian			
Lower Cretaceous	Albian			
	Aptian			
	Berremian			
	Hauterivian			
	Valanginian			
	Berriasian			
Upper Jurassic	Purbeckian			Days Creek Formation
	Portlandian			Riddle Formation
	Kimmeridgian			Dothan Fm.
	Oxfordian			Galice Fm.
	Callovian			Rogue Intrusive Formation

Figure 5 . Stratigraphic correlations in the southeast quarter of the Bone Mountain quadrangle, Oregon.

intimately intermixed fine to coarse-grained tuffs, agglomerates, flow breccias, and flows and their metamorphic equivalents. The rocks in the thesis area are interpreted to be part of the Rogue Formation due to lithologic and stratigraphic similarities to exposures at the type section.

Distribution and Thickness

The Rogue Formation was tentatively mapped in the adjoining west area by Rud (1971). The rocks of this unit form a linear northeasterly trending belt approximately two and one-half miles in width. An easterly dip is assumed. An irregular body formed by a sequence of intrusive rocks is almost entirely enclosed within the meta-volcanic rocks. Baldwin (1968, 1969) mapped areas to the south also as Rogue. The southern extension of the Rogue is assumed to correlate with similar rocks exposed at the Rogue River near Marial.

Wells and Walker (1953) estimate the thickness of the Rogue Formation to be 15,000 feet in the type area. Baldwin (1968) states that the formation is nearly 10,000 feet thick in the Mule Creek drainage. An estimate obtained from cross section A-A' in Plate 1 shows that the Rogue is at least 6,000 feet thick. Folding and faulting have obscured the true thickness and the estimate is probably

small. The northern outcrops near Gold Mountain show less major structural deformation, except for a greenschist unit. The southern exposures from Mt. Bolivar to Saddle Peaks appear to have been faulted and folded more intensely, with subsequent loss of petrographic texture.

Description

The intrusive rocks that are enclosed within the Rogue Formation are described under a separate section. The rocks of the thesis area are similar to those found by Helming (1966) in the Rogue River Traverse of the type section. The high grade metamorphic amphibole gneiss found by Helming was not seen in the area. However, rocks similar to the spilite and metatuffs found in the northern Mount Reuben-Hungry Hill Traverse by Helming were found to be located in widely scattered outcrops. The acidic volcanic unit described by Hixson (1965) was not located within the area. These rocks as described by Hixson are intensely fractured, veined, and altered flows and bedded ash. The porphyritic dacites and rhyolites found by Wells and Walker (1953) in the type section are not found in the area.

Figure 6 shows the locations of the thin sections studied. Table 1 shows the associated rock types. The

Figure 6. Index map of thin section localities.
See Table 1 for rock types.

TABLE 1
ROCK TYPES FOR THIN SECTION
LOCALITIES AS FOUND IN
FIGURE 6

<u>Sample</u>	<u>Rock Type</u>
Tt 30	arkosic wacke
Tt 35	arkose
Tuu 64	arkosic wacke
Tuu 85	arkosic wacke
Kdc 55	mudstone
Kdc 72	lithic wacke
KJr 78	lithic wacke
KJr 79	lithic wacke
Jd 108	lithic wacke
Jd 119	chert
Jd 166	feldspathic wacke
Jd 178	arkosic wacke
Jd 205	lithic wacke
Jr 122	coarse mylonitic tuff
Jr 135	hematite-plagioclase-epidote-quartz schist
Jr 136	greenschist
Jr 145	spilite
Jr 148	coarse-grained tuff
Jr 149	coarse-grained tuff
Jr 150	altered coarse-grained tuff
Jr 208a	tuff mylonite
Jr 208b	biotite-plagioclase-epidote schist
Jr 213	porphyritic andesite
Jr 214	fine-grained tuff
Jr 217	augen mylonite
Jr 220	sausseritized porphyritic (andesite?) flow
Jr 222	coarse-grained tuff
Jr 227	agglomerate
Jr 228	poypyritic andesite
Jr 283	spilite
Jr 292	slightly mylonitic coarse-grained tuff

TABLE 1 (CONTINUED)

<u>Sample</u>	<u>Rock Type</u>
Jid 144	metadiorite, sausseritized
Jid 147	hornblende metadiorite, sausseritized
Jid 197	hypersthene-hornblende metadiorite, sausseritized
Jid 221	hornblende diorite, sausseritized
Jid 223	hornblende diorite, sausseritized
O 275	sausseritized porphyritic hornblende diorite; pyroxenite; diabase

Rogue has not been divided into mappable lithologic units due to the intense fracturing and faulting that has destroyed the stratigraphic order. However, several rock types including agglomerates, fine to coarse-grained tuffs, flows, volcanic breccia and possibly pillow lava are present and have undergone slight metamorphism. General trends from east to west are spilites; tuffs; agglomerates (Figure 7); and porphyritic andesites. Local outcrops show augen mylonites and schists that are associated with shear zones. The Wilson Creek Traverse (Appendix A, Figure 2) is perpendicular to the trend of the Rogue. Similar stratigraphic sequences, as found in the Wilson Creek Traverse, could not be found and correlated in the Rogue.

The majority of Rogue rock types in the area are hydrothermally altered lithic tuffs (Figure 8), and are called greenstone in hand specimen. The range of alteration varies. The varying light to dark green color is due to ubiquitous chlorite, epidote, and clinozoisite, but color banding was not seen. The tuffs weather from light brown-green, to pale brown. The typically deformed tuffs tend to be well indurated.

The fine-grained tuffs are microcrystalline with a slight lineation. The coarse-grained tuffs range from

Figure 7. Flows and agglomerates of the Rogue Formation on north side of Gold Mountain.

Figure 8. Photomicrograph of coarse-grained tuff of the Rogue Formation. Note calcite veining and fragment with amygdulcs. Sample no. Jrg 149. Crossed nicols, x2.5.

augen mylonites to slightly deformed mylonites. The angular crystal fragments of the augen mylonite show trails of quartz and broken fragments. The crystal lithic tuffs show strong deformation with granules of pyroxene, quartz, and feldspar in the groundmass. The undeformed tuffs have apparent lithic fragments up to 5mm. The fragments are composed of volcanoclastic material with amygdules and previous flow rock fragments. Plagioclase is characteristically altered to sericite, epidote, and some clinozoisite. The An content range is 6 to 43 in most of the tuffs. Magnetite, ilmenite, calcite, pyrite, and chalcopryrite are minor accessories. Amygdules in the lithic fragments are filled with quartz, calcite, and zeolites (?).

The flow rocks of the Rogue include porphyritic andesite (Figure 10) and spilite (Figure 9). A typical porphyritic andesite volume percent is shown in Appendix B. The porphyritic andesites are black-green in hand specimen. They weather to form large angular blocks, especially near apparent shear zones. Pillow structures are not readily visible in the outcrops. Some of the flow rocks weather spheroidally and fracture conchoidally. Bedding planes between flows could not be traced due to metamorphism, fracturing, and folding. The groundmass in the porphyritic

Figure 9. Photomicrograph of spilite of the Rogue Formation. Note porphyritic pyroxene with albitic laths in sausseritized groundmass. Sample no. Jrg 145. Crossed nicols, x10.

Figure 10. Photomicrograph of porphyritic andesite of the Rogue Formation. Note twinned hornblende and plagioclase altering to epidote and sericite. Sample no. Jrg 213. Crossed nicols, x2.5.

andesites makes up at least 50 percent of the rock. The andesine phenocrysts range from An₄₀ to An₅₁ and are not zoned. The pilotaxitic groundmass is composed of plagioclase laths, epidote, chlorite, clinozoisite, and minor magnetite and quartz. Amygdule fillings are calcite, quartz, chlorite, epidote, and possibly zeolites. Other phenocrysts are clinopyroxenes (mainly augite) which are largely replaced by chlorite. Sericite is scattered throughout the plagioclase phenocrysts. Unaltered glass was not observed, although possible relict shards were noted.

The spilites are black-green to dark green in hand specimen. Fractures are typically conchoidal and highly angular. In thin section the albitic plagioclase phenocrysts are in a microcrystalline, felty to pilotaxitic groundmass. Oligoclase is rarely present. The groundmass consists of euhedral plagioclase altering to epidote and sericite. Clinozoisite and chlorite are also abundant, but less than epidote. Calcite, magnetite, and actinolite-tremolite are also present in the groundmass. Augite phenocrysts are altered to chlorites.

Several schists representing higher pressures and temperatures near shear zones, are found within the Rogue and are thought to represent dynamic metamorphism. A

biotite-plagioclase-epidote schist is found near the fault contact of the Rogue and Dothan Formations, and is probably of the quartz-albite-epidote-biotite subfacies of the greenschist facies of regional metamorphism (Turner and Verhoogen, 1960, p.538). Since some of the undeformed rocks of the Rogue are of the low greenschist facies, the schist probably represents a slightly higher grade of greenschist metamorphism of the Rogue. Sample number Jr 135 (see Figure 6) is a hematite-plagioclase-epidote-quartz schist. This schist is found at or near what is thought to be the sole of the thrust fault. The thrust has brought the Rogue in contact with the Myrtle Group. Peridotite is near the Jr 135 outcrop. The epidote occurs in bands, sworls, with many crystals angular and rotated. Plagioclase is of indeterminant composition. The hematite occurs as bands and sworls.

Greenschist is located in the most northern outcrops of the Rogue Formation. The greenschist trends N. 19 W. and dips 39 NE. along foliation. It is included with the Rogue due to similarities between the greenschist facies of metamorphism, and an apparent gradational contact from the Rogue metavolcanics to the south. The schist is medium green, foliated, aphanitic, and granoblastic. Minerals

and their approximate percents are: epidote (40 percent); chlorite (10 percent); augite (15 percent); quartz (20 percent); actinolite (8 percent); with minor amounts of pigeonite, clinozoisite, magnetite, pyrite, and iron oxides (6 percent). Stringers of chlorite and quartz are seen, even though schistosity is not pronounced.

Contact Relations

The Rogue is fault bounded on the east with the Dothan Formation (Figure 11). No stratigraphic continuity was found. The Rogue and Dothan are generally interpreted to be separated by a fault (Baldwin, 1969)(Hotz, 1969). Serpentinite has intruded along the fault as narrow bodies in the northern contact (Figure 12).

The Rogue is thrust westward over the Riddle Formation. Rud (1971) presents evidence for the thrust in the western adjacent area, and Baldwin (1969) shows thrusting of the Rogue Formation along the Rogue River two miles south of the thesis area. In the thesis area evidence of thrusting includes presence of serpentinite, a flatlying lower contact of the Rogue as defined by the outcrop pattern, and the physical position of the Rogue metavolcanics above the younger strata of the Myrtle Group.

Figure 11. Mule Creek drainage area from Mt. Bolivar. Note: 1) type area of Rogue Formation; 2) apparent faceted spurs on the Rogue Formation; and 3) approximate normal fault trace between the Rogue Formation (right) and Dothan (left). View looking southeast.

Figure 12. Serpentinite outcrop in sec. 32, T. 31 S., R. 9 W. Note resistant ridge.

Age and Correlation

Imlay and others (1959) state that the Riddle Formation rests with angular unconformity upon the Rogue Formation, and that the Rogue is at least Kimmeridgian in age or older. Hotz (1969) states that gabbro and quartz diorite plutons that intrude the Rogue have K-Ar dates of 138 to 150 million years. Lanphere and others (1968) date the end of the Nevadan Orogeny as 130 million years. The Rogue Formation in the thesis area contains intrusive rocks. Widespread regional metamorphism is thought to have occurred shortly after the Rogue was intruded by diorites, therefore the Rogue is assumed to be Middle to Late Jurassic and pre-Nevadan.

Exposures in the thesis area are called the Rogue Formation because of the similar lithologies to the type section (Wells and Walker, 1953), petrology of the type section (Helming, 1966), and presence of intrusions of supposed Nevadan age. Mapping of the adjacent area to the west by Rud (1971) also suggests thrusting. Stratigraphic positions of rocks in the thesis area are similar to those of the above areas and also to those shown by Hotz (1969) and Hixson (1965). Baldwin (1968, 1969) also referred to this rock type as the Rogue in the Mule Creek area.

Dothan Formation

Introduction

The Dothan Formation was named by Diller (1907) for a now abandoned railroad station along Cow Creek approximately eight miles east of the thesis area.

The thickness and petrology of the type section are unknown. The stratigraphic positions of the Rogue, Galice, and Dothan Formations have been a controversy since Diller (1907, 1914) stated that the section near Galice may be overturned. Taliaferro (1942), Wells and others (1949), Wells and Walker (1953), Dott (1965, 1971), Hotz (1969), and Baldwin (1969) have all discussed the relationships of the formations. As described by Wells and Walker (1953), the Dothan Formation in the Galice quadrangle is of Jurassic age and consists of a thick sequence of sandstone, siltstone, and shale, with a few lenses of chert and conglomerate, and layers of volcanic rock.

Distribution and Thickness

The Dothan has a large regional extent, ranging from Roseburg to the Oregon-California border at the coast (Wells and Peck, 1961). Dott (1971) states that the formation may be traced into California for some miles. The regional

trend is northeast, as it is in the thesis area, where the aerial extent is triangular. The width at the southern border is 5.3 miles, narrowing to about one mile in the northern section. A total of about 21 square miles is shown in Plate 1. Wells and Walker (1953) estimate the thickness to be greater than 18,000 feet. The thickness of the Dothan in the area is estimated to be 6,000 to 7,000 feet (Figure 13), based on lithologic outcrop patterns and general southeasterly dip of the formation. The actual thickness may be more, however, and the thickness has been adjusted to conform to the apparent structure.

The folds of the Dothan are commonly inclined or overturned to the northwest (Figure 15). Faulting has caused an increase in the apparent thickness. A measured stratigraphic section was not prepared owing to the complex deformation. The three units shown in Figure 13 are representative of major lithologic and textural differences in the Dothan. Actual gradations within the units many times are assumed, as are the stratigraphic positions of the units.

Figure 44 is a summarization on a contoured equal area net of the dips of the Dothan. The diagram indicates a southeast-northwest trend.

Figure 13. Generalized columnar section of the Dothan Formation. Thicknesses are estimates from cross sections. Symbols after Compton, 1962, p. 338.

Description

The rocks of the Dothan are entirely sedimentary. Volcanic flow rocks similar to those found by Wells and Walker (1953) and Baldwin (1969) to the south and east were not found. The Dothan is divided into three units based on apparent lithologic changes perpendicular to the average strike of the formation. The units are shown in Figure 13. Many of the beds, and even the units, are probably repeated by folding and faulting. The units are differentiated by sandstone volume content.

Unit one appears to be characterized by chert lenses, rhythmic sandstone and shale beds, and coarse conglomerates. The cherts are lenticular, about 30 feet by 15 feet thick, and commonly red or white. Figure 14 shows a typical alternating sandstone and shale sequence from unit one. The rhythmic sequence is 20 feet thick. Angular siltstone fragments in the sandstone are up to 9mm long. Conglomerate beds are discontinuous, dark gray, with about 30 percent matrix, and well indurated. The commonly fractured pebbles are red, white, green, black, and brown. One conglomerate sequence measured 38 feet thick. However, the thickness is probably modified in part by faulting and the actual stratigraphic thickness is unknown. Unit one crops out in

Figure 14. Typical alternating sandstone-shale sequence of unit 1, Dothan Formation.

the northern section and can be traced into the Dutchman Butte quadrangle (Figure 16). It also crops out in the southeastern section and can be traced into the Galice quadrangle.

The sandstone beds of unit two are more numerous and form massive, high angle outcrops (Figure 17). The sandstone content is more than that of unit three. Alternating beds are less common and conglomerate beds are absent. Friable mudstone beds are commonly interbedded. The mudstone beds weather readily to light brown clays, locally with chert concretions.

Unit three seems to contain the least volume of sandstone. Mudstones, siltstones, and shales are very abundant, especially in the western Mule Creek (Figure 18). The sandstone beds are much thinner and less widespread than in the other two units. The outcrops tend to form talus slopes composed largely of silts. Limestones lenses form small knolls 10 feet high in sec. 9, T. 32 S., R. 9 W. The mudstones become progressively argillaceous toward the Rogue fault contact in a zone ranging from 30 feet to 500 feet. Phyllites rarely exceed beyond four feet of the contact, and are well foliated, green-white, micaceous, with a satiny luster. They are well developed into drag

Figure 15. Slightly inclined fold in the Dothan Formation. Fold inclined to the northwest. Note hammer at center of fold.

Figure 16. Dothan Formation 'Unit 1' in sec. 27, T. 32 S., R. 9 W., alternating sandstone and siltstone beds. Note hammer at lower center.

Figure 17. Dothan Formation 'Unit 2' in sec. 29 T. 32 S., T. 9 W., massive sandstone with shale beds. Note hammer at lower center.

Figure 18. Dothan Formation 'Unit 3' in sec. 26, T. 32 S., R. 10 W. Note steeply dipping siltstones.

folds (Figure 46).

Sandstones of the Dothan Formation are lithic wacke, arkosic wacke, and feldspathic wacke (Figure 19). Modal compositions are shown in Appendix C for four samples. The lithic wackes are found in the apparent unit one. The arkosic and feldspathic wackes are found in the apparent unit two. Figure 20 shows the high chert content of the feldspathic wacke and Figure 21 shows the siltstone fragments found in many of the dark gray coarse lithic wackes. The high content of volcanic fragments in the sandstones indicates that deposition of the Dothan was probably during or not long after volcanic activity nearby. The percentage of matrix is low compared to alteration minerals and chert. The chert is probably due to weak incipient metamorphism of the Dothan. Many of the grains are angular and the muscovite tends to be crenulated.

The quartz grains were classified according to Folk (1968). Mosaic quartz is equivalent to recrystallized metamorphic, common quartz is plutonic, and composite quartz is reworked sedimentary with strong undulose extinction due to previous overgrowths. Plagioclase feldspar is much more abundant than the alkali feldspars. The An content of 29 plagioclase grains was determined by using

Figure 20. Photomicrograph of feldspathic wacke of the Dothan Formation. Note angular and unsorted plagioclase, lithic fragments, and mica. Sample no. Jd 166. Crossed nicols, x10.

Figure 21. Photomicrograph of lithic wacke of the Dothan Formation. Note angular siltstone fragments. Sample Jd 205. Nicols not crossed, x10.

the Michel-Lévy method (Kerr, 1959, p. 258) (Figure 22).

The frequency distribution is bimodal. This indicates at least two differentiated sources for the Dothan sandstones.

Contact Relations

The Dothan is in contact with the Rogue Formation, intrusive rocks, and serpentinite. A high angle fault, believed to be normal, and dipping to the southeast, separates the Dothan from the Rogue. Further discussion is in the structure section. Hotz (1969) also notes that the Rogue and Dothan are always separated by a fault and that a stratigraphic continuity does not exist between the formations. Baldwin (1968, 1969) states that a fault is separating the formations to the east and south. The amount of displacement is unknown.

The same high angle normal fault has placed the Dothan in contact with intrusives in sec. 5, T. 31 S., R. 9 W., and in Wilson Creek (Appendix A). No apparent metamorphism due to the intrusion has occurred in the Dothan. The lack of intrusive veining in the Dothan, xenoliths of Dothan sedimentary rocks in the intrusion, and the lack of high grade contact metamorphic minerals in the Dothan support a fault and not a gradational contact between the Dothan and intrusive rocks. A steep dip in the

Figure 19. Ternary diagram for comparison of sandstones of the thesis area (after Willams, Turner, and Gilbert, 1954).

Figure 22. An content for plagioclase grains in Dothan coarse grained sandstones.

Dothan shales (phylonites) in Wilson Creek also indicates a fault contact.

Serpentinite has intruded along the fault between the Dothan and Rogue Formations. The serpentinite is approximately 50 feet wide in the fault zone northeast of Gold Mountain. The largest outcrop is three-quarters of a mile wide where it has been emplaced between the Dothan and intrusive rocks at the confluence of Walker and West Fork Cow Creeks.

Age and Correlation

The age of the Dothan Formation is apparently Late Jurassic and post-Nevadan. Ramp (1969) found Buchia piochii in the Dothan on the Chetco River. This places the Dothan as Tithonian in age according to Imlay and Jones (1970). Fossils were not found in the Dothan in the thesis area. Several other factors point to a post-Nevadan age for the Dothan. The lack of intrusions indicate that deposition was post-Nevadan. The lack of regional metamorphism that has effected the nearby Rogue is absent throughout most of the Dothan. The relatively high content of volcanic rock fragments in the lithic wackes shows that a volcanic source was available and erosion was occurring in the volcanics. The low alkali feldspar content indicates that the source

area was lacking in granitic-plutonic type rocks and therefore may have been volcanic. However, Dott (1971) states that the K-spar content of the Dothan is deceptively variable, and that reasons for the variation are problematic. The An content of the plagioclase feldspars indicates that an andesitic source was available, such as the Rogue volcanics found in the area. These factors point to a post-Nevadan age and post-Rogue age for the Dothan.

Correlation with the Dothan as mapped by Wells and Walker (1953) is based largely on the similar lithologies of the unit in the extreme southeast section to exposures of the Dothan in the adjacent Galice quadrangle. The rocks mapped as Dothan in the area are also texturally, structurally, and lithologically similar to those described by Diller (1907) in the type section along Cow Creek, where access to the thesis area may be obtained from Riddle. The rocks are also mapped as Dothan by Wells and Peck (1961) on the Geologic Map of Western Oregon.

Myrtle Group

Introduction

The Myrtle Group of Diller (1898) was redefined by Imlay and others (1959) to include the Days Creek and Riddle Formations, and to exclude older strata. The name has been assigned to the rocks in the thesis area that are correlative lithologically and paleontologically to those in the type area. A historical summary of the name is given by Rud (1971).

The Myrtle Group in the thesis area is continuous with the rocks mapped as Myrtle Group by Imlay and others (1959) at Foggy Creek, three miles to the southwest. The lower part contains conglomerates, which grade into siltstones and the uppermost part is largely sandstones. According to Imlay and others (1959), the Myrtle Group is divided lithologically into the Riddle and Days Creek Formations by an abrupt change upward from a sequence that is dominantly gray siltstone to a sequence that contains many units of massive, greenish-gray sandstone.

Faunal localities confirm that these rocks are Myrtle Group as defined by Imlay and others (1959) (Figure 23 and Table 2). Representative ages in the area are Late

Figure 23. Index map of fossil localities.
See also Figure 24.

TABLE 2

FOSSIL LOCALITY IDENTIFICATION
AS FOUND IN FIGURE 23

<u>Sample</u>	<u>Name</u>	<u>Age</u>
Tuu 26*	<u>Ostrea</u> sp.	---
Tuu 34	plant debris	---
Tuu 73*	<u>Ostrea indigena</u> ? Anderson	---
Kdc 20*	<u>Buchia crassicolis</u> Keyserling	Lower Cretaceous
Kdc 23**	Pectinid pelecypod (<u>Neithes</u> ?)	Hauterivian?
Kdc 59**	<u>Crioceratites</u> sp.	Hauterivian
	<u>Pleuromya</u> sp.	Hauterivian
	<u>Phylloceras trintense</u> Anderson	Hauterivian
	<u>Lytoceras</u> sp.	Valanginian?
	<u>Buchia crassicolis solida</u>	Valanginian
Kdc 76**	<u>Pleuromya</u> sp.	Hauterivian
Kdc 77**	<u>Pecten operculiformia</u> Gabb	Hauterivian?
	numerous unidentifiable	
	ammonite scraps	---
Kdc 89**	ammonite scrap (<u>Phylloceras</u> ?)	Hauterivian?
	belemnite scraps	---
KJr 6	<u>Buchia piochii</u>	Upper Jurassic
KJr 38**	<u>Buchia</u> cf. <u>Buchia fischeriana</u>	Upper Jurassic
	belemnite scraps	---
KJr 80	<u>Buchia piochii</u>	Upper Jurassic
KJr 87	<u>Buchia piochii</u>	Upper Jurassic
KJr 93	<u>Buchia piochii</u>	Upper Jurassic
KJr 136	belemnite scraps	Lower Cretaceous?
KJr 156	<u>Buchia piochii</u>	Upper Jurassic
KJr 268	<u>Buchia piochii</u>	Upper Jurassic
KJr 272**	<u>Buchia piochii</u>	Upper Jurassic
KJr 274	<u>Buchia piochii</u>	Upper Jurassic

* Identification by R.E.Thoms, Portland State University, Portland, Oregon.

** Identification by D.L.Jones, U.S. Geological Survey, Menlo Park, California, personal communication, November 24, 1971.

Other tentative identification by writer.

Jurassic to Hauterivian (Jones, personal communication, November 24, 1971). The fauna indicate a discontinuous, broken sequence. The Buchia species also define the formations of the Myrtle Group, with Buchia crassicollis (Days Creek) and Buchia piochii (Riddle) useful in the field because of their distinct physical differences (Imlay, 1960).

Riddle Formation

Introduction

The Riddle Formation is named for the town of Riddle in Douglas County, but the type section is located about 10 miles east of Riddle on the South Umpqua River. The Riddle in the type section is divided into five paleontological and lithologically distinct units by Imlay and others (1959). Briefly, these are from the base: coarse conglomerate, nonfossiliferous (Unit 1); siltstone with limestone and conglomerate lenses, and Buchia piochii (Unit 2); conglomerate and conglomeratic sandstones, with Buchia piochii (Unit 3); interbedded siltstones and sandstone, with Buchia piochii and Buchia fischeriana (Unit 4); and conglomerate with siltstone and sandstone, the basal part containing Buchia piochii and Buchia fischeriana (Unit 5).

Jones (1969) states that the Riddle is also Berriasian with Buchia uncitoides as the diagnostic fauna. Figure 24 shows the faunal correlations in the thesis area.

Distribution and Thickness

The Riddle Formation is exposed in a northeasterly trending belt, thinning to the north, slightly out of the thesis area. A resistant conglomerate ridge is formed along the west side of West Fork Cow Creek. Dark gray siltstones are the dominant rock type near the eastern exposures.

The thickness in the type section as measured by Imlay and others (1959) is 1,088[±] feet. The thickness in the thesis area could not be measured due to folding and faulting that has apparently increased the actual stratigraphic thickness. The Riddle is believed to form an anticline, slightly inclined to the northwest. The general dip is southeast near the Rogue Formation, and northwesterly near the Days Creek Formation contact. Fauna evidence further provides evidence for the fold. This is discussed further in the following description and structure section.

Description

Units correlated with the type section as defined by Imlay and others (1959), are discussed from the eastern

European series and stages			Characteristic fossils in northwestern California and southwestern Oregon	This Study	Characteristic fossils in northwestern California and southwestern Oregon	This Study
LOWER CRETACEOUS (in part)	Valanginian	Upper	<i>Olcostephanus pecki</i>	Kdc59	<i>Buchia crassicolis</i>	Kdc20
			<i>Homalosomes quatsinensis</i>		<i>Buchia solida</i>	Kdc59
			<i>Thurmanniceras jenkinsi</i> <i>Crucerutites</i> sp., and <i>Neocraspedites giganteus</i>		<i>Buchia keyserlingi</i>	
		Middle	<i>Tollia mutabilis</i>		<i>Buchia pacifica</i> and <i>B. inflata</i>	
UPPER JURASSIC (in part)	Berriasian	Lower	<i>Thurmanniceras</i>	Kdc59	<i>Buchia aff. B. tolmatschowi</i>	
			<i>Spiticeras (Negreliceras) stonyense</i> and <i>Neocosmoceras</i> spp.		<i>Buchia uncioides</i> and rare <i>B. okensis</i>	
			<i>Substeuoceras</i> , <i>Proniceras</i> , and <i>Blanfordiceras</i>		<i>Buchia aff. B. okensis</i>	
			<i>Parodontoceras</i>		<i>B. fischeriana</i>	KJr38
UPPER JURASSIC (in part)	Volgian	Upper	<i>Kossmatia</i>	Kdc59	<i>Buchia piochii</i>	KJr6
					<i>Buchia elderensis</i>	KJr80
					<i>Buchia elderensis</i>	KJr87
					<i>Buchia elderensis</i>	KJr93
UPPER JURASSIC (in part)	Portlandian	Upper		Kdc59		KJr156
						KJr268
						KJr272
						KJr274

Figure 24. Faunal correlation in the southeast quarter of Bone Mt. quadrangle, Oregon (after Imlay and Jones, 1970).

exposures to the western exposures of the Riddle Formation. This is done to show that units are apparently repeated westward, and that faulting, or more probably, folding is the mechanism. Faulting is extensive and a few blocks of undifferentiated units are anomalous.

Unit 5 conglomerates were found within 50 feet of the Rogue contact in sec. 35, T. 31 S., R. 10 W. The pebbles consisted largely of apparent greenstone. Attitudes were not obtainable due to shearing, which also indicates proximity to the thrust and therefore correlation of this unit is unreliable.

Unit 4 is usually found in contact with the Rogue in the area. The unit was noted in the Wilson Creek Traverse (Appendix A). Figure 23 shows several Buchia piochii localities apparently along strike of the Riddle. The siltstone is typically dark gray, thin bedded, and locally massive or shaly. Buchia fischeriana was found in lithologically similar rocks near the Rogue contact on the western edge of the map (Figure 23). Limestone lenses occur sporadically, as do siltstones containing pebbles of green, black, and white chert. Alternating sandstones and siltstones of this unit overlie a thick bed of conglomerate in West Fork Cow Creek, and dip southeasterly.

Unit 3 is at or near the inferred surface trace of the axial plane of the anticline. It is composed largely of pebble conglomerate. Light brown sandstones are apparently scattered throughout, but of unknown stratigraphic position in the unit. The type section contains abundant Buchia piochii within this unit, but none were found in the area that could be correlated. The pebbly chert conglomerate is the most extensive unit of the Riddle in the area. Southern outcrops begin in Fuller Creek and extend northeasterly, forming ridges up to Stanley Creek at the boundary of sec. 19 and 18, T. 31 S., R. 9 W. A thickness of 125 feet was measured in the West Fork Cow Creek, one mile south of Ashur Flat. The bed appeared to be continuous, though locally fractured. Imlay and others (1959) measured unit 3 as 180 feet in the type section. The two other conglomerate units in the type section, 1 and 5, have measured thicknesses of 51⁺ feet, and 33 feet, respectively. The thickness, and composition of the pebbles indicate that this is unit 3 and not unit 1 or 5.

Unit 3 is overlain by conglomerates of the upper Umpqua member near the center of the intersection line of secs. 23 and 24, T. 31 S., R. 10 W. The conglomerates, where fresh, are difficult to distinguish in the field.

When weathered, the Riddle is typically reddish-brown and the Umpqua is light brown (Figure 25). The Riddle conglomerate in the area is much more sheared, and commonly shows slickensiding (Figure 26). The wacke matrix of the Umpqua is about 30 percent of the conglomerate, while the green-gray sandstone matrix of the Riddle conglomerate is about 15 percent of the total rock by volume. Table 3 shows a comparative analysis of the composition, sphericity, and roundness for 100 pebbles from each of the two conglomerates. The Umpqua data is presented in this section for comparative purposes. The Umpqua pebbles vary much more in composition and include many rock types. This would be expected since the Umpqua apparently overlies many varying rock types of the Klamath Mountains. The Riddle conglomerate of unit 3 is almost homogeneous in pebble composition, as it is in the type section. The older Triassic and Jurassic rocks of the Klamath Mountains contain many chert bearing beds. This could be a source for the Riddle chert conglomerate.

The average roundness for both conglomerates did not show a large difference. Pettijohn (1957) states that pebbles may become rounded over short travel distances. The comparative sphericity of the conglomerates indicates possible differing transport distances, energy available

Figure 26. Slickensided conglomerate of the Riddle Formation in sec. 24, T. 31S., R. 10W., note sheared pebbles. Note camera lens cap at lower left. Apparently correlative to Unit 3 of Imlay and others, 1959.

Figure 25. Conglomerates of the upper member of the Umpqua Formation (left), fresh Riddle Formation (rear center), and weathered Riddle (right). Umpqua sample is 15 inches long. Note angular pebbles of the Umpqua, and the well-rounded pebbles and reddish-brown color of the weathered Riddle.

TABLE 3

PERCENT COMPOSITION, SPHERICITY AND
ROUNDNESS FOR CONGLOMERATES

	Umpqua Fm. Component			Riddle Fm. Component	
	Sedimentary	Igneous	Metamorphic	Sedimentary	Igneous
* C	2	2	0	26	0
CP	6	2	0	10	0
CB	8	8	0	28	2
CE	6	4	2	20	0
P	2	4	0	0	0
B	14	8	4	12	0
E	20	0	2	4	0
UP	2	0	0	0	0
UB	0	4	0	0	0
UE	0	0	0	0	0
% Each	sandstone: dioritic:greenstone:			chert:	basaltic:
Rock	46	14	8	98	2
Type	chert: basaltic:				
	4	12			
	siltstone: granitic:				
	10	4			
	ultramafic:				
		2			
Total	60	32	8	98	2
Average					
Griffiths					
Sphericity	0.46	0.52	0.44	0.62	0.50
Total					
Average	0.48			0.61	
Roundness	0.67	0.63	0.61	0.67	0.78
Total					
Average	0.66			0.68	

* C = compact; B = bladed; E = elongated; V = very;
P = platy. See Figure 27 for further explanation.

to transport, composition of pebbles, and mode of transport (Figure 27). The Riddle pebbles show a higher sphericity, less tendency to be elongated, and a greater tendency to be compact.

Twenhofel (1947) states that conglomerates by themselves are not indicators of environmental significance. Other features, such as shapes and rounding of particles, sorting, orientation of particles in a deposit, presence of fossils, distribution and associations of deposits, and sedimentary structures in the conglomerates and interbedded sediments need to be analyzed for environmental indicators. Association of the Umpqua conglomerate with near shore sediments indicates that it was deposited on a beach environment, probably in a transgressive sequence. The environment of deposition of the Umpqua is further discussed in the formation section. The association of the Riddle conglomerate with shallow water fauna (Imlay and others, 1959), indicate a near shore agitated environment of deposition. Gradational contacts with other units of the Riddle are assumed to correlate with the type section.

Unit 2 of the Riddle Formation is found in a few outcrops west of Ashur Flat. The dark gray siltstone contains limestone concretions with Buchia piochii. The

* S = short axis; L = long axis; I = intermediate axis.

Figure 27. Sphericity form diagram for particle shapes (After Folk, 1968). See also Table 3.

outcrops average less than 10 feet thick.

Unit 3 apparently is continuous up the east slopes of the ridges, with unit 2 exposed only in centrally located isolated outcrops. The conglomerate has been faulted and broken into large blocks up to 30 feet thick.

Unit 4 is again exposed and separated from unit 2 west of Ashur Flat by the above conglomerate. Buchia piochii are not common, however the unit is characterized by interbedded siltstone and sandstone (Figure 28).

Scattered outcrops of this unit can be traced south along the ridge and northwest of Stanley Creek. The sandstone of the unit is a lithic wacke (Appendix C). A low alkali feldspar content has also been reported by Johnson (1965) and Hixson (1965) for Riddle sandstones near the type area. The high percentage of chert and calcite may indicate available silica and calcite during deposition in a marine environment (Figure 29). The low percentage of feldspars indicates a high chemical maturity with alteration and replacement of the matrix by minerals such as sericite.

Unit 5 apparently forms the ridge crest. The lower percentage of chert pebbles indicates that units 1 or 5 are present. Buchia piochii is more common in unit 5 than in unit 1 (Imlay and others, 1959). Lower Cretaceous

Figure 28. Interbedded siltstone and sandstone of the Riddle Formation in sec. 25, T. 31 S., R. 10 W. Apparently correlative to Unit 4 of Imlay and others, 1959.

Figure 29. Photomicrograph of lithic wacke of the Riddle Formation. Note abundant chert and calcite. Sample no. KJr 79. Crossed nicols, x10.

fauna, indicative of the Days Creek Formation, were found at 2800 feet on the west side of the ridge, and gives an approximate contact for the Riddle and Days Creek. The sandstone beds at this elevation are medium-grained, greenish-gray. This further indicates that the Days Creek is represented.

Folding appears to have been the major deformational mechanism because Buchia crassicollis, found near the upper Riddle unit 5, is indicative of the lower units of the Days Creek. Therefore the structure represented is anticlinal because: 1) the base of the Days Creek is near the upper Riddle on the western flank of the ridge; 2) the dips of units 4 and 5 of the Riddle are generally in opposition; and 3) the units of the Riddle are repeated to the west.

Contact Relations

The contact between the Riddle and Rogue Formations is apparently a thrust fault. The evidence is further discussed in the structure section. Serpentinities are in contact with the Riddle in the northern sections. The drag folded siltstones of the Riddle at the contacts are shaly, but unmetamorphosed. A fault contact, related to the thrust fault, is therefore, concluded. Remobilization

of the "cold" serpentinite may have occurred during thrusting, or during later orogenic movements, but the serpentinite does not appear to intrude the Riddle Formation. Allocthonous blocks of the Riddle are not found within the serpentinite.

The Riddle is assumed to be overlain by the Days Creek, based on fauna and attitudes near the contact. The contact appears to be conformable. In the northern section, the Umpqua overlies the Riddle with angular unconformity (Figure 34).

Age and Correlation

The age of the Riddle Formation is Tithonian to Berriasian (Imlay and others, 1959), (Jones, 1969), (Imlay and Jones, 1970). The Berriasian Buchia uncitoides as reported by Jones (1969) was not found in the area. Late Jurassic Buchia piochii and B. fischeriana (of the upper subzone of B. piochii) are abundant in the area (Figure 30), Table 2). Therefore the age of the Riddle in the thesis area is at least Tithonian (Late Jurassic) to probably Berriasian (Early Cretaceous).

The presence of Buchia piochii as identified by Jones (personal communication, November 24, 1971) in the Riddle, and its occurrence in the Otter Point Formation

(Koch, 1966), indicates that it persisted longer than previously supposed. Baldwin and Hess (1971) show Humbug Mountain Conglomerate unconformably upon the Otter Point, and the Humbug Mountain Conglomerate is generally considered equivalent to the Riddle Formation.

The rocks in the area are named Riddle Formation based on lithologic and paleontologic correlation with the type section, and with the Myrtle Group near Foggy Creek (Imlay and others, 1959).

Days Creek Formation

Introduction

The Days Creek Formation, as defined by Imlay and others (1959), concordantly overlies the Riddle Formation. The formation is named after the village of Days Creek in Douglas County. The type section is adjacent to and downstream from the type section of the Riddle. The Days Creek is distinguished from the Riddle by having greenish, thicker, and more sandstone beds that weather to a darker brown. The lower part of the Days Creek commonly contains plump Buchia crassicolis (Figure 31) that are easily distinguished from the slender Buchia piochii (Figure 30) in the underlying Riddle. The name Days Creek replaces the

Figure 30. *Buchia piochii* Gabb (Late Jurassic)
from the Riddle Formation. Sample no. KJr 272.

Figure 31. *Buchia crassicollis solida* (Valanginian)
from the lower member of the Days Creek Formation.
Sample no. Kdc 59C.

Horsetown Formation and the Cretaceous part of the Knoxville Formation, as used by Diller and Kay, 1924 (Imlay and others, 1959).

Distribution and Thickness

The Days Creek Formation is exposed for about three square miles in the thesis area. The best exposures are located on the western tributary of the West Fork Cow Creek. The formation forms the lower eastern slopes of the cuesta capped by the Tyee Formation. The formation is believed to dip northwesterly.

The thickness in the type area is about 800 feet (Imlay and other, 1959). Folding and faulting have probably stratigraphically thickened the formation. Rud (1971) measured a thickness of 1,300 feet in the adjacent exposures to the west. This is also the probable thickness in the thesis area.

Description

The contacts between the units of the Days Creek Formation are obscure within the area. Major folds or faults could not be traced, and the minor structure is not traceable for more than a few tens of feet. Both the lower (Valanginian) and upper (Hauterivian) members as defined by Imlay and others (1959) are represented in the area.

The lower and upper members of the Days Creek Formation are found in outcrop Kdc 59 (Figure 23). Fauna from this locality are Valanginian and Hauterivian (Jones, personal communication, November 24, 1971). The outcrop contains well indurated, greenish-gray, fine-grained, concretionary, sandstone weathering to red-brown. Intermixed siltstone with wood fragments complicate the stratigraphic relationships. Slickensiding and polished surfaces indicate extensive faulting has occurred. Since Buchia crassicollis solida (Valanginian), and the ammonite Phylloceras trintense Anderson (Hauterivian) (Figure 32) are present, a close proximity to the depositional contact of units 4 (lower member) and 5 (upper member) of the type section may be inferred. However, a fault contact is more probable since the outcrop is highly faulted and since Phylloceras trintense of the Wellsia packardi zone (Imlay, 1960) is found only in unit 7 of the type section. Buchia crassicollis was also found in an outcrop near the western margin of the area (Figure 23). Paleontologically, the lower and upper members may be arbitrarily divided along the centerline of sec. 34, T. 31 S., R. 10 W.

Unit 2 of the type section is believed to be represented in the southwest outcrops of the Days Creek. Medium

Figure 32. Phylloceras trintense Anderson (Hauterivian) from the upper member of the Days Creek Formation. Sample no. Kdc 59F.

Figure 33. Pleuromya sp. (Hauterivian) from the upper member of the Days Creek Formation. Sample no. Kdc 59B.

greenish-gray siltstone with numerous concretions yield the Buchia crassicollis. Unit 5 of the type section appears similar to outcrops in the eastern half of sec. 26, T. 31 S., R. 10 W. The unit consists of massive, dark greenish-gray sandstone. Dark gray siltstone containing numerous limestone concretions appear to be interbedded. The western half of the above section is dominated by a massive light greenish-gray pebbly sandstone that is well bedded in a few outcrops (Figure 35), and believed similar to unit 6 of the type section. A modal composition of the sandstone was made (Appendix C). The sandstone contains a high percentage of quartz, chert, calcite, and matrix (Figure 36). The sandstone is more quartzitic than the sandstones of the Riddle Formation. A siltstone unit that weathers spheroidally, and contains numerous concretions crops out west of, and stratigraphically above, the sandstone. This is assumed to be unit 7 of the Days Creek.

Contact Relations

The Days Creek Formation is overlain with angular unconformity by the upper member of the Umpqua Formation. Most of the contact is covered by vegetation, and slump blocks of the Umpqua. The contact is inferred from a definite change in lithology from a greenish-gray well

Figure 34. Angular unconformity between the upper member of the Umpqua Formation (above) and the Myrtle Group (below) in northern part of study area.

Figure 35. Bedded sandstone of the upper member of the Days Creek Formation in sec. 26, T. 31 S., R. 10 W.

indurated siltstone of the Days Creek, to a medium brown clayey siltstone of the Umpqua.

The contact with the Riddle Formation is assumed to be conformable. The absence of Buchia pacifica and Buchia uncitoides with associated fauna from the lower Valanginian and Berriasian are presumed to be due to faulting. An apparent lack of key beds, or distinctive lithologic sequences has caused some reliance upon Buchia zonation in order to correlate with the type section.

Age and Correlation

The age of the Days Creek Formation in the thesis area is defined by the fauna to be Valanginian and Hauterivian (Jones, personal communication, November 24, 1971). The fauna are shown in Table 3. The fauna zonation indicates that the Days Creek may be a syncline plunging to the southwest. Further biostratigraphy is apparently needed.

The rocks in the area are Days Creek based on lithologic and paleontologic similarities to the type section, and to the section near Foggy Creek (Imlay and others, 1959).

Myrtle Group Depositional Environment

The high percentages of chert and calcite in the sandstones of the Myrtle Group indicate deposition in marine waters. The basal conglomerate in places indicates periods of transgressive seas. The fauna of the Myrtle Group have been correlated with similar zones in Eurasia and Alaska by Imlay and others (1959). The fauna found in the area indicate the following environment (Imlay, 1959, 1960), (Imlay and others, 1959), (Jones, 1969), (Jones and others, 1969), (Imlay and Jones, 1970): 1) Buchia thrives on hard bottoms in shallow much agitated waters, generally less than 100 feet deep; 2) the presence of the thin shelled ammonites, the phylloceratids and Lytoceras (Sample number Kdc 59) suggest that the Valanginian and Hauterivian marine waters along the Pacific Coast were connected broadly with the main ocean immediately to the west; 3) the lack of any close affinities with Valanginian and Hauterivian faunas in Mexico suggests the presence of some kind of a barrier, either physical or environmental, or both; and 4) the affinities with Eurasia and the lack of them with Mexico suggest that major currents in the northern Pacific Ocean were similar to those existing today.

The lack of turbidity type sediments and volcanic units indicate shallow water, noneugeosynclinal deposition. The evidence therefore indicates deposition in a shallow marine embayment with a source area to the south and east. The older Mesozoic rocks of the Klamath Mountains which presumably were uplifted in Nevadan times apparently provided some of the source material.

Figure 36. Photomicrograph of lithic wacke of Days Creek Formation. Note angular grains of quartz, abundant chert and calcite, and dark red staining of iron oxides. Sample No. Kdc 72. Crossed nicols, x10.

Umpqua Formation

Introduction

The Umpqua Formation consists of eugeosynclinal rocks of the southern Coast Range and was named by Diller (1898) while mapping the Roseburg quadrangle. The members are separated by angular unconformities. Baldwin (1964, 1965) has divided the Umpqua into lower, middle, and upper members, the type sections of which are in the Camas Valley and Roseburg quadrangles.

The upper member is present in the thesis area and is traceable from the adjacent western area (Rud, 1971). Baldwin (1965) states that distinction in the field is difficult, and reliance upon stratigraphic position is often necessary. Since the Umpqua of the thesis area is overlain by the Tyee with a very slight angular unconformity, including the exposures in the upper member is reasonable.

The best exposures of the upper member are in the Camas and Flourney Valleys. Here the unit has a thin, basal conglomerate or pebbly sandstone grading upward into siltstone, and appears to be of shallow water origin as shown by coal beds and oysters.

Distribution and Thickness

The upper member of the Umpqua Formation is exposed as a narrow belt trending northeast. A slight thickening in the north may be due to massive slumping. The best exposures are north of the thesis area.

The thickness of the upper member, based on cross sections, is approximately 800 to 1,000 feet. Rud (1971) measured the unit as 800 feet thick in sec. 33, T. 31 S., R. 10 W. The thickness in the Flourney Valley ranges between 2500 and 3500 feet (Baldwin, 1964).

Description

The upper member of the Umpqua Formation in the thesis area contains conglomerate, sandstone, sandstone interbedded with siltstone, and siltstone. The sandstones are arkosic wackes based on modal compositions (Appendix C, Figure 19).

The lower beds contain more conglomerate and pebbly sandstone than the upper beds. A basal conglomerate overlies the Riddle Formation in secs. 23 and 24, T. 31 S., T. 10 W. The composition, roundness, and sphericity is discussed under unit three of the Riddle Formation and shown in Figure 27 and Table 3. The conglomerate is not laterally continuous along strike.

The sandstones that were point counted show very low feldspar contents as compared to those of Rud (1971), Krans (1970), and Trigger (1966). This is probably due to a higher matrix count since the sandstones were fine-grained and the feldspars are highly altered to sericite. The sandstone grains are poorly sorted, angular to sub-rounded with up to 30 percent matrix (Figure 37). Lithic fragments are common and typically volcanic. The sandstone beds range from two inches to 10 feet in thickness. The thicker sandstone beds grade into a sandstone-siltstone sequence in the middle part of the formation (Figure 38). Oysters were found in dark gray, thin bedded, concretionary siltstone beds (Figure 39). Sedimentary structures such as cross bedding and flute casts were noted in slump blocks in southerly exposures.

The upper member is not well exposed in the area due to soil cover and vegetation. Stratigraphic sequences were not measured due to slumping. However, the uppermost beds directly beneath the Tyee Formation are well exposed in several outcrops. These beds tend to be siltstone and finely laminated coaly layers with plant debris. The siltstone is light brown and micaceous. The oysters and coaly layers are suggestive of a shallow water origin for the

Figure 37. Photomicrograph of feldspathic wacke of the upper member of the Umpqua Formation. Note abundant angular quartz and chert. Sample no. Tuu 64. Crossed nicols, x10.

Figure 38. Interbedded dark gray siltstone and sandstone of the upper member of the Umpqua Formation. Lowermost beds contain oysters. Note hammer lower left. Fossil locality Tuu 73.

Figure 39. *Ostrea indigena*? Anderson from the upper member of the Umpqua Formation. Sample no. Tuu 73.

upper member in the thesis area.

Contact Relations

The upper member of the Umpqua Formation overlies the Myrtle Group with angular unconformity (Figure 34). The basal conglomerate is in contact with Riddle Formation conglomerates and Days Creek Formation coarse-grained pebble sandstone. Faulting in the Myrtle Group is extensive and this contact relationship cannot be traced in the field for long distances. Extensive slumping of the Umpqua Formation also obscures the contact, which is more readily seen in the northern part of the area between the Riddle and Umpqua Formations. Lithology and attitude changes suggest the contact. The Myrtle Group sandstones tend to have a greenish tinge and are much better indurated than the Umpqua sandstones, which are light brown. Except where mass movements occur, the attitudes of the Umpqua tend to be regionally constant, while the Myrtle Group ranges from vertical to horizontal within short distances.

The upper member of the Umpqua is overlain by the Tyee Formation with slight angular unconformity. The contact appears to be disconformable in numerous outcrops in the thesis area. Regionally, however, the Tyee is shown to overlie the three members of the Umpqua (Baldwin,

1965). The contact is indicated by a contrast between the siltstones of the upper member of the Umpqua and a cliff forming basal pebble sandstone of the Tyee. Slightly more mica is noted in hand specimen of the Tyee, than the Umpqua sandstones. The upper Umpqua overlies the Rogue and Dothan Formations north of the thesis area.

Age and Correlation

Ostrea indigena? Anderson were found in the thesis area (Figure 39). Numerous unidentifiable pelecypods and gastropods were also found. Baldwin (1965) states that:

"The age of the upper Umpqua is apparently middle Eocene. Foraminifera from the upper part of the Rock Creek section near Bone Mountain were considered to be in the upper B zones or Narizian by Rau (written communication). Its position between the middle Umpqua and the Tyee Formation also points to a middle Eocene age."

The basal conglomerate, coal beds, oysters, and sandstone grading upward to siltstones indicate that the upper member in the thesis area is similar to the upper member of the Camas and Flourney Valleys (Baldwin, 1964).

Tyee Formation

Introduction

The Tyee Formation was named by Diller (1898) in the Roseburg quadrangle. A type section has not been designated, however, Tyee Mountain can be considered the type locality. The reader is referred to bordering areas for a more complete description of the formation (Rud, 1971) (Krans, 1970) (Johannesen, 1972).

Description

The Tyee Formation is the youngest unit exposed in the thesis area, and makes up less than two square miles. The Tyee occupies a major north-south trending syncline of the Coast Range. The thickness of the formation in the adjacent western area was measured as 3500 feet (Rud, 1971). Baldwin (1965) states that the thickness is about 2500 feet at Eden Ridge.

Three units of the Tyee were noted in the thesis area. A basal pebbly sandstone is about 50 feet thick. This basal sandstone forms prominent cliffs which can be seen for a number of miles (Figure 45). Cross bedding in the sandstone was noted. Overlying the pebbly sandstone is a sequence of thin interbeds of coal seams, bluish-

brown concretionary sandstone, black shales, and light tan sandstones. The sequence was measured as 23 feet thick. The interbedded sequence is overlain by massive, micaceous, light brown, coarse-grained sandstones that can be traced out of the thesis area. Modal compositions of the sandstones are shown in Appendix C. The sandstones are classified as arkosic wackes. Concretions up to five feet in length were found in the upper massive sandstone of the thesis area (Figure 40). Fossil logs are found in nearby areas (Rud, 1971).

Age and Correlation

The Tyee Formation overlies the upper member of the Umpqua Formation in the thesis area. Contact relations are discussed in the Umpqua section. Diagnostic fossils were not found in the area, however plant debris near thin coal beds was found. The coal beds, fossil logs, and lateral structures such as cross bedding, cut and fill, and flute casting indicates a near shore environment for the Tyee.

Thoms (1964) has assigned the Tyee Formation to the Ulatisian Stage of Mallory. Thoms (1964) states that this is "approximately equivalent to Turner's determination of a 'Domengine' age...and seems to corroborate the 'Domengine'-

Ulatisian equivalence in California."

Figure 40. Calcareous concretions in the Tyee Formation. In sec. 27, T. 31 S., R. 10 W.

Intrusive Rocks

Peridotite-Serpentinite

Distribution. A linear belt of ultramafics as shown by Wells and Peck (1961) on the Geologic Map of Oregon was not found between the Rogue and Dothan Formations. Several exposures of peridotite, very commonly serpentinitized, occur in the area. Serpentinite also occurs in numerous small scale shear surfaces in the Riddle and Dothan Formations. The largest body of peridotite is in the northern part of the area (Plate 1). The irregular surface configuration is nearly one square mile. This outline suggests obscure internal faulting, deep erosion, and emplacement along or into a previous sheared and irregular surface or fracture and fault system. Outcrops along West Fork Cow Creek show the typical greenish-black color with abundant quartz veins (Figure 41). The numerous offset veins indicate the highly sheared effects of post-intrusive movements. Serpentinite can be traced from the western border of the body to a linear pattern along the Rogue and Dothan Formation contact near Gold Mountain Creek.

A second body of peridotite, $1\frac{1}{2}$ miles long by $\frac{1}{2}$ mile wide, almost entirely altered to serpentinite, is found

Figure 41. Peridotite with quartz veining. Note numerous offset veins indicating movement after emplacement. Located in West Fork Cow Creek.

separating the Rogue and Dothan Formations along Wallace Creek. The double tongued body is apparently entirely enclosed within the Rogue. The shape indicates that the serpentinite has been squeezed up into fault zones that were not located in the field, but are suggested by relationships on the map (Plate 1). These faults cannot be traced into the Dothan. Several large enclosed blocks of unaltered peridotite were found at the crest of the resistant serpentinite ridge.

Other serpentinite exposures are also associated with the fault zones. The smallest mappable serpentinite body in the area is located between the Rogue and Dothan Formations east of Mt. Bolivar. The exposure is in a road-cut and can be traced for less than 100 feet in all directions by float. A serpentinite body less than $\frac{1}{2}$ mile in diameter was located between the Rogue and Riddle Formations in the southern part of the area. Exposures and contacts are largely covered by vegetation and soil cover. A small series of outcrops of serpentinite was located between the Rogue Formation and alluvium at the southwestern border below Saddle Peaks.

Contact Relations. The serpentinite is characteristically highly sheared and locally foliated. The color

ranges from yellow-green and green, to black. The outcrops, especially in the northern region, typically show the serpentinite as sharp flaky chips, with spheroidal, slickensided and waxy slip surfaces. These features allow the serpentinite to be in sharp contrast with adjacent rocks.

Serpentinite contacts with the Riddle Formation are probably faults genetically related to the thrust fault. This may be assumed if the serpentinite acted as a "tectonic carpet" for thrusting as suggested by Coleman (1969). Since much of this serpentinite appears to be highly sheared, the fault may be related to later orogenic movements.

A large body of serpentinite northwest of Gold Mountain surrounds part of the Rogue Formation. Exposures indicate that several untraceable fault systems exist through the peridotite in a northeast trend. Several allocthonous blocks of Rogue greenstone are enclosed within the serpentinite in the two large northern bodies. Serpentinite has apparently intruded along shear zones into diorite in sec. 5, T. 31 S., R. 9 W. The diorite is cut by the Rogue-Dothan fault and the serpentinite does not appear to cross the fault into the Dothan Formation. The diorite intrudes the serpentinite in exposures along West Fork Cow Creek.

Diorite

Distribution. The intrusive rocks that are completely enclosed within the Rogue Formation have not previously been mapped in the area. Baldwin (1968, 1969) found similar intrusive rocks that are also enclosed within the Rogue Formation. These rocks have the appearance of gabbro or metagabbro in hand specimen. The rocks form an irregular linear belt almost the entire length of the Rogue.

Description. Modal composition of four samples of the diorite are shown in Appendix B. All the rocks have been hydrothermally altered to differing degrees. Secondary minerals are shown separately to indicate the extent of alteration. In hand specimen the rocks are medium gray with a slight greenish tinge, and equigranular, medium-grained plagioclase and hornblende occur in a dark gray groundmass.

In thin section the rocks are hypidiomorphic-granular, allotriomorphic with some panidiomorphic, felty plagioclase, and locally pseudo-ophitic. Secondary minerals, epidote, clinozoisite, and zoisite, have completely replaced the plagioclase in numerous specimens. Whether the grains were plagioclase cannot be ascertained with certainty, however, the squarish euhedralism of the grains indicate plagioclase.

Since many euhedral unaltered plagioclase grains were observed in some of the thin sections, it is assumed that the completely altered euhedral grains were plagioclase. The secondary minerals may have formed from a number of the parent minerals and may preclude verification of alteration products. The rocks are called metadiorite because sausseritization due to hydrothermal alteration has occurred in all of the samples.

Subhedral coarse-grained hornblende and hypersthene occur in large enough amounts in a few of the specimens to use them as descriptive minerals of the diorite. The hornblende is commonly pleochroic from brown to green. The apparent freshness and replacement of the plagioclase in some thin sections indicate that the rocks are incompletely adjusted to the greenschist facies.

The An content of sample Ji 144 indicates that this rock is of the greenschist facies. Turner and Verhoogen (1960, p. 533) state that the plagioclase of the greenschist facies is An₀ to An₇. Helming (1966) also notes that many of the rocks in the type section of the Rogue Formation are incompletely adjusted to the greenschist facies. The modal compositions indicate a high percentage of clinozoisite either as a replacement of the euhedral plagioclase or as

replacement of the groundmass. When clinozoisite is abundant, plagioclase is noticeably in small amounts, and indicates that replacement has occurred.

Quartz, pyroxene, and biotite are absent or not abundant in all of the samples. Whether the hornblende is a replacement of the primary pyroxene is not known. However, hornblende is shown in Figure 42 to be altering to actinolite-tremolite. This replacement is common in the greenschist facies (Turner and Verhoogen, 1960, p. 534), and would indicate that the hornblende is primary and not a replacement of pyroxene. Pseudomorphs of hornblende after pyroxene were not found. Where pyroxene was found above trace amounts, chlorite occurred in relative abundance, indicating that chlorite may be the replacement product.

The rocks are named diorite because: 1) the rocks contain less than 50 percent ferromagnesium minerals and their apparent replacement products; 2) the plagioclase, when unaltered, tends to be about An_{35} to An_{45} ; 3) alkali feldspars are absent; 4) quartz is absent, or not in abundance; and 5) the original textures, though locally cataclastic, appear to be hypidiomorphic-granular.

Contact Relations. Gradational, and fault contacts

occur between the diorite and the Rogue Formation east of Mt. Bolivar. However, several outcrops were found with Rogue xenoliths in the diorite (Figure 43). It is believed that the more gradational contacts are in zones of intense shearing, indicating that alteration has obscured the contact. The diorites are therefore believed to be igneous, and not metamorphic equivalents of the Rogue.

The diorites do not intrude the Dothan Formation and are sheared by the fault in sec. 5, T. 31 S., R. 9 W. They are intruded by serpentinite in this area, yet the outline of the serpentinite indicates that faults controlled the intrusion. The diorite is seen to intrude the peridotite-serpentinite in the West Fork Cow Creek. The diorite also is sheared by the fault as shown in the Wilson Creek Traverse and appears to enclose part of the Rogue Formation.

Other

Samples found in the creek bed of sec. 36, T. 31 S., R. 10 W. are of igneous origin. These samples indicate that the intrusive body probably is about $\frac{1}{2}$ mile upstream. One sample contained phenocrysts of hornblende with the groundmass highly altered to epidote group minerals. A second sample contained augite and plagioclase in an

Figure 42. Photomicrograph of hornblende diorite. Note alternation of hornblende to actinolite-tremolite, and dark sausseritized groundmass. Sample no. Jid 221. Crossed nicols, x10.

Figure 43. Diorite with xenoliths of Rogue greenstone. Near confluence of Slide and West Fork Cow Creeks. See figure 2.

ophitic texture. Alteration in this diabase was not complete. A sample composed almost completely of enstatite was also found. Antigorite and chromite are minor constituents.

Petrology

The intrusive rocks in the thesis area are considered to be Late Jurassic since they intrude the Rogue Formation. Similar intrusive rocks occur in nearby areas (Lund and Baldwin, 1969), (Baldwin and Hess, 1971). The rocks in the adjacent Galice and Marial quadrangles (Baldwin, 1968, 1969), (Kays, 1967), tend to be structurally controlled by faulting and fracture zones. Irwin (1964) discusses ultramafics between the major arcuate thrust belts in the Klamath Mountain-Sierra Nevada Complex. Coleman (1969) states that the serpentinites may act as tectonic lubricating "carpets" for overriding thrust sheets. However, the serpentinites are located sporadically along the thrust fault.

Factors to be considered regarding the emplacement of the intrusive rocks are the source of the material, variation in the physical state and temperature between the source and position of the body, and post-intrusion history. The source of the peridotite in the thesis area

is unknown. However, nearby peridotites have been studied. Lack of metamorphic aureoles in the Rogue Formation near contacts indicate that the peridotite was tectonically emplaced in a fairly solid state (Coleman, 1969), (Dietz, 1963). The peridotites originated in the mantle (Medaris, 1972) (Coleman, 1971). Association with the Rogue Formation also indicates an oceanic mantle derivation for the peridotites in the area. Helming (1966) indicates that the Rogue Formation in the type section may be of primary magma and of a marine environment. The source of the spilites in the Rogue are of primary origin and not metasomatism of marine sediments (Helming, 1966).

Serpentinization of the peridotite, according to Turner and Verhoogen (1960), occurs under aqueous conditions where the peridotite has cooled to below 500° during, or subsequent to, intrusion. This is a possible explanation for the lack of metamorphism of the Riddle Formation which is in contact with the serpentinites and supports the presence of a fault contact.

The source of the diorite intrusion in the thesis area is unknown. The linearity of the diorite is suggestive of a previous structural control, probably related to the original orogenic environment of the Rogue. Since the

diorite is slightly metamorphosed, presumably at the same time as the Rogue, it was probably emplaced shortly after the Rogue, but before regional metamorphism occurred. The linear pattern of the diorite also suggests that it is nearly vertical, similar to a dike, and discordant with the Rogue, assuming the Rogue is dipping generally southeastwardly. Since the diorite is seen to intrude the peridotite, it is younger. However, serpentinite that is presumed to have been remobilized, has intruded the diorite.

In summary, the Rogue Formation in the thesis area is intruded by mantle derived peridotite that was probably emplaced tectonically during the Nevadan Orogeny. Apparently under similar structural controls, and during the Nevadan, the diorite then intruded the Rogue and peridotite. Serpentinite, presumably from the local body of peridotite and other nearby peridotite masses, was intruded into faults and fracture zones developed during and after the Nevadan Orogeny.

STRUCTURAL GEOLOGY

Introduction

Several intense periods of structural deformation are represented in the thesis area. The strike of the pre-Tertiary rocks conforms to the surrounding northeast trends in the Klamath Mountains. The dips of the oldest rocks are southeasterly while the Tertiary rocks dip northwesterly. The Tertiary rocks have been subjected to relatively milder periods of deformation.

Most of the structural features in the pre-Tertiary rocks appear to be related to compressional stresses from the southeast. The Rogue Formation appears to have been the most severely effected unit in the area.

Folding

The folding of the pre-Tertiary rocks is apparently related to the two major fault systems in the area. Large scale folding was not observed in the Tertiary rocks.

Structural features in the Rogue Formation are largely obscured by metamorphism, weathering, and vegetation, however, a few aspects have been noted. Wells and Walker

(1953) state that the Rogue dips steeply to the southeast. Kays (1967) states that folds in the Rogue in the type area are reclined to the southeast, and plunge mainly north. Dips on agglomerate and flow beds on the north flanks of Gold Mountain are northeast to northwest. However, the intense deformation and numerous faults within the strata indicate that these attitudes are not reliable. If the Wilson Creek Traverse may be taken as at least one valid section perpendicular to the assumed strike of the formation, then the different rock types are not repeated in an ordered sequence and the Rogue may not be complicated by internal folding. At least two features may be concluded from the Traverse: 1) the Rogue is not horizontal, and therefore conforms to regional attitudes; and 2) the beds are vertical, steeply dipping, or do not have great thicknesses, as shown in the Traverse and West Fork Cow Creek exposures by the continually changing lithologies perpendicular to the assumed strike.

A regional southeasterly dip of the Dothan Formation was noted by Wells and Walker (1953). Kays (1967) states that the Dothan appears to be plunging to the north. A Schmidt net analysis of bedding attitudes of the Dothan is shown in Figure 44. The analysis indicates the style

Figure 44. Schmidt net plot of bedding (S_0) in Dothan Formation. Contours represent number of poles/1 percent area; total of 52 poles.

and orientation of structure and not type or size. The type and size are indicated by reference to the field map. As shown in the figure, a weak girdle exists from southeast to northeast (P. E. Hammond, personal communication). The style of fold appears to be reclined. The dips of the Dothan appear to be generally southeast in the western sections, and northwest in the eastern sections. A more detailed structural analysis may indicate this. The dips therefore appear to be toward a central region, indicating a synclinal feature.

The size of this feature is indicated by the changing lithologies of the Dothan and are termed units 1, 2, and 3 in this report. Unit one is designated as the youngest based on the general attitudes shown by the analysis and would be indicated as being the youngest based on a regional southeasterly dip of the formation. Unit 1 crops out in the eastern sections of the Dothan exposures.

Factors that have been considered are that attitudes plotted on Schmidt nets for an entire formation may indicate several depositional generations, and therefore would plot as plunging folds. Also considered is the fact that a number of assumptions and generalities have been made. The folding conforms to an apparent regional compressional

stress from the southeast.

Folding in the Myrtle Group is complicated by the numerous small scale faults observable in the field. Evidence for the anticlinal structure in the Riddle Formation has been discussed in a different section. In summary: 1) the units correlated to the type section are apparently repeated perpendicular to the strike of the Riddle; 2) attitudes are opposite to a central region within the Riddle; and 3) fauna locality identification indicates repetition on the flanks of the structure. The formation dips to the southeast near the Rogue thrust fault and therefore conforms to regional inclined folding in the Myrtle Group. Overturning of the Myrtle Group apparently has not occurred.

A fold in the Days Creek Formation is inferred from fauna identification and attitudes of bedding. The fauna indicate that the oldest beds of the Days Creek are in contact with the Riddle and also are located near the western border of the map (sample numbers Kdc 20, and Kdc 59). Whether the Riddle continues to encircle the Days Creek in northern areas is unknown due to the concealment by Tertiary beds. These factors indicate that the Myrtle Group may occupy a gently southwesterly

plunging syncline.

The Tertiary rocks in the thesis area are locally folded. The Tyee and Umpqua Formations strike northerly and dip northwesterly with dips averaging about 20 degrees. The beds occupy the eastern edge of the Eden Ridge syncline (Baldwin, 1965) (Rud, 1971). Gentle warping of the upper Umpqua apparently occurred before deposition of the Tyee (Baldwin, 1964). The northerly strike may be due to east-west stresses (Rud, 1971). The dips appear to be slightly greater than those in the adjacent western areas of the syncline and may be due to higher depositional dips on the edge of the syncline which is shown by the shallow water depositional environment of the coaly beds and oysters.

Faulting

Faulting was not observed in the Tertiary sedimentary rocks of the thesis area, except for minor faults related to mass movement blocks of the Umpqua. Two faults that are regionally important have been mapped (Plate 1). Evidence indicates that a thrust fault as mapped by Rud (1971) is continuous into the thesis area in sec. 16, T. 32 S., R. 10 W. (Figure 45). A contact as shown by

Wells and Peck (1961) and Baldwin (1964, 1965) has been mapped as a normal fault. Baldwin and Rud (1972) also indicate this fault to be normal. However, new evidence in the thesis area indicates a southeasterly dip and relative movement, with the Dothan Formation downfaulted, to be opposite of previous observations. Relative regional movement of this fault is not shown by Wells and Walker (1961).

Minor internal faulting has been noted in the units of the area. Trends of several fault zones are discussed in the introduction based on a rose diagram of stream orientation (Figure 3). Folding in the area is believed to be contemporaneous with the major faulting.

The thrust fault brings the Rogue Formation into contact with the Riddle Formation. The contact was not observed, but Riddle siltstones and Rogue greenstone provided numerous outcrops for the approximation. The contact in Wilson Creek and West Fork Cow Creek was covered by vegetation. The dip of the fault is between 30 and 40 degrees, as shown by relationships between the formations up streams. The thrust is continuous from the west based on field relationships, and indicated or suggested by the following: 1) the trace of the fault is

sinuous, indicating a relatively low angle and undulatory fault surface; 2) the pre-Nevadan Rogue is topographically higher than the post-Nevadan Riddle, especially in stream valleys and cannot be explained by folding; 3) serpentinite and peridotite are present along the contact, indicating tectonic as opposed to intrusive emplacement (Coleman, 1969, 1971). The irregular outline of the largest body indicates an irregular surface during thrusting; 4) rocks of the Riddle Formation exhibit higher pressures and shearing effects. The siltstones are brittle, more argillaceous, and locally shaly near the contact, while the conglomerates are slickensided and contain sheared pebbles; 5) the dips of the Riddle conform to a regional compressive stress; 6) apparent folding of the Myrtle Group is slightly inclined to the northwest, again indicating forces from the southeast; 7) greenschists probably derived from the Rogue greenstones are in the northern sections. This indicates higher pressures and temperatures that would be associated with the sole of the thrust; and 8) inclined folding in the Dothan Formation (Figure 15) also suggests compressive forces from the southeast.

The age of thrusting cannot be obtained from the contacts within the thesis area, except to show that it is

post-Days Creek and therefore probably no older than Late Cretaceous in age. However, a date may be inferred from contacts just north of the area. Here the upper member of the Umpqua Formation overlies the Rogue greenschist and Riddle Formation. Baldwin and Lent (1972) state that the lower member of the Umpqua Formation (lower Eocene) may have been thrust in areas to the west and the Colebrooke Schist may rest on Paleocene and early Eocene beds. The thrust therefore could have occurred during the early part of the middle Eocene. There may be several stages of thrusting in southwestern Oregon.

The thrust fault is of regional extent as shown by Irwin (1964), who first postulated major thrust belts of the Klamath-Sierra Nevada Complex. Baldwin (1969) shows that a thrust fault exists at the western contact of the Rogue Formation in the type area. Baldwin and Rud (1972) indicate that the relative movement of the Rogue was westward over the Dothan Formation and then dropped by normal faulting against the Dothan. Baldwin (1969) shows the Rogue-Dothan contact dipping southeasterly.

A second fault of regional extent is found in the thesis area. The fault is found between the Rogue and Dothan Formations from the thesis area to Shasta Costa

Creek, northeast of Agness. It is approximately parallel to the thrust fault, but is apparently a high angle normal fault. Serpentinite has intruded along the fault in the northern sections, and the fault cuts intrusions in the Rogue Formation. Slickensided rocks of the Rogue near the contact are numerous. The Dothan is locally phyllitic and shows drag folding (Figure 46).

Relative movements on the fault have not been shown prior to this report except by Baldwin and Rud (1972). In the thesis area, the Dothan Formation has been downfaulted relative to the Rogue Formation by a high angle normal fault as indicated or suggested by the following: 1) drag folding in the Dothan Formation on West Fork Cow Creek show the Dothan to be downfaulted; 2) apparent drag folds in the Dothan in Wilson Creek shown by a southeasterly dip of the beds near the Rogue contact (Appendix A); 3) the fault trace does not appear to be topographically controlled, and is dipping 85 southeast in West Fork Cow Creek; 4) appearance of faceted spurs in the Rogue Formation in the Mule Creek area (Figure 11); 5) the West Fork Cow Creek has produced a narrow gorge where it flows through the Rogue Formation, suggesting a superposed stream; and 6) Johannesen (personal communication, 1972) states that an

Figure 45. Eden Valley (E.V.) and western sections of thesis area from Saddle Peaks. Note approximate location of thrust fault and cuesta capped by the Tyee Fm. in background (arrow). X indicates western border of thesis area in sec. 16, T. 32 S., R. 10 W. Compare Plate 1. View looking north.

Figure 46. Normal fault contact between the Dothan Formation (left) and Rogue Formation (right). Note the drag folding of the Dothan argillites and phyllites. Near confluence of Walker and West Fork Cow Creeks, looking south.

extension of the fault would explain an anomalous part of the lower Umpqua in the area north of Gold Mountain, and the east side would have to be downdropped.

Regional correlations are suggestive of an age for the fault. The upper member of the Umpqua Formation overlies a northern extension of the fault in a questionable contact just north of the area. This would indicate that the fault is pre-middle Eocene. Baldwin (1968) shows southward extension of the fault displacing the middle member of the Umpqua Formation. The age of the fault may be therefore inferred as middle Eocene.

The two major faults in the thesis area appear to be of similar age. Apparently the exact age will have to be determined outside the thesis area. A working model for the genesis of the faults in the thesis area must include evidence for thrusting and apparent compressional stresses from the southeast on the overriding block, or a similar stress on the underthrust sheet from the northwest. The apparent uplifted block of Rogue metavolcanics cannot be accounted for in its present position by being dropped after thrusting as proposed by Baldwin and Rud (1972), unless an opposite movement on the same Rogue-Dothan normal fault occurred after the Rogue was dropped, and

therefore indicates a later tectonic pulse.

Several authors have shown that northwestward thrusting has occurred. These include: Irwin (1964); Dott (1971); Baldwin (1969); Baldwin and Rud (1972); Baldwin and Lent (1972); Davis (1969); Coleman (1971); Coleman and Lanphere (1971); and Hamilton (1969). Westward thrusting has therefore occurred during the Cenozoic. This would seem to preclude a working model based on the suggestion that the Rogue-Dothan normal fault has a greater strike slip component than a vertical component, which can be inferred from the great regional length and linearity. Therefore the Rogue-Dothan fault does not appear to be related to strike slip movements on the transform San Andreas Fault System (Atwater, 1970).

The appearance of the Rogue-Dothan normal fault indicates crustal lengthening, but association with the Rogue Thrust Sheet suggests that the fault may be more genetically related to thrusting and therefore crustal shortening. A proposed working model according to the evidence in the thesis area and regional thrusting suggests that the Rogue Formation and associated ultramafics were thrust up from beneath the Dothan Formation. Several problems exist with this model. The drag folds in the

Dothan in the Galice quadrangle (Baldwin and Rud, 1972) are explained. The thrust and normal faults do not appear to be genetically related unless the normal fault bends eastward at depth, or the normal fault represents a relaxation of the Rogue Thrust Sheet. Evidence for this cannot be presented. The Rogue Formation and associated intrusives could then have been thrust westward and squeezed up from depths. Deep burial would account for the regional metamorphism of the Rogue volcanics.

Whether the assumptions are valid and consistent with regional deformation will be seen with more detailed structural analysis of the Rogue-Dothan normal fault near the Rogue Thrust Sheet.

GEOLOGIC HISTORY

The geologic record began in the thesis area with the deposition of the Rogue volcanics in a deep, submarine environment, as indicated by the thicknesses of the Rogue and parts of the contemporaneous Galice Formations. The deposition of the Rogue apparently began during Oxfordian to Kimmeridgian stages of the Cretaceous with submarine flows, tuffs, agglomerates, and breccias probably forming islands. Intrusion of mantle derived peridotites into the basin apparently began during the Nevadan Orogeny, about late Kimmeridgian. Serpenitization of the peridotites apparently occurred during this time by intrusion into the marine rocks of the eugeosynclinal basin. The mafic intrusives were presumably intruded into the Rogue Formation along linear fracture zones that may have also been the routes for the peridotites. Hydrothermal alteration of the Rogue also occurred by deep burial apparently during the Nevadan Orogeny, since the associated intrusive rocks also show alteration. Whether the Rogue Formation was part of the regional thrusting during the Late Jurassic cannot be ascertained in the thesis area.

Following this period of deformation, thick sequences of graywacke and siltstone of the Dothan were probably deposited on a marine shelf. The paucity of fauna, the presence of black shale units, and conglomerate lenses indicate that the depositional environment of the Dothan must have been extensive. The source area may have been to the east since the formation appears to contain more siltstones to the west. Parts of this eugeosynclinal basin were sources of volcanic rocks probably related to late pulses of the Nevadan Orogeny. The angular unconformity between the Myrtle Group and the Rogue and Dothan Formations in the type area indicate that another period of deformation followed deposition of the Dothan which caused destruction of stratigraphic correlation within the eugeosynclinal basin. Irwin (1964) shows the Rogue thrust over the Dothan Formation. However, apparently the survival of the Buchia piochii during this pulse indicates that the Riddle Formation sediments may have interfingered with the Dothan near shore deposits.

The Myrtle Group was deposited in an apparent marine embayment, probably the continental slope and shelf. The Riddle Formation contains lowermost conglomerates with abundant fauna. The structures of the beds and fauna

species indicate that lateral currents were available for movement of the deposits. Major uplift could have occurred at this time since the thick lower conglomerate beds may represent rapid deposition in the basin, or uplift of the source area. Since the Days Creek contains more sandstone beds than the Riddle, uplift of the source area, or eugeosynclinal basining, may have ceased during the deposition of the upper parts of the Myrtle Group. Although conformity is interpreted here, a small hiatus representing a short erosional period may have occurred during the deposition of the Myrtle Group, as indicated by the lack of fauna during middle Valanginian.

The geologic record is missing in the thesis area from late Early Cretaceous to lower or middle Eocene. During the Eocene, but apparently before deposition of the upper member of the Umpqua, a major period of tectonism occurred. Two major faults in the area are believed to have formed at this time. The Rogue Formation may have been thrust over the Riddle Formation, and during, or shortly thereafter, the Dothan was downfaulted with respect to the Rogue. Serpentinite acted as a lubricant along the planes of the thrust and possibly along normal faults also. Major folds apparent within the Dothan and Myrtle Group

further indicate compressional stress from the southeast.

While major faults were obscuring the geologic history of the Klamath Mountains, a linear geosyncline had developed along the Pacific margin. The trough had been filled with volcanics and thick sediments by middle Eocene and the upper Umpqua was deposited in the thesis area. Basal conglomerates of the upper member of the Umpqua Formation that represent a transgressive sea are the first deposits in the area since the Days Creek was laid down. The faulting had ceased by this time. Pebble compositions indicate that the source for the conglomerate of the Umpqua was most of the Klamath Mountains and early Eocene sediments. Overlying sandstones and siltstones containing plant debris and oysters indicate that the area was on the margins of swampy inlets and yet open to brackish waters.

Uplift of the Klamaths during the close of the middle Eocene caused regression of the Umpqua sea and rapid deposition of the Tyee Formation into a linear basin from the south and east. The Tyee in the thesis area contains a sequence of coaly beds which indicate the southern borders of the basin, and possible the latest of the Tyee deposition.

Changes in the sea level, probably during the Pleistocene, caused the deep erosion of the Rogue in the area.

Gravels containing gold were deposited in northeast trending streams. Erosion and weathering of both provinces in the thesis area have occurred since that time.

ECONOMIC GEOLOGY

Gold and copper are the economic minerals that have been mined within the thesis area. Placer gold has been taken from stream gravels in Fuller Creek, part of the upper West Fork Cow Creek, and northeast in sec. 36, T. 32 S., R. 10 W. As reported by Brooks and Ramp (1968), some placer mining was done in Fuller Creek (Fuller Placer or Gold Back Mines) between 1936 and 1941. At that time a low bench gravel was being hydraulicked in a pit about 200 feet in diameter, and 10 to 75 feet deep. Production values are not recorded. Gold can still be obtained by panning in both of the above pits. The amount and values are small however. The gravels appear to be part of a Pleistocene stream valley that trended northeast. The source may have been the diorite body in the Rogue meta-volcanics as lode gold has been reportedly mined throughout the area.

Lode gold deposits are confined to the mafic intrusive body as mapped in the area and the Rogue Formation (Brooks and Ramp, 1968) and (Hotz, 1971). As reported by Brooks

and Ramp (1968) the gold occurs in quartz fissure veins with mixed sulfides and some free gold. Sulfides in these veins usually include pyrite, chalcopyrite, and arsenopyrite with less common galena, pyrrhotite, and sphalerite. Gold is often mechanically intermixed with these sulfides, and in places the sulfide concentrates are exceptionally rich in gold. Most of the veins are less than a foot wide. Near shear zones where fracturing has allowed oxidation and leaching, supergene enrichment of the gold has produced rich pockets (Brooks and Ramp, 1968).

Two lode gold mines have been reported in the thesis area by Brooks and Ramp (1968). Several others have been active along the Mule Creek south of the area. An abandoned state lode gold mine is recorded on the southeast flanks of Gold Mountain. Local residents state that the location is activated each summer, and a small cabin can be seen on the hillside. The other mine (Paradise Mine) was located between the 4116 and 3931 elevation peaks of Saddle Peaks, at about 3200 feet (Brooks and Ramp, 1968). They report (after Butler and Mitchell, 1916) that the mine is reached by $4\frac{1}{2}$ miles of steep trail, presumably from Marial. Dump piles can be seen from Saddle Peaks in this location. Three tunnels were dug, from 230 feet to 45 feet long.

The vein is faulted with discontinuous tapering segments widening to as much as four feet in places, with an easterly strike and dipping steeply to the south. Free gold values are unknown, and about 1000 pounds of selected ore was taken. The mine was apparently active around 1900.

Copper deposits are also associated with Nevadan intrusive rocks in the thesis area. The copper deposits may be the result of precipitation from solutions associated with the mafic intrusion of the area, but this has not been ascertained. The solutions apparently entered the weak shear and fracture zones near where the peridotite-serpentinite had been emplaced. Diller (1914) reports similar deposits throughout the Klamath Mountains. The minerals usually associated with the copper deposits are chalcopyrite, pyrite, pyrrhotite, and oxidized ores of malachite, azurite, cuprite, and chrysocolla (Diller, 1914). Copper mineralization was noted near several exposures of the serpentinite in the thesis area, especially in the northern body.

Copper has been mined at the Bolivar Copper mine located in a north trending ridge from Saddle Peaks. The mine is largely open pit, and tunnels now concealed have been dug 790 feet into the ridge and were 197 feet from the

surface. Bornite samples were taken from these tunnels that were dug in the early part of the century in search for lode gold (R. F. Carr, personal communication, Roseburg, Oregon, 1972). Two carloads of 100 tons each were sent from the mine to a smelter in Tacoma, Washington in 1967 with copper concentrate percentages of 16 percent, and 7 percent (Carr, personal communication, 1972). The mine is now inactive.

The mineralization in the thesis area occurs in sporadically rich deposits as shown by the mining activity. Terrain, vegetation, and investment have also been reasons for discouragement of the development of the mineral deposits.

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APPENDIX A

WILSON CREEK TRAVERSE

Wilson Creek is an east-west trending tributary of the West Fork Cow Creek. The trend may follow a weak fracture zone. A fault shear zone was not located parallel to the course of the creek. The horizontal cumulative distance is given in feet beginning 400 feet east of the Dothan-Rogue contact. See Plate 1 for symbol explanation.

Figure 47. Numbers refer to sample localities. See description. See also Figure 2.

APPENDIX A (CONTINUED)

<u>Feet</u>	<u>Description</u>
0	143. Fine sedimentary beds. Black, thin-bedded well indurated shales of the Dothan Formation. Numerous quartz veins at oblique angles to bedding planes. Elevation 2270 feet. Trend N. 36° E., 80°-90° SE.
400	144. Diorite. Light green aphanitic, very hard in hand specimen. Elevation 2265 feet. Lineations absent.
720	145. Spilite. Dark green, porphyritic, with epidotized phenocrysts in aphanitic groundmass. Appears very microcrystalline and fractures conchoidally. Weathers spheroidally. Epidote (?) veining. Elevation 2260 feet. Trend N. 15° E., 80°-90° SE.
1330	146. Undifferentiated greenstone. Confluence of unnamed stream. Pebbles from stream are gabbro and diorite. Elevation 2220 feet. Lineations absent.
1860	147. Hornblende diorite. Light green-gray, equigranular, euhedral plagioclase, and anhedral hornblende in aphanitic groundmass. Elevation 2190 feet. Lineations absent.
2940	148. Coarse-grained tuff. Dark black-green, non-foliated. Porphyroclasts up to 4mm. Slightly mylonitic. Elevation 2140 feet. Lineations absent.
3970	149. Coarse-grained tuff. Dark black-green, massive. Quartz veining. High specific gravity. Angular porphyroclasts up to 5mm. Elevation 2130 feet. Lineations absent.
4650	150. Coarse-grained tuff. Sausseritized, pilotaxitic, slightly trachytic groundmass. Dark green groundmass. Clasts are white-green

APPENDIX A (CONTINUED)

<u>Feet</u>	<u>Description</u>
	up to 7mm. Lenticular dark gray-green nodules which are unoriented and appear cherty in hand specimen. The nodules average 3 inches long.
5310	151. Sausseritized flow (?). Aphanitic. Light green. Highly fractured. Quartz veins abundant. Elevation 2040 feet. Lineations absent.
5570	152. Siltstone. Black. Numerous small folds. Lenticular limestone nodules average 10 inches long. Underlain by conglomerate with chert pebbles dominant. Strike N. 61° E., 39° SE. Elevation 2030 feet.

The total horizontal distance is 5570 feet, and the total elevation loss is 240 feet.

APPENDIX B

MODAL COMPOSITION OF IGNEOUS ROCKS VOLUME PERCENT

Thin Section No. Component	Jid 144 (a) (Intrusive)	Jid 147 (b) (Intrusive)	Jid 197 (c) (Intrusive)	Jr 213 (d) (Rogue Fm.)	Jid 223 (e) (Intrusive)
Clinopyroxene (i)	2.1	0.7	trace	16.0	trace
Plagioclase (ii)	40.1	14.2	0.1	24.2	0.2
Epidote	37.2	14.6	2.5	3.1	15.2
Hornblende	3.5	22.9	25.8		22.6
Hypersthene	0.6		2.9		0.8
Enstatite					trace
Chlorite	11.3	trace			trace
Quartz	0.9				
Idocrase		0.4	trace		
Clinozoisite (iii)			37.5		

APPENDIX B (CONTINUED)

Thin Section No. Component	Jid 144 (a) (Intrusive)	Jid 147 (b) (Intrusive)	Jid 197 (c) (Intrusive)	Jr 213 (d) (Rogue Fm.)	Jid 223 (e) (Intrusive)
Opaque	5.3	7.5	2.2	2.3	1.6
Groundmass (iv)		39.8	27.4	53.8	50.6
Actinolite-Tremolite		trace			9.2
An Range	10	27-40	*	40-51	*
Content Average	7	35		44	
Classification (after Williams, Turner, and Gilbert, 1954)	Metadiorite	Hornblende Metadiorite	Hypersthene- Hornblende Metadiorite	Porphyritic Andesite	Metadiorite

* unknown due to alteration and replacement

(i) mainly augite, rarely pigeonite

(ii) includes undifferentiated K-feldspar in trace amounts

(iii) may include some epidote and zoisite

(iv) includes clinozoisite, zoisite, plagioclase, epidote, sericite, iron oxides, sphene, calcite, and possibly quartz; appears white under reflected light, and

APPENDIX B (CONTINUED)

drusy - cloudy-opaque under plane polarized light

- (a) some chlorite is pennine; opaques are magnetite, illmenite
- (b) opaques include magnetite, illmenite, pyrite, chalcopyrite; idocrase occurs within hornblende; sausseritized groundmass
- (c) opaques include pyrite, magnetite (especially within hornblende); sausseritized groundmass
- (d) opaques include magnetite; epidote includes undifferentiated chlorite; groundmass includes chromite; clinopyroxene mainly augite; sericite altering from plagioclase in trace amounts
- (e) opaques include pyrite, chalcopyrite, magnetite; sausseritized groundmass; uraltized clinopyroxene

APPENDIX C

MODAL COMPOSITION OF SEDIMENTARY ROCKS
500 COUNTS PER THIN SECTION
IN PERCENTAGE

Thin Section Formation	Tt30(a) Tyee	Tt35(i) Tyee	Tuu64(b) Umpqua	Tuu85(c) Umpqua	Kdc72(d) DaysCreek
Constituent					
Common quartz	20.5	29.9	21.9	17.4	12.1
Mosaic quartz	2.4		0.4		0.6
Composite quartz	0.8		4.3	1.0	0.6
Vein quartz	0.6				
Detrital chert	1.2		0.2		2.3
Plagioclase(1)	11.5	31.4	6.3	3.9	3.3
K-feldspar	9.5	26.7	4.8	4.3	1.8
Sedimentary rock fragment	0.4		0.2	2.8	4.7
Volcanic rock fragment	7.6	2.5(k)	4.1	1.2	0.2
Metamorphic rock fragment	2.5	3.0(k)	0.4		0.6
Muscovite	7.5		9.8	5.1	1.6
Biotite	0.2	17.9(k)			
Pyroxene	tr	0.8(k)	0.4	0.4	
Opaque	0.2	9.2(k)	0.2	8.5	1.9
Chert(2)	9.8		12.7	12.6	15.2
Calcite(2)	tr				32.1
Chlorite(3)	4.1	3.3(k)	4.3	6.5	5.1
Sericite(3)			6.9	5.7	4.7
Iron oxides(3)	3.5		3.9	0.8	0.9
Matrix(4)	23.3	32.4	18.4	29.6	13.5
Other	0.6	36.9(k)	1.0	0.2	0.8
Classification*	arkosic wacke	arkose	arkosic wacke feldspathic wacke	arkosic wacke feldspathic graywacke	lithic wacke lithic graywacke

APPENDIX C (CONTINUED)

Thin Section Formation Constituent	KJr79(e) Riddle	Jd178(f) Dothan	Jd166(g) Dothan	Jd205(h) Dothan	Jd108(j) Dothan
Common quartz	6.2	22.8	26.6	22.2	19.6
Mosaic quartz	0.8	3.2	1.1	3.3	0.8
Composite quartz	1.4	2.6	0.6	0.9	0.4
Vein quartz					
Detrital chert	4.2	1.3	2.5	0.4	1.2
Plagioclase(1)	1.9	13.2	14.1	7.3	12.3
K-feldspar	0.2	0.4	0.4	0.2	0.4
Sedimentary					
rock fragment	9.5	1.3	5.6	10.8	5.7
Volcanic rock					
fragment		3.6	4.0	2.5	4.8
Metamorphic					
rock fragment		0.4	0.4	1.9	1.8
Muscovite	1.2	2.8	1.5	0.9	1.9
Biotite		1.3	1.3		
Pyroxene			1.1	1.6	0.8
Opaque	4.8	1.1		1.6	1.9
Chert(2)	22.4	15.6	19.8	26.6	23.8
Calcite(2)	22.4		0.4	1.9	2.5
Chlorite(3)	10.2	7.7	9.1	7.1	9.0
Sericite(3)	1.9	6.2	3.7	7.7	9.4
Iron oxides(3)	1.4	3.6	0.4	0.8	0.6
Matrix(4)	10.4	5.1	4.3	1.4	3.7
Other		1.1	5.2	1.2	0.1
Classification*	lithic wacke lithic graywacke	arkosic wacke feldsp graywacke	feldspa wacke feldspa graywacke	lithic wacke lithic graywacke	lithic wacke lithic graywacke

* Classification after Williams, Turner, and Gilbert, 1954; Pettijohn, 1957.

- (1) undifferentiated feldspar reported as plagioclase.
- (2) as cement
- (3) as part of matrix
- (4) matrix-includes unidentifiable clays, opaque material, indistinguishable quartz, chert, sericite, chlorite, plagioclase, and some replacement minerals.
- (a) includes trace amounts of zircon, unidentifiable grains, magnetite, hornblende.

APPENDIX C (CONTINUED)

- (b) includes trace amounts of illmenite, magnetite, unidentifiable grains.
- (c) includes trace amounts of calcite; opaques include pyrite, chalcopyrite; sedimentary rocks mainly siltstone; alkali feldspars tend to be cloudy.
- (d) opaques include pyrite, chalcopyrite, illmenite; iron oxides include limonite, hematite; other includes unidentifiable grains.
- (e) opaques include chalcopyrite, magnetite, pyrite; the low percentages for plagioclase indicate high replacement; chert may be felty; matrix includes replacement chlorite; calcite also occurs as veinlets.
- (f) includes trace amounts of augite; some chlorite is pennine; opaques are magnetite, chalcopyrite; other includes hornblende, orthopyroxene, calcite.
- (g) other includes epidote, hornblende, unidentifiable grains; chlorite replacing biotite; plagioclase is cloudy and replaced by sericite in many grains; opaques are chalcopyrite; chlorite also occurs as pennine.
- (h) other includes epidote, unidentifiable grains; opaques include chalcopyrite, magnetite; angular siltstone fragments up to 8mm.
- (i) stained for feldspar after heavy mineral separation; matrix percent assumed from loss during separation.
- (j) opaques include magnetite, chalcopyrite; other includes zoisite, epidote, replacement clays; metamorphic fragments are phyllite and schist
- (k) heavy mineral separation; percents are of total heavies.

GEOLOGIC MAP of the SOUTHEAST QUARTER of the BONE MOUNTAIN QUADRANGLE

COOS, CURRY, & DOUGLAS COUNTIES, OREGON

PLATE 1

EXPLANATION

QUATERNARY	Qal	Alluvium Unconsolidated silts, sands and gravels
	Unconformity	
MIDDLE EOCENE	Tt	Tye Formation Massive micaceous sandstone and siltstone
	Unconformity	
MIDDLE EOCENE	Tuu	Upper Umpqua member Micaceous sandstone and siltstone
LOWER CRETACEOUS	Kdc	Days Creek Formation Siltstone and sandstone
LOWER CRETACEOUS - UPPER JURASSIC	Kjr	Riddle Formation Siltstone, sandstone and conglomerate
UPPER JURASSIC	Jd	Dathan Formation Sandstone and siltstone with conglomerate and chert lenses
UPPER JURASSIC?	Jid	Intrusive Rocks Mafic, variably metamorphosed
UPPER JURASSIC?	Jps	Ultramafic Rocks Peridotite and Serpentine
UPPER JURASSIC?	Jrg	Rogue Formation Metavolcanics

- ?--- Contact, dashed where inferred
- U D ---?--- Fault, U, upthrown; D, downthrown, dashed where inferred
- ?--- Thrust Fault; sawteeth in upper plate, dashed where inferred
- 30
1
Strike and dip of bedding
- A --- A' Line of cross section

TOPOGRAPHY BY U. S.
GEOLOGIC SURVEY, 1954

CONTOUR INTERVAL 80 FEET

GEOLOGY BY
RICHARD C. KENT, 1972

SCALE 1:31,250
1/2 0 1 2 miles

GEOLOGIC CROSS SECTIONS

APPROXIMATE MEAN
DECLINATION, 1954