STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

702 Woodlark Building

Portland 5, Oregon

Bulletin No. 40

PRELIMINARY DESCRIPTION

of the

GEOLOGY OF THE KERBY QUADRANGLE, OREGON

by

Francis G. Wells, Preston E. Hotz, and Fred W. Cater, Jr.

Geologists, United States Geological Survey

1949

Prepared in Cooperation with the United States Geological Survey

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*Geologists, U. S. Geological Survey

INTRODUCTION

Purpose

Knowledge of the geology of an area is essential to an adequate appraisal of its mineral resources and to a solution of engineering and scientific problems that are related to bedrock, soils and surficial deposits. Therefore the Oregon State Department of Geology and Mineral Industries in cooperation with the U. S. Geological Survey is preparing geologic quadrangle maps of the state as rapidly as funds and available personnel will permit. It is the policy of the State Department of Geology and Mineral Resources to release promptly information that is of value to the public. In line with this policy this geologic map of the Kerby quadrangle, based on field work finished in November 1946, is being issued now before it has been possible thoroughly to digest the data collected and to complete laboratory studies of the materials collected. Hence, as most geologists will understand, the map is to be regarded as preliminary. The classification and description of the rocks shown on the map is largely based on field examination alone and is certain to be modified in some particulars by laboratory study of the specimens collected. A final report embodying the results of this study and of other scientific work is planned for later publication by the U. S. Geological Survey.

Field work

Geologic mapping of the quadrangle was begun in July 1940 and continued until the end of October; it was resumed the first week of June 1941 and continued until the end of September. During these two seasons the project was under the immediate direction of Francis G. Wells of the U. S. Geological Survey. He was assisted by Preston E. Hotz, Gordon L. Bell and Harold L. James. As the season of 1941 progressed Wells was able to give only supervision and review, and it became necessary to recess the project after war was declared. Wells, ably assisted by Fred W. Cater, Jr., resumed field mapping in May 1945 and continued until the second week of September; they returned to the field late in May 1946 and completed mapping the end of October. Hotz and Cater have contributed much to the preparation of this report, which has been written by Wells.

Acknowledgments

Cordial thanks are due to the many inhabitants of southwestern Oregon and to other persons interested in its resources for generous help and cooperation. It would be impossible to name all those to whom the parties were thus indebted but the following persons were particularly helpful: Edward Cox, Fritz Grunow, William L. Heustis, E. W. Kubli, Chester M. Zachary, and H. F. Byram of the Rustless Steel Mining Co.; the personnel of the Oregon State Department of Geology and Mineral Industries, the former Director Earl K. Nixon, the present Director F. W. Libbey, and geologists of the Department stationed in Grants Pass--Ray C. Treasher, Elton Youngberg and Hollis Dole.

Anyone who lives and works in unsettled mountainous country must depend on the Forest Service for many things, and the Survey parties enjoyed the liberal generosity and courtesy extended by all of the personnel of the Siskiyou National Forest, especially by H. C. Obye, Supervisor, C. D. Cameron, Harold Bowerman, and Cecil Hathaway.

Previous work

Many of the mineral deposits in the quadrangle as well as some of the geology have been described in published reports, a selected bibliography of which is given at the end of this text. P. J. Shenon (14) has systematically mapped 33 square miles in the vicinity of Takilma, and his work is incorporated in the present map. Geologic maps of the Riddle, Grants Pass and Medford quadrangles, which adjoin the Kerby on the northwest and east, and the Port Orford quadrangle to the northwest, have been published either by the U. S. Geological Survey or by the State Department of Geology and Mineral Industries in cooperation with the U. S. Geological Survey.

GEOGRAPHY

Location

The Kerby quadrangle is in southwestern Oregon and is bounded by the meridians 123° 30' and 124° 00' west, and by parallels 42° 00' and 42° 30' north. Its south boundary almost coincides with the Oregon-California state line, and all of the quadrangle except the southwestern quarter, which is in Curry County, is in Josephine County. The quadrangle comprises 890 square miles.

Accessibility

No railroad enters the quadrangle but good roads serve its eastern part. U. S. Highway 199 traverses the length of the Illinois Valley, and gravelled or paved roads lead up its broader tributary valleys to the west, such as Clear and Sucker Creeks. Dirt roads, impassable in wet weather, lead short distances up the narrow valleys and ridges. Three Forest Service roads lead westward from Highway 199. They are from north to south, the Onion Mountain Road that goes to Ferren Guard Station, the road down Illinois Canyon to Oak Flat, and the older Wimer road which goes to Sourdough Camp in the southwestern corner of the quadrangle. All are impassable from late fall to late spring except the road down Illinois Canyon.

No road penetrates the western third of the quadrangle. One can drive to within a few miles of its northwestern corner by taking the Forest Service road to about three miles beyond Agnes. Otherwise, this rugged region is accessible only by trails, and many of which are in poor condition and impassible to pack trains.

Topography

Some of the most rugged terrian in southwestern Oregon is in the Kerby quadrangle. Except for 60 square miles of rolling hills and flats in the Illinois Valley, the region is a wilderness of narrow ridges and steep canyons. Slopes that have an average grade of 30° or more, through a range of 2,000 to 4,000 feet are common. Box canyons 100 or more feet deep wall in many of the streams in the north and west.

The peaks in the southeastern corner of the quadrangle are over 5,200 feet above sea level. Pearsoll Peak near the center of the quadrangle has an altitude of 5,091 feet, and in general the ridges and summits are above 4,000 feet. The lowest point in the area is on the Illinois River in the northwestern corner of the quadrangle with an altitude of between 100 and 200 feet. Many of the stream beds lie below 1,500 feet.

Three independent river systems, the Illinois, Chetco and Smith, drain the quadrangle, except for the northeastern corner which is drained by Rogue River.

Culture

The high precipitation of the region--51.5 inches per year at Waldo--gives it a dense covering of vegetation, much of which is underbrush. Mixed forests, predominantly coniferous, cover most of the area. Large portions of the wooded tracks are of little use, but there are large stands of good timber and the accessible stands of these have yielded much lumber. A little farming and some stock raising are carried on in the Illinois and its broader tributary valleys and the adjacent slopes. All but about a dozen of the 3,800 people who live in the quadrangle are settled in these valleys. Cave Junction is the largest community with a population of about 1,000 in 1940. Although mining has been carried on actively in the past, very little was going on in 1945 and 1946.

DESCRIPTIVE GEOLOGY

General statement

The general distribution of the larger rock units in the Kerby quadrangle is simple. Bands of sedimentary, volcanic, and intrusive rocks--metamorphosed to various degrees--trend across the quadrangle in a north-northeast direction. From east to west they are: metavolcanic and metasedimentary rocks of the Applegate group of Triassic(?) age; slates, sandstones and metavolcanic rocks, of the Galice formation of Upper Jurassic age; intrusive peridotites of late Mesozoic age; a complex of other Mesozoic intrusive rocks; and a band of massive sandstones, shales and flows of the Dothan formation of Upper Jurassic age. At various places within these bands are small areas of younger rocks. A small area of Cretaceous sandstone crops out in Illinois Valley, and nearly flat-lying Tertiary and Quaternary conglomerates and sandstones are scattered in the quadrangle. Younger dikes, possibly Cretaceous in age, are widespread. Close folds parallel to the north-northeast trend are the dominant structures of the region. Thrust faults parallel to the axes of these folds and complicated faulting at angles to them modify the fold-pattern.

Some alluvium is found in the broader parts of the stream valleys.

Amphibole gneiss (age uncertain)

Gneissic and schistose rocks are exposed in several areas in the Kerby quadrangle. The largest mass extends from the northern boundary of the quadrangle 10 miles south by west, a second area is in the valley of the Chetco and Little Chetco Rivers, and the third crops out along the ridge dominated by Chetco Peak. Scattered between these large areas of gneiss are a few smaller bodies, each occupying a few acres or less, which occur as roof pendants in the peridotitic and granitic rocks.

The gneiss and schist in all the areas are alike in lithology and in the degree of metamorphism which they exhibit. In general, the rocks are dark- to light-gray, banded, medium-grained rocks which on closer inspection are seen to consist of alternating light- and dark-colored folia, usually a few millimeters thick. On a larger scale these folia are grouped to form light-colored predominantly quartz-rich layers up to 8 feet in thickness and dark-colored layers ten or even hundreds of feet thick.

Broadly speaking, the rocks may be divided into two general types that grade into each other. The more abundant of the two types are rocks composed of different amounts of hornblende, plagioclase, epidote, clinozoisite, quartz, and minor quantities of magnetite. Sphene in minor but noteworthy amounts is usually present. The composition of the plagioclase ranges from albite to anorthite, but albite is most common. Where anorthite is present, the associated amphibole is the calcic amphibole, pargasite; and in the gneisses exposed along the Chetco River and in the Carter Creek-Little Chetco River area, the amphibole is in some places actinolite rather than hornblende. As a rule these rocks are distinctly foliated with hornblende-rich folia alternating with folia in which plagioclase and quartz or clinozoisite and epidote are predominant. In some rocks hornblende is the principal constituent and any or all of the above listed minerals may be absent. Minerals of the clinozoisite-epidote group are also common in most of these rocks, and constitute more than half of some thin sections examined.

Less abundant are the rocks of the second type, which are composed of quartz, biotite, and plagioclase, with variable though generally minor quantities of garnet and magnetite, and less commonly chlorite and muscovite. No sphene was identified in them. With increases in quartz these rocks grade into quartzites containing accessory biotite and in places some plagioclase. Garnet occurs as an accessory in nearly all of these rocks and may make up several percent. Plagioclase in rocks of this type commonly falls in the oligoclase-andesine compositional range. Hornblende is rare, and of several sections of quartzite examined under the microscope only one contained a few small crystals of hornblende. Clinozoisite and epidote appear to be lacking.

In many places the gneiss has been metasomatically altered, and small veinlets of quartz, albite, hornblende, epidote and clinozoisite, chlorite, and rarely of prehnite, have cut and replaced the host rock. A few grains of apatite were seen in one thin section.

Along the contact of the diorite and gneiss in the valley of Little Chetco River thin layers of chlorite and of gneiss alternate in a zone which is called lit-par-lit structure. The same structure is found along the contact of the gneiss and peridotite at the head of Todd Creek. In both areas the hornblende of the gneiss is recrystallized to a very coarse-grained mass, some of the crystals being as much as 4 inches in length.

The formation strikes from a few degrees east of north to northeast and dips steeply to the east. Some westward dips are found, and detailed mapping might disclose the folds and make it possible to determine the thickness of the formation. Drag folds of all dimensions are a characteristic feature of the gneiss. Large drag folds are most conspicuous in the siliceous beds, whereas smaller folds--even of microscopic size--are found in the thinly foliated layers.

The greatest width of the outcrop belts of gneiss is 2 to 3 miles. If the thickness of the exposed gneiss is repeated once by close folding, its true thickness probably does not exceed 5,000 feet.

The amphibole gneiss is belived to be the product of metamorphism of an assemblage of sedimentary volcanic material, some of which was high in calcium and some quite siliceous. Interlayered with it were flows of a different composition. In its general character the gneiss resembles the "younger metamorphic rocks" of the Medford quadrangle, which are in part a metamorphosed facies of Applegate group of Triassic(?) age. They differ distinctly from the "old schists" of the Grants Pass and Medford quadrangles.

Triassic(?) system

Applegate group

A thick assemblage of metamorphosed volcanic rocks with lens-shaped interbeds of argillite, chert, quartzite, conglomerate, and marble is exposed over hundreds of square miles in southwestern Oregon and northwestern California. It extends from the Tertiary overlap in the Medford quadrangle west for about thirty-four miles to the thrust fault that separates these rocks from the Galice formation in the northwestern part of the Grants Pass quadrangle and in the southeastern part of the Kerby quadrangle. This assemblage of rocks is here named the Applegate group after the drainage basin of Applegate River, where the group is the prevailing country rock. The thickness of the group is unknown, but is probably to be measured in miles, although its apparent thickness may be exaggerated by faulting and close folding.

The Applegate group underlies about 60 square miles in the southeastern part of the Kerby quadrangle.

Metavolcanic rocks.—The metavolcanic rocks are pale green to greenish gray, and their textures range from moderately coarse-grained to fine-grained. A large part of the series consists of porphyritic rocks, probably andesitic or basaltic lavas. The microcrystalline groundmass contains phenocrysts of plagioclase and what was once pyroxene. These feldspars are more or less cloudy and now approach albite in composition, though they doubtless were originally more calcic. Almost invariably the pyroxenes have been altered to actinolitic hornblende. Chlorite is rare in these rocks, but in almost every specimen either clinozoisite or epidote, or both, are conspicuous. Some of the rock shows traces of flow structure, and a vesicular or amygdaloidal structure is common. Calcite is so abundant in many of the layers as to suggest that the lavas flowed into a basin, where they mixed with limy muds accumulating there, and later were consolidated as vesicular breccia bound together by a calcareous matrix.

Agglomerates and flow breccias are common in the southeastern corner of the area, and just to the east of the quadrangle on French Mountain. The agglomeratic structure is seen best on weathered surfaces, where angular and subangular amygdaloidal fragments are set in a fine-grained, partly calcareous matrix. Part of the series probably consisted originally of fine-grained, thin-bedded tuffs.

The formation as mapped includes some small bodies of basic intrusive rocks, and some lenses of argillite, a few feet to a few tens of feet in thickness, which were impracticable to map separately. The larger lenses of argillite, some of which are several hundred feet thick and several miles long, have been mapped with other metasedimentary rocks.

Metasedimentary rocks.—Metasedimentary rocks make up from one-third to one-half of that part of the Applegate group which crops out in the Kerby quadrangle - a far greater proportion than is found in the same group to the east. Though sedimentary strata may occur in sequences totaling several thousand feet in thickness, they usually contain some interbedded volcanic rocks. In general the sediments have undergone some metamorphism and today consist principally of chert, argillite, quartzite, fine-grained quartzite, conglomerate and lentils of marble.

The cherts are commonly white to dirty gray, rarely red or black. They are fine-grained, dense and usually thin-bedded (less than 2 inches), and contain abundant remains of microscopic radiolaria. In places the cherts grade into gray or white limestone, now recrystallized to marble. The bodies of marble rarely exceed 100 feet in thickness and a few hundred feet in length. Lime Rock, a bold outcrop on the mountain southeast of Kerby, is a conspicuous example. The marbles grade by interlayering into silty argillites.

Conglomerates form distinctive beds in the sediments. The constituent pebbles are predominantly small though in some of the beds they exceed an inch in length. They are principally subangular gray or black chert fragments, but occasionally a small rounded pebble of fine-grained mica schist may be found. The conglomerates grade into and are interbedded with even-grained and coarse pebbly quartzites. Rock fragments, largely from basic flows, and quartz pebbles constitute the bulk of the coarser grains in the quartzites, and much of the material could properly be classed as a graywacke. Interbedded with the conglomerates and cherts are argillites. They are fine-grained, have a tabular cleavage, and where unweathered are usually black. Originally they were silty sandstones and siltstones, and where deeply weathered these rocks break down into their component grains. Small outcrops of such weathered material are hard to distinguish from younger less-metamorphosed formations.

With a few exceptions the attitude of the metavolcanic rocks is known only from their contact with the interlayered metasedimentary rocks. These dip steeply to the southeast and strike prevailingly east of north.

Strongly metamorphosed schistose (plagioclase) amphibolites, quartz-hornblende gneiss and quartz-mica schist with thin beds of quartzites, marble or lime silicate rock have been mapped as contact aureoles in the Grants Pass quadrangle. They are with few exceptions marginal to igneous stocks, and they grade into normal metavolcanic and metasedimentary rocks of the Applegate group. They closely resemble the amphibole gneiss found in the Kerby quadrangle, so it is suggested that the two may be correlative and that all these rocks are metamorphosed facies of the Applegate group.

No rocks that are known to be older than the Applegate group are exposed in the Kerby quadrangle, hence the basement on which the Applegate group accumulated is unknown. In the Grants Pass quadrangle the group is separated from older schists by igneous intrusions or faulting. If the amphibole gneiss is a metamorphosed facies of the Applegate group, then the Upper Jurassic Galice formation rests with angular unconformity on the Applegate group.

Age and correlation.—Diller (7) briefly described the rocks of the Applegate group. He did not give them a name but on the basis of fossil determinations by Kindle, classified these rocks as Paleozoic in age. Diller placed part of them in the Devonian system and part in the Carboniferous. Highly metamorphosed facies of these rocks he (Diller 8) named the May Creek formation. Subsequent writers have followed Diller's dating, as did the writer (Wells, 19,20) on the preliminary maps of the Grants Pass and Medford quadrangles, where they are called metavolcanic and metasedimentary rocks. After the publication of the geologic map of the Grants Pass quadrangle, Reeside studied the collections of fossils made by the writer and reexamined the collections made by Diller. He pronounced them to be of Mesozoic age, probably Upper Triassic.

Jurassic system

Galice formation

Distribution and general character.—The Galice formation was named from Galice Creek, which rises just to the north of the Kerby quadrangle and empties into Rogue River 5 miles farther north. As defined by Diller (5) the Galice formation included only the slates and sandstones in the type area, but mapping by the writers clearly shows that the volcanic rocks are intercalated with the slates and sandstones and form part of a continuous cycle of deposition. Therefore these latter have been included in the formation, which has been traced by the writers from the type locality south-westward into and beyond the Kerby quadrangle. These sedimentary and interbedded volcanic rocks crop out over most of the northeastern quarter of the quadrangle and as far south as Deer Creek. The maximum width of outcrop is 13 miles in this area.

The formation is bounded on the west by metamorphic and igneous rocks, and its boundary is very irregular in detail. From Deer Creek southward the Galice formation crops out in two separate prongs divided by a mass of periodotite. The eastern prong continues to the south boundary of the quadrangle and beyond. It is constricted to the vicinity of O'Brien by the southwestern extension of Triassic rocks but increases to a width of six miles at the southern boundary. The western prong is cut out by the westward extension of the peridotite.

The Galice formation is made up of rocks of many different lithologic characteristics which may be grouped into a lower predominently volcanic member made up largely of agglomerates, tuffs and flows and an upper sedimentary member made up of shales or slates, a small amount of sandstone and a very few thin discontinuous layers of grit or conglomerate.

The shaly and slaty parts of the formation erode easily so that the areas underlain by them are characterized by broad valleys of low relief; the volcanic rocks on the contrary tend to stand as bluffs and form a very rugged terrain, a good example of which is the Craggies, a sharp saw-toothed ridge between Babyfoot and Carter Creeks.

The structural complexities of these rocks and the various conditions under which they were accumulated from place to place introduce irregularities into this grouping. In the northern part of the area slates are interlayered with the volcanic rocks, but to the south the lower member contains little if any slate, though stratified tuffs are common. The upper member is almost free of volcanic rocks, but a large percentage of the constituents of the sediments are of volcanic origin.

Volcanic member.—Although the types of volcanic rocks are irregularly intermingled both vertically and horizontally throughout the volcanic member and it has, therefore, been impossible to map any distinctive horizons, nonetheless certain general groupings have been recognized. The lower part of the member which crops out from the northern boundary of the quadrangle to Illinois River, is characterized by thick andesitic flows and flow breccias, and coarse agglomerates. This is overlain by tuffs and thin flows, many of which are of dacitic and a few of rhyolitic composition; many of the intercalated tuffs are well bedded and water stratified. This tuffaceous sequence is overlain by dominately andesitic flows and agglomerates. From north of Onion Mountain south to Days Gulch the base of this agglomerate zone is characterized by maroon to rusty-brown scoriaceous lavas; intermingled with this type of lava are irregular masses of red or brown chert and varied pyroclastic material.

The flows of the Galice formation show a wide variety of textural and structural features. They range in composition from andesite to dacite and rhyolite. The most common type is a gray to greenish-gray, fine-grained, porphyritic andesite containing euhedral phenocrysts of feldspar and hornblende recognisable in hand specimens. Under the microscope the groundmass is seen to be a felt-like mass of plagioclase laths; epidote grains are usually common and chlorite may be present though in general the rocks are not much altered. The groundmass of the aphanitic type may be glassy; more commonly it is a glass with scattered needle-like microlites of feldspar. The coarse-grained flows have a poorly developed diabasic texture. Augite is usually present in this type, and alteration to epidote and chlorite is more common. Many of the flows have an amygdaloidal structure; the amygdules may be filled with calcite, quartz, chlorite and rarely epidote.

The dacitic flows are light-colored, fine-grained holocrystalline rocks with a porphyritic texture. Euhedral fresh-looking plagioclase, and possibly orthoclase, crystals about 3 millimeters long and occasional small crystals of euhedral black hornblende are set in a trachytic groundmass.

Although some of the rhyolite may be intrusive into the other volcanic rocks, it is believed, nevertheless, to be a part of the Galice formation. The rhyolite is usually porphyritic with euhedral phenocrysts of orthoclase and quartz in a very fine-grained, light-colored groundmass. Bodies of this rock are generally quite small.

The fragmental character of the volcanic breccia of the Galice formation can be discerned only in large exposures either in bluffs, or in long stretches of waterworn outcrops along large streams. In small outcrops it cannot be distinguished from flows; hence it is difficult if not impossible to map along the strike well exposed breccia layers which are known to be hundred or thousands of feet thick. The breccias are best seen along Illinois River upstream from the mouth of Fall Creek. Here the rocks are mostly dark greenish gray to gray, and in places purplish to maroon in color. Where weathering is favorable fragments of various shapes, ranging in size from an inch or less to 5 inches, can be seen scattered through a dense to fine-grained matrix. The fragments are chaotically mixed and some are angular, but many are elongate rounded bombs with smooth knobby protusions. Most commonly they have a vesicular structure, but fragments of dense, fine-grained lava and of porphyritic lava are also present. A few bombs with scoriaceous surfaces, and a few fragments of granitoid rock were found.

Some of the breccias are flow breccias which, except where favorable weathering has revealed their fragmental character, may be mistaken for flows. Commonly they consist of masses of small irregular fragments of fine-grained vesicular and porphyritic lava set in a green matrix of plagioclase, epidote, and chlorite and occasionally hornblende. These masses lie between large fragments of flow rock.

Well stratified fine- to medium-grained tuffs are scattered through the volcanic sequence. They may occur as small lentils within the coarse pyroclastic rocks and flows, but more commonly they are associated with thin interlayered, light-colored, dense, platy flows. Together they form masses a hundred to several hundred feet thick that have been traced for thousands of feet along the strike. Such masses are common from north of the Illinois River to south of Little Chetco River and are exceptionally well exposed in the bluffs of Whetstone Butte.

The tuffaceous rocks are well bedded, the beds ranging in thickness from a fraction of an inch to a foot or more. Light-colored beds are prevalent; light gray is the most common color; pale-green, buff and light-red beds are also common. Medium- and coarse-grained sandy tuffs are found, but in general the tuffs range from fine sand to silt. In places the tuffs are cross-bedded, and occasionally they show gradational bedding.

The tuffs range in composition from gray dense rhyolitic tuff through dacitic to green andesitic tuff. Under the hand lens fresh feldspar crystals, glass shards, some chlorite plates, and drawn-out fragments of pumice can be seen in the dacitic tuffs. Brief microscopic examination has shown the rock to be a fine-grained crystal tuff with fragments of albite, secondary chlorite and epidote. In some of the specimens the grains show rounding by water.

Sedimentary member.—The sedimentary member of the Galice formation is made up largely of slaty shale with subordinate sandstone, a little grit, and a few thin lenses of conglomerate. The distribution of these rock types through the section is not definitely known. On Rough and Ready Creek and about two miles to the south, on the West Fork of the Illinois River, at the contact with the peridotite the formation is largely sandstone and grades upward into shale. Diller (5) found a similar sequence on Graves Creek, 11 miles north of the Kerby quadrangle. Neither of these localities is known to be the depositional base of the formation. Where the formation lies unconformably on the amphibole gneiss, careful traverses along the transecting streams showed slaty siltstone and shales resting on the gneiss and continuing for thousands of feet higher in the formation. No systematic distribution of the grits and conglomerates has been found.

Shale or siltstone makes up the bulk of the sedimentary member of the formation. It may be interbedded with sandstone, and in places, for example along U. S. Highway 199 at Hayes Hill and north of Dryden, "ribbon" shales consisting of alternating black shale and gray siltstone an inch or so thick can be seen. In general, however, one can traverse the beds of streams across the strike for thousands of feet without seeing any sandstones, or at most a few thin beds less than 6 inches thick. The shale is dark gray to black. Where the rock is smooth and polished by stream action it may appear massive although fine color and textural banding is not rare. Those bands which range from a millimeter to a few centimeters in thickness show alternating gray and black layers; the gray layers may grade from clay to silt sizes. In places the very thin layers show ptygmatic folding probably formed in the unconsolidated mud. Generally individual mineral grains cannot be recognized with the unaided eye and are even seen with difficulty through the hand lens. The microscope shows the shale to have an average grain size of less than 0.01 millimeter. Angular crystal fragments of quartz, and plagioclase of an intermediate composition are the principal identifiable minerals. Kaolin and black opaque argillaceous material is very abundant and may mask the other grains. Slight metamorphism is commonly indicated by the presence of tiny flakes of biotite, sericite, and some pale chlorite.

Epidote and clinozoisite grains are rarely present. Opaque material seen under the microscope is probably magnetite, ilmenite or pyrite, though some of it may be carbonaceous material.

Carbonaceous layers up to 4 inches thick have been found in a few places. These layers are black and have a sooty appearance in some places; more commonly, however, they contain many carbonized fragments of woody plant remains.

Interbedded with the shales are beds of sandstone from one to several feet thick. In parts of the formation sandstone may be present to the almost complete exclusion of shale, as for example, near the mouth of Rough and Ready Creek.

The fresh sandstone is generally gray, dark gray, or reddish brown. Generally it is thick-bedded although rhythmically bedded strata are present. Almost invariably the sandstone is very dense and well lithified so that is is broken with difficulty. Cross bedding was seen in a few outcrops. Highly lenticular and local pebbly layers are interspersed through the coarser facies, and the uniform texture of the sandstone is interrupted in places by single or scattered subrounded pebbles. Lens-shaped subangular fragments of black shale up to a foot long are common at certain horizons. Many beds were seen which have a large proportion of black shale fragments up to an inch long and a fraction of an inch wide.

The feldspathic nature of the sandstone is clearly recognizable with the hand lens. Brilliant crystals of plagioclase and quartz are the most noticeable minerals and the principal constituents. Fragments of chert and greenstone can also be recognized but other fine-grained minerals and rock fragments are not identifiable. The mineral grains average about 0.25 millimeters, but the foreign rock fragments are larger than the mineral grains. Both grains and fragments are angular, more so in some specimens than in others. In general the rock fragments show slightly more rounding than the mineral grains. The sandstone is commonly "dirty", and in all specimens studied the sorting was poor. Although well lithified the compaction is not good, and were it not for the siliceous cement the rock would have a high porosity.

Under the microscope the quartz is clear and free of inclusions. The feldspar has the composition of andesine or oligoclase-andesine, but albitic varities have been recognized, and grains of orthoclase have been found in a few specimens. The ratio of feldspar to quartz is about 3 to 1, there being from 60 to 75 percent feldspar and 20 to 25 percent quartz. Other minerals which are present but never abundant are: sericite, magnetite, biotite, chlorite and epidote, sphene, clinozoisite and apatite, rutile, zircon and garnet. Lithic fragments include chert, shale, altered diabase and basic lava, occasional quartzite and rarely pumice. Of these fragments chert, shale, and altered basic lavas are by far the most common. The lithic fragments rarely amount to more than 10 percent of the rock.

The strong lithification of the sandstone is due to silica cement which can be seen as very finely crystalline quartz surrounding the grains and forming strong bonds between them. Ferruginous material in the form of hematite commonly is seen in the cement and is very abundant in the reddish-brown sandstone. The sandstone and siltstone could be called graywacke. Carbonaceous strata with plant remains similar to those found in the shale are also present in the sandstone.

Although it has been impossible to follow any bed of grit or conglomerate for more than a thousand feet along the strike, a traverse that crosses a few thousand feet of the sandy parts of the sedimentary section will disclose one or more lenses of grit and conglomerate. The conglomerate is either pebbly with a sandstone matrix, or composed entirely of subangular and angular rock fragments bound together by silica cement. Coarse-grained grits consisting of rock fragments between 2 and 5 millimeters in diameter are more abundant. In general the degree of rounding seems to be greater the larger the fragment, so that the grit fragments are angular, whereas the conglomerate fragments are subangular to subrounded. The fragments are not well compacted but are strongly bound together with silica cement. Pieces of vari-colored chert, volcanic rock, sandstone, and shale are the most common constituents and are similar to the fragments found in the sandstones.

Structure.—Distinct parting has been developed in the shales and sandstone of the Galice formation since deposition. The rocks are slaty shales rather than true slates, because their cleavage and degree of metamorphism are not strongly enough developed to allow them to be placed in the class of slates (though other writers including Diller and Taliaferro have called them slates). The cleavage is fairly good but discontinuous, the planes being intersected by cross fractures which either cause the rock to break completely or allow the cleavage to pass on to another plane. In most places it can be shown that the cleavage parallels the stratification, but on the crest of tight folds it very commonly lies at an angle to the bedding. It likewise intersects the laminae in cross-bedded structures.

Several joint systems can be observed. There is usually a prominent joint which trends more or less parallel to the strike of the beds, either parallel or at an angle to the dip. These joint planes dip to the east or west depending upon the direction of inclination of the bedding. Another set of joints normal to the bedding can be observed dipping north or south at steep to moderate angles. The usual northwest-northeast joint pattern holds in the Galice formation as well as the other rocks, and is thought to have been the result of strain produced by compression from an east-west direction. They lie more or less at 45 degrees to the bedding. Bedding joints are common in the massive sandstone.

"Pencil structure" is common in the shale on the crest of folds and is useful for determining the axis of folds. It consists of short pencil-like prisms due to closely spaced converging cleavage planes.

Drag folds are common and occur in thinly bedded sandstone layers as well as in the shale. In fact, where a sandstone is between shale beds, the shales are more commonly crumpled and broken, whereas the sandstone is folded. Many drag folds are found on the larger structures; occasionally they are broken and pass into small faults.

The folds seen in good exposures are typical of the deformation of relatively incompetent beds. They are small tight structures, generally asymmetrical and discontinuous, and tend to have their axial planes dipping southeast at high angles. Some are slightly overturned to the west and plunge to the south at moderate angles.

These numerous small folds can be traced for only a few feet and larger folds have been followed for a fraction of, or at most, a mile. Both are undoubtedly small plications on major folds which may have involved the whole formation.

In the absence of marker beds or of persistent zones of distinctive lithology, it is impossible to interpret with certainty the structure of the Galice formation and hence to determine its thickness. Any reasonable interpretation of the facts ascertained in mapping the formation over a distance of 50 miles from Rogue River to the South Fork of Smith River indicates that the volcanic member is about 10,000 feet thick and that the sedimentary member is at least 15,000 feet thick.

Age and correlation.—The Galice formation was assigned an Upper Jurassic age by Diller (5) who correlated it with the Mariposa formation of California on the basis of its fossil fauna. Taliaferro + (15) has correlated it with the Kimmeridgian of Eurpoe. The formation rests with angular unconformity on the amphibole gneiss. The gneiss, whatever its age, has been subjected to a period of dynamic metamorphism that was not experienced either by the Galice or the Dothan formations. In both the Kerby quadrangle and the Grants Pass quadrangle to the east, the Galice formation, of the Applegate group along its eastern margin, is in thrust-fault contact with the metavolcanic and metasedimentary rocks. The Galice formation may comprise the first deposits that accumulated on these rocks after they were highly folded. As the Galice formation and the Dothan formation are nowhere in contact within the Kerby quadrangle, no new direct evidence as to their relationship has been observed.

Dothan formation

Distribution.—The name Dothan formation is retained in this report for the sedimentary rocks that were mapped in reconnaissance by Diller (7) from their type locality near Dothan post office on Cow Creek, Douglas County, southwestward into the northwestern corner of the Kerby quadrangle. Interlayered with the sediments are irregular tabular bodies of altered basalt flows. This assemblage of rocks extends along the western border of the quadrangle from its northern to its southern boundary; according to Butler (2) it extends westward to the Oregon coast. On the east these rocks are bounded by various intrusive and some gneiss; peridotite cuts them out in the southwestern corner of the quadrangle, and in the northwestern corner of the quadrangle they are separated from the rocks of the Knoxville formation to the west by serpentine and intrusive diorite except where all these rocks are buried beneath a southern prong of Tertiary conglomerate and sandstone.

These sedimentary rocks can best be studied in the canyons of the Illinois and Chetco Rivers, but they are also well exposed in the bed of the North Fork of Smith River, where they are accessible by road. Sandstone makes up about 40 percent of the formation, shale close to 30 percent, chert 10 percent, and conglomerate about 5 percent.

The sandstone is very hard and massive. Rarely can bedding be discerned in it, and it breaks into irregular blocks. Fractures pass through the sand grains. The rock is commonly cut by many narrow veinlets of white quartz which about ¼ inch wide are irregular in course, and have no systematic arrangement. In weathered exposures the sandstone is straw-colored to reddish brown, but on freshly broken surfaces it is typically light gray to greenish gray. On close examination the rock is seen to be speckled, poorly sized, and fine- to medium-grained. In places the sandstone is coarser grained (3-5mm.) and is a grit. With the hand lens fresh angular plagioclase crystals and angular to subangular quartz grains can be distinguished, generally in greater amount than the sum of the other constituents. Some specimens contain many shale fragments; pieces of chert and volcanic rock can also be recognized. Greenish chloritic material is common as interstitial material, and flakes of biotite can be seen. The constituent grains are cemented by silica. Such a rock is commonly called a graywacke.

Evidence of the beginning of recrystallization under strong dynamic action is found in parts of the sandstone, and consists of an abundance of sericite aligned in a common direction. The microscope may reveal sericite between the grains, and some of it appears under the hand lens to be growing out of the mineral fragments. Biotite flakes give further evidence of recrystallization, and the alignment of these minerals gives the rock an incipient schistose structure. The recrystallization has not progressed to the stage where the plagioclase or quartz are affected.

It is important to note that under the microscope thin sections of sandstone of the Dothan formation are identical in appearance with sandstone from the Galice formation, in that they show the same degree of angularity of grains, poor sorting and compaction, excellent cementation with silica (and sometime hematite), fresh plagioclase and similar composition. Furthermore, the same accessory minerals in both rocks can be found in the same proportions. In brief, the sandstones in the Dothan and the Galice sediments are both typical arkosic sediments of the graywacke type.

Shale is less common in the Dothan formation than in the Galice. It forms interbeds between the massive sandstone layers and is usually associated with chert lenses and basaltic lava. It is black to dark gray, usually somewhat massive, and lacks well-defined bedding. In places it is hard and brittle but nowhere seems to show the degree of lithification of the slaty-shales of the Galice formation. The shale is commonly a microcrystalline argillaceous rock although in places it may be sandy. Where it occurs as thin interbeds between massive sandstone layers, it is usually strongly sheared. As in the Galice some shale beds are distinctly carbonaceous and carry carbonized wood fragments.

Conglomerate rarely occurs in the Dothan formation within the Kerby quadrangle. There are a few pebbly lenses in the sandstone but they are rare. The conglomerate lenses are like those in the Galice formation.

Chert lenses are common in the Dothan formation. They are not confined to one horizon, but where one lens is present there are likely to be others. They are rarely more than 300 feet thick or a quarter of a mile long, and are interbedded in the sandstone but usually have a little shale associated with them, most often at their base.

The chert is dense and cryptocrystalline. It is commonly light gray or cream-colored but occasionally has a greenish tinge. Some of it is pink to reddish. Rarely is it dark gray to black. The chert is commonly fractured and filled with narrow veinlets of silica. The rock is generally very massive.

A distinct stratigraphic horizon of basaltic lava lies at the top of the Dothan formation within the Kerby quadrangle. It crops out continuously along the diorite contact from the valley of the North Fork of Silver Creek south to Tincup Creek and spottily from there to its most southern exposure on the east slope of Johnson Butte. Several other small lentils of lava in the sandstone are scattered through the rest of the Dothan formation north of Tincup Creek.

The basalt weathers to various shades of green or, as on the ridges to the north and south of Tincup Creek, a reddish-brown color, not unlike the color of weathered peridotite. In places it is aphanitic and looks like green chert. The weathered surfaces have a blocky appearance in many places and some appear to be flow breccias. Well developed pillow structure can be seen in the mass of lava which crops out on the ridge just west of the head of Yukon Creek.

In the hand specimen a fresh surface of basalt is greenish and fine-grained, and may be porphyritic. Some specimens are also amygdaloidal with spherical amygdules 1 to 3 millimeters in diameter; the amygdules commonly are filled with white chalcedony, or green crystalline epidote or chlorite. Plagioclase crystals about a millimeter long, light-greenish uralitic hornblende, and in some specimens, dark-green to black stubby pryoxene crystals are visible with the hand lens. Small specks of magnetite and not uncommonly grains of epidote and greenish microcrystalline chloritic material can also be seen.

The lava is sheared in places to a dark-green phyllitic rock which occasionally has a serpentinous appearance. Along the contact with the "diorite", the basalt is altered to a schistose rock or transformed to a light-colored, fine-grained rock similar to a fine-grained diorite.

Structure.—The structure of the Dothan formation, like that of the Galice, is the product of great tangential compression. Being dominantly a sandstone formation, it has reacted to these forces more competently than the slates of the Galice formation. Faulting apparently is more common in the Dothan. The small scale isoclinal folding which characterizes the slates of the Galice has not been observed in the Dothan formation, though tight folds with successive axial planes less than 1,000 feet apart have been mapped on the Illinois River near the mouth of Klondike Creek and on the Chetco River at the western edge of the quadrangle. Drag folds are not common, though they have been observed in the shale interbeds. Where a relatively thin shale bed is confined between thick massive sandstone members, it is usually much crumpled, broken, and sheared.

The folds are of small amplitude, short-rarely exceeding a mile in length but aligned, and tend to plunge to the south. Only one large folded structure, an anticline in the North Fork of Smith River near Sourdough, has been followed for any distance. On the limbs of this fold, which may be called the Sourdough anticline, are small anticlines and synclines which have the character of drag folds. It is quite possible that there are other folds similar in magnitude to the Sourdough anticline, but the absence of good marker beds and the difficulties of the terrain have made it impossible to map them.

The deformation has been more severe in the northern parts of the belt of the Dothan formation than in the central part, between the Illinois River and Johnson Butte, where the beds are inclined at moderate angles or are flat lying. Even here, they are considerably disturbed, however, for altitudes change rapidly across the strike, indicating very small, fairly flat folds. To the north and south, however, the beds are inclined at moderate to steep angles and the folds are compressed much more closely.

As previously mentioned, bedded structures are difficult to ascertain, but prominent joints that seem to be parallel to the bedding are common. In addition there are prominent cross-joints like those in the Galice formation.

Slaty cleavage is not a feature of the shales, though a pseudoclevage--probably due to movement in the massive confining beds--is developed in a few places.

Thickness.—Because of lack of marker beds and structural data it is difficult to estimate the thickness of the Dothan formation. Furthermore, the western limit of the formation does not lie within the quadrangle and the eastern limit may not be at the top of the formation. It can be assumed, however, that the beds exposed in the Chetco River are nearly flat lying, because only gentle folding would allow one horizon to remain at the surface for several miles in a direction normal to the strike. Here, then, the formation must be at least 3,000 feet thick, for there is that much relief and the Dothan crops out from top to bottom. As this part of the section is near the top and close to the eastern margin of the formation which extends many miles to the northwest, it is not unreasonable to assume that an equivalent thickness lies beneath the horizon at the river level. Therefore, we may with safety estimate that the Dothan is from 5,000 to 7,000 feet thick. Diller (8) estimates the thickness of the Dothan formation in the Riddle quadrangle to be from 5,000 to 6,000 feet.

In general the basalt along the eastern contact is gently inclined and it appears thicker than it actually is. The thickness of the basalt here varies between 1,000 and 2,000 feet.

Stratigraphic position and age.—There has been much discussion of the stratigraphic position and age of the Dothan formation. If the reader is interested in the controversy he may read the literature to which references Louderback (10), Ward (16), Diller (5, 6, 7, 8), Knowlton (9), Taliaferro (15) are given. No fossils have been found in the formation within the Kerby quadrangle. Mapping of the quadrangle has proved that the Galice formation rests unconformably on gneiss in the northeastern part and that the Dothan formation is in fault contact with similar gneiss in the southwestern part of the quadrangle. No other new structural or stratigraphic evidence pertinent to the problem has been found. Nowhere in the quadrangle have the Galice and Dothan formations been seen in contact. Until new and convincing paleontological data are found or until sufficient systematic mapping of the type localities of the two formations and the intervening terrain is done, the writers think it best to follow the conclusions of Diller, namely, that the Dothan is younger than the Galice, and is equivalent in age to the Franciscan group of the Coast Ranges of California. The lithologic similarity of the Dothan and Franciscan can be attested to by the writers.

Late Jurassic or early Cretaceous intrusive rocks

Intrusive igneous rocks occupy more than half of the Kerby quadrangle, and a belt of these rocks 15 miles wide crosses the quadrangle from north to south. They are varied in texture and structure and range in composition from ultramafic to dacitic. Where occurring together they form heterogeneous mixtures and the relationships of one to another are often in doubt. The problem of the genesis of this complex petrographic assemblage cannot be solved until more detailed study has been made. In assigning relative ages to the various rock types where cross-cutting relationships are lacking or are ambiguous, the writer has set up a sequence based on a widely held petrologic concept, namely, that in any region igneous intrusion progressively changes from basic to silicic. This expedient is used as the most favorable working hypothesis.

Ultramafic rocks

Peridotite.—Peridotites are medium-grained rocks, consisting of olivine with or without other mafic minerals. They are sometimes called ultramafic rocks, a term which implies essentially a high proportion of magnesium and iron. Peridotites of various compositions are designated by varietal names; a type containing more than 95 percent olivine and little or no pyroxene is called dunite; whereas a variety with more than 95 percent pyroxene is called pyroxenite. The most common variety of peridotite in the Kerby quadrangle contains from 5 to 95 percent of the orthorhombic pyroxene, enstatite, and is called saxonite. The ultramafic rocks as a whole are commonly called serpentine by the prospector and geologist alike, because they are more or less altered to minerals of the serpentine group. This practice has been followed in all the previously published geologic maps of southwestern Oregon. In this report, peridotite is used to denote all rocks of the group whose general physical appearance still resembles that of the original rocks. It was impractical to map separately the different varieties.

More than 225 square miles, or slight more than one quarter of the area of the K quadrangle, is underlain by peridotite. T largest body extends from the edge of the Illinois Valley westward a distance of ten miles along the southern boundary of the quadrangle; to the north it widens to 13 m in the latitude of Hawks Rest and Josephin Mountain, where it forks. The eastern for continues northward with diminishing width near Squaw Mountain, where the rock is map locally as serpentine, but about 2 miles farther north it is mapped as peridotite, thence continues as two parallel strips nc northeast to the northern boundary of the quadrangle. The western belt is discontin but the numerous bodies of peridotite and serpentine that occur at intervals in a nc northeast direction to the northern bounda of the quadrangle are probably part of a c continuous sheet which has been cut out he and there by later igneous intrusion and subsequent erosion. This great body of peridotite will be called the Josephine peridotite sheet.

Weathered peridotite is characteristi buff to rusty red; the dunite variety is commonly buff, and the saxonite becomes re with increase in pyroxene content. As the soil on peridotite is usually thin and veg tation is sparse, areas underlain by perid are distinctive. Everywhere the peridotit cut into blocks by numerous joints. heet or reticulate jointing is dominant in plac but generally the joints are apparently patternless and irregularly curved. The surface of a peridotite terrain is strewn either with blocks and scattered piles of blocks projecting through a scant, maroon-colored soil or, with accumulations of sho sized pellets of iron oxide. Tufts of squ grass are common, and in wet spots luxuri growths of pitcher plants are almost diagnostic.

In weathered outcrop the dunite may b smooth and even-grained, like a medium-gra sandstone, with an occasional black grain chromite or magnetite. Saxonite surfaces similar except that the surface may be thi studded with 2 to 5 mm. crystals of enstat In places the enstatite crystals may be so large and thick that they make a rough su thus grading into a pyroxene-rich saxonite even in pyroxenite. On Pearsoll Peak the saxonite is coarse-grained and cleavage p of pyroxene an inch long can be seen shin in the sun. Dunite or pyroxenite may occ anywhere within saxonite as irregular bod Occasionally they are rudely layered. Di lets of dunite and pyroxenite cut the sax and each other. Concentrations of chromit are described elsewhere in this report.

Freshly broken peridotite ranges fro water-green or yellowish-green vitreous ro to greenish-black felt-like rock dependin the degree of serpentinization. Light-co peridotite is but little altered; whereas dark-colored rock is almost completely al to a felt-like mass of antigorite. The cleavage of the pyroxenes is easily seen the fresh rocks and is discernible even i highly altered ones.

Examination of the map shows that peridotite and serpentine are widespread in the Applegate group and within the volcanic member of the Galice formation, but are sparingly present in the sedimentary member of the Galice and apparently absent in the Dothan formation. The distribution of the serpentine in the Applegate group, as for example on the west slope of Alder Mountain, suggests that the two are interlayered.

Its distribution in the volcanic rocks of the Galice formation merits discussion. Serpentine areas 30 or 40 acres in extent are scattered through these volcanic rocks, and outcrop areas of one or two acres have been found but not plotted. Some of the areas are lenticular, others have a rectilinear outline. They may occur at intervals along the strike of the formation, suggesting that they are parts of larger once continuous sheets which are so thin in places that their croppings are lost or have been complicated by faulting. Many of them have random distribution. That not all the bodies of ultramafic rock in the Galice formation are of th s character, however, can be seen in the walls of the canyon of upper Babyfoot Creek. Here a nearly horizontal body of serpentine crosses the canyon and rudely semi-circular cross section of the mass can be seen in both walls. It seems apparent, however, that in general the ultramafic bodies within the Galice formation are thin, roughly conformable, and tabular with irregular boundaries in plan.

The tabular structure and conformable relationships of the peridotite sheet exposed along Josephine Creek can be seen in many places. The tabular form is best seen when the mass of peridotite capping County Line Ridge near Pearsoll Peak is viewed from the southwest. The conformable contact of the peridotite and the Galice formation is exposed near Whetstone Butte and the conformable contact of the peridotite with the Dothan formation is well exposed in the canyon of the North Fork of Smith River. Along the upper reaches of Todd and Briggs Creeks the contact of the amphibole gneiss and the peridotite shows a slight angular relation, and near Chetco Peak the well exposed contact shows an angular discordance. The interpretation of the structure of the Josephine sheet that best explains all the known facts is the assumption that the peridotite was intruded as a great sheet and came in along planes of weakness. In places it followed the unconformity between the amphibole gneiss and the Galice formation; elsewhere it followed the contact between lithologically different members of the Galice formation or other bedding planes and joint planes. Hence the sheet does not occur at one horizon but is multiple, composed of several connected layers. Furthermore any layer may jog up or down from one horizon to another. There is evidence that it was folded during and after consolidation, and was involved in the faulting which was the last phase of isoclinal folding.

The thickness of the sheet is to be measured in thousands of feet but probably does not exceed 15,000 feet.

Cobbles of peridotite are found in the Horsetown formation, and iller (8) shows peridotite (serpentine) cutting the Knoxville formation to the north in the Riddle quadrangle. The peridotite, therefore, is believed to be of late Knoxville age.

Pyroxenite.—Dikelets of pyroxenite an inch or two in width cut the peridotite masses in many places. Narrow dikes a few feet in width are also found, and several small mappable masses of pyroxenite with or without peridotite occur as roof pendants in the diorite. Three of these which are from 0.5 to 1 mile long and upwards of 0.25 of a mile wide are found in the diorite in the vicinity of the Chetco River; two other smaller ones were mapped west of Gold Basin.

The pyroxenite is a dark green, coarsely crystalline rock with large (3/8 to 1-1/4 inch) crystals of green pyroxene a milar in appearance to that in the saxonite. Generally 100 percent of the rock is pyroxene, but occasionally a gray feldspar occurs interstitially and large magnetite grains are commonly associated with the feldspar. These patches are irregular in outline and the feldspar content is usually small but in a few places it may be as much as 25 percent.

Serpentine.—The rocks mapped as serpentine are those peridotite masses or parts of peridotite masses that have been so completely altered to minerals of the serpentine group and sheared (owing to the structural weakness of these minerals) that the rocks are distinctive in outcrop, and readily distinguished from the less-altered and less-deformed peridotite. The prospectors sometimes call the rock "slickentite." Such material is found in major fault zones that cut across or follow the edges of the larger peridotite bodies; in places it also makes up the whole of a thin sheet which has been completely crushed by the fault movement. A good example of the former condition is found in upper Josephine Creek and of the latter west of Onion Mountain. Folding has been so intense throughout the rocks that any thin sheet of peridotite may have been crushed and altered to serpentine. In some places younger igneous rocks have intruded peridotite and intensely serpentinized it nearby. This material has been crushed by later movements. A good example is near McKee Cabin.

Outcrops of the most intensely deformed serpentine are greenish gray. Such material is cut by innumerable slip surfaces matted together to form plaits which are braided on a larger scale. The plaits curve around scattered blocks of unsheared felt-like serpentine that is usually dark green to black in color. In slumped outcrops this material forms a mass of flakes and lumps altered almost white, and scattered through it are the blocks of unsheared serpentine, now weathered on the surface to a rusty red. Less intensely sheared serpentine is cut by many slickensided planes of movement, and is characterized by curved or bellied polished surfaces. The rock may be honey-colored, green to dark green or even black. The lighter colored pieces have a waxy to horny luster, and are commonly translucent.

Olivine gabbro

It has been possible to outline a body of olivine gabbro within the hornblende diorite with a fair degree of accuracy, and furthermore to map coarse-grained and fine-grained facies of this body. The boundary between the two facies can be followed with relative ease, but the contact between the fine-grained facies of the gabbro and the diorite can be determined with certainty only where outcrops are good enough to permit the recognition of the small grains of olivine which serve to distinguish gabbro from diorite in hand specimen.

Near York Creek, on the Illinois River trail, typical coarse-grained gabbro is exposed. It is a dark rock with a gabbroid texture that varies from coarse- to medium-grained. On weathered surfaces it is gray with rust spots due to weathering of the pyroxene. On fresh surfaces the feldspar is white to bluish plagioclase and interstitial with it are partly altered anhedral pyroxene, and brown olivine as small yellowish crystals. Occasionally the pyroxene is completely altered to uralite, and in some specimens uralite can be seen rimming fresh crystals of pyroxene.

On good exposures the proportion of mafic minerals varies greatly from place to place, and there are parts of the rock that are almost all feldspar with but little pyroxene and no olivine. This rock called anorthosite, is coarsely crystalline and on broken surfaces the large crystals of bluish-gray feldspar show broad cleavage faces with prominent twinning bands.

The contact between the coarse-grained gabbro and the fine-grained facies is fairly sharp. The latter facies varies, however, from fine- to medium- grained, is dark-colored and the feldspar has a distinct bluish cast. The fine-grained gabbro and the contiguous diorite are similar in texture but in hand specimen the gabbro is distinguished by an abundance of olivine as small (1 millimeter) brownish-yellow crystals. The pyroxene may be easily mistaken for hornblende because it is always accompanied by a little hornblende.

Under the microscope the texture of the gabbro is typically hypidiomorphic-granular. The grain size of the coarse variety is 3 to 4 millimeters; that of the fine-grained type averages 1 millimeter. The plagioclase is bytownite (Ab_{25-30}) and occurs as large subhedral crystals that make up 50 to 65 percent of the rock; it is fresh, clear, and twinned according to both albite and pericline laws. Anhedral grains of hypersthene and augite are interstitial with the plagioclase and make up 5 to over 20 percent of the rock. Both minerals are replaced in part by green hornblende, which also varies in amount. Magnetite is common (5 - 10 percent), and is invariably associated with the hornblende. Pleonaste also is common, and is found with and replaced by magnetite. The original olivine content was commonly less than 10 percent, and the olivine is invariably—if not completely—altered to serpentine.

Metagabbroic complex

Several bodies of dark-gray gabbroic rock occur either within the peridotite and serpentine or as a streamer-like bodies adjacent to the peridotites. In general they are poorly exposed. Judging from small croppings and scattered float, they differ considerably in mineralogical composition and texture, but all of them are holocrystalline rocks which under the microscope are seen to be much altered. In places they have been cut and may be partly altered by later diorite but the diorite bodies are too small and intricately intruded to be mapped separately. Augite, which is common to all the metagabbro bodies is usually present as relict cores surrounded by fibrous green uralitic hornblende or actinolite. Original olivine has been altered to serpentine or hornblende, and in some instances to biotite. The feldspars may be cloudy, or partly or completely altered to zoisite and calcite. It is obvious that some of the gabbro is younger than the peridotite, and that some of the gabbro is cut by diorite. The relationship of the olivine gabbro to the metagabbro is not revealed by field evidence.

Dolerite and related dikes

Fine- to medium-grained white or dark-colored dikes cut the peridotite and serpentine but are less commonly found cutting other nearby rocks. The dikes are rarely more than a score of feet wide or more than a few hundred feet long. Most of them have not been mapped, but a few that attain widths of over 100 feet and lengths of 500 feet or more have been plotted. The dikes appear to be localized along zones of shearing in the peridotite and serpentine. Commonly they are tabular though some have very irregular shapes. Some of the dikes appear to pinch out in depth and become isolated masses or "knockers" in the sheared serpentine. Their long dimension usually trends northeast, parallel to the regional structure. Some of them are fairly flat lying and sill-like in character. None of the dikes show any contact effects other than slight baking in a few places and the production of a narrow serpentine selvage in the peridotite.

The dark-colored dikes have a dioritic composition, and either a diabasic or intersertal texture. They consist of about equal amounts of subhedral interlocking crystals of plagioclase that surround irregular but squarish crystals of pyroxene - either dark-green augite or pigeonite - together with 5 to 10 percent of titaniferous magnetite, or ilmenite or both. Now, however, the feldspars are more or less altered to saussurite, the pyroxenes to a fibrous uralitic variety of hornblende and the ilmenite to leucoxene. Some of the diabase contains a bladed brown variety of hornblende that seems to be primary, but no evidence of olivine could be found.

Other dark-colored basic dikes may be included in this group.

Short sinuous dikes and niggerheads composed of a dense fine-grained white rock are common and conspicuous features of shear zones in peridotite, and rectilinear dikes of the same rock are less commonly seen in the unsheared peridotite. The dikes are usually less than 2 feet thick and the niggerheads less than 2 feet in diameter. Some of the dikes are so fine-grained that the constituent minerals cannot be resolved under the microscope, whereas in others diposide, wollastonite, garnet-zoisite, and chlorite have been recognized. In many places the white rock is associated with diorite, but this is not universal. In a few places, as for example at the Oregon Chrome mine (42), it grades into the diorite by gradual gain of recognizable feldspar and of dark-colored pyroxene. These dikes are unusually rich in calcium, and it is believed that they represent the end product of the diorite magma and that the abnormal composition is due to the loss of constituents to the peridotite by the hydrothermal action of solutions accompanying the diorite. The association, appearance, and composition of this rock are similar to the rodingite found in New Zealand. Not to be confused with the rodingite type rock are "blow-outs", irregular areas of a few hundred square feet of delicately banded chalcedonic silica; these siliceous bodies invariably occur in highly fractured and serpentinized peridotite.

As all the dikes cut the peridotite and have inclusions of serpentine in them, they are later than the serpentine and peridotites. Although they are associated with the ultramafic rocks, they are not believed to be differentiates from them. Their relationship to the olivine gabbro and hornblende diorite is not clear.

Hornblende diorite and related rocks

Distribution.—Hornblende diorite and related rocks occupy a belt about 23 miles long and 5 miles wide in the northwestern quarter of the quadrangle. They are bounded on the west by the Dothan formation and on the east by ultramafic rocks, the amphibole gneiss, and the volcanic member of the Galice formation. The mass is structurally, texturally and mineralogically complex. Over half of it is composed of hornblende diorite and there is considerable hornblende-hypersthene gabbro. A roughly elliptical body of olivine gabbro, which has been described above, is enclosed within the diorite north of the Illinois River. A small irregular body of granodiorite intrudes the diorite, and also forms a reentrant into the peridotite in the vicinity of Oak Flat; a large dike of granodiorite porphyry cuts the diorite at Pine Flat on the Illinois River. Large irregular sporadic masses of pegmatitic hornblende diorite occur in the southern half of the diorite body. Aplitic, and less commonly acid pegmatitic dikes cross-cut the diorite in a number of places.

A small elongate intrusion of biotite-hornblende diorite about 3-1/2 miles long and 1-1/2 miles wide intrudes the main peridotite body in the southern part of the quadrangle west of Mud Springs. It, in turn, is intruded by a light-colored, fine-grained rock which is probably related to the dacite porphyry.

Other small intrusions of diorite, coarse hornblende diorite, and metagabbro cut the peridotite in the vicinity of Diamond Creek at the south boundary of the quadrangle. A small body of diorite cuts the Applegate group south of Page Mountain in the southeastern corner of the quadrangle.

It was not practicable to map all the varieties of the basic and intermediate intrusive rocks. Only those types that could be readily distinguished in the field were differentiated in the mapping. They are the olivine gabbro, the diorite rich in hornblende and pyroxene, the pegmatitic diorite, and the granodiorite.

Hornblende diorite.—The hornblende diorite which probably makes up the bulk of the igneous mass is characterized by a wide variation in texture and structure, much of which may be seen within the confines of an average-sized outcrop. Gneissic structure is common, and on Little Chetco River the diorite merges into the amphibole gneiss through a transitional zone of lit-par-lit structure. Strong banding is found at places within the diorite. Among the smaller structures a radial arrangement of crystals was noted. The texture varies from fine- to medium-grained (the medium-grained being the more common,) and the color varies within a hand specimen from light gray to greenish black, depending on the hornblende content. The textural and mineralogical variations give to an outcrop either a banded or mottled appearance. Under the microscope the average rock exhibits a hypidiomorphic-granular texture, and consists of about 50 percent plagioclase, 45 percent hornblende, and about 1 percent quartz. The plagioclase is zoned and the zones range in composition from labradorite (Ab_{38}) to andesine (Ab_{54}). Magnetite and apatite are the common accessory minerals. Alteration is varied, the products being chlorite, actinolite, kaolin, zoisite, and hematite. Few of the crystals are euhedral, but some of the larger hornblende crystals poikilitically enclose rounded grains of plagioclase.

This rock grades into a facies even richer in hornblende which has been observed at places throughout the mass. The facies contains magnetite and the plagioclase is usually a calcic labradorite.

Gabbro.—The average specimen of gabbro is holocrystalline, medium-grained, and dark gray. The light minerals are slightly in excess of the dark minerals. The feldspar generally has a distinct bluish cast. Anhedral to subhedral, black to very dark-green hornblende and pyroxene are intergrown with the plagioclase. The lustrous black pyroxene is always rimmed with dark-green to black hornblende. Where intergrown with pyroxene the hornblende is anhedral, but it is not unusual to find specimens in which black hornblende occurs as euhedral prisms. In such specimens pyroxene appears to be absent. Quartz is rare, and where it occurs there is also a little biotite.

Fresh calcic plagioclase makes up about 60 to 75 percent of the rock. The composition is fairly uniform and is within the labradorite-bytownite range, the albite molecule ranging from 25 to 45 percent, and being most often Ab_{30}. About 25 percent of the rock is composed of the pyroxene minerals hypersthene and augite. Both minerals occur commonly in the same specimens, with the hypersthene being slightly more abundant. Hornblende is ubiquitous and is invariably associated with the pyroxene it replaces. In some specimens primary hornblende, which is not the pale-green, fibrous, uralitic variety, completely encloses the pyroxene. It usually makes up less than 10 percent of the total rock. Magnetite is not abundant (less than 10 percent). A small amount of primary quartz is found in the rock, an unusual mineral for a rock of this composition.

Pegmatitic hornblende diorite.—Large irregularly shaped bodies of pegmatitic diorite are concentrated in the southern end and probably also near the roof of the diorite mass. The rock shows a wide variety of textures and structures, including comb structure, but its distinctive feature is the presence of large prisms, commonly 2 to 4 inches long, of black or dark-green hornblende. The largest crystals seen crop out in the NW¼ sec. 26, T. 38 S., R. 11 W., south of Johnson Butte, where the crystals commonly measure 2 feet in length. The amount of hornblende varies, but generally makes up less than half of the rock. Associated with the hornblende are augite and partly saussuritized labradorite, enclosed in and interstitial with the hornblende. The minor accessory minerals are magnetite and pleonaste, which make up about 2 percent of the pegmatite and are characteristic constituents. Some of the pegmatites carry a little hypersthene, partly serpentinized olivine, and in places some sulphide minerals.

Gneissic migmatite.—Under this name are grouped a large number of xenolithic blocks ranging in outcrop area from a few acres to as much as a square mile. The larger areas are commonly called roof pendants. They occur at all depths within the exposed part of the intrusive, and are of two types - blocks of amphibole gneiss that are scattered through both the diorite and the peridotite, and blocks of chlorite, actinolite, and hornblende schists enclosing remnants of peridotite that are found only within the diorite. Both types are common in the area between Soldiers Creek and Vulcan Peak, and both types are characterized by gneissic structure.

The amphibole gneiss found within the peridotite in outcrop resembles the other gneiss in the area, except that occasionally the hornblende seems to have recrystallized into larger prisms. Where it is found in the diorite, the gneiss is commonly injected by the diorite, and cut by small diorite dikes. There has been interaction between the constituent minerals of host and intruding rock.

An excellent example of a roof pendant of peridotite in diorite, and the resulting migmatite extends through a sharp ridge at the head of Nome Creek. This body is approximately one-half mile long, 500 feet thick at the crest of the ridge, and wedges out 900 feet down the dip. Partly serpentinized peridotite contains lenticular masses of talc and dense massive chlorite schist that lie approximately parallel to the original structure in the peridotite, which strikes N. 10° W. and dips 65° NE. The pendant is surrounded by a thick contact zone of chlorite-actinolite schist with a schistosity that strikes northwest and dips northeast. The hornblende diorite at the schist contact is fine-grained and cut by numerous quartz veinlets. At Chrome Butte the peridotite has been shattered. The fractures are filled with talc, chlorite and actinolite, and the adjoining hornblende diorite contains inclusions of dunite seamed with chlorite and rimmed by radiating hornblende crystals. There are also coarse chlorite schists that contain remnants of unaltered dunite.

That these bodies may be related to the pegmatitic hornblende diorite is indicated in the NW¼, sec. 32, T. 37 S., R. 10 W., where from east to west the following zones of mineral association are seen: hornblende diorite grades rapidly to coarse hornblende magnetite rock: next, coarse pyroxene with interstitial plagioclase; then a central core of hornblende gabbro containing partly serpentinized pyroxene; this central core is bounded on the west by epidote-veined hornblende gneiss, and to the west of this is coarse hornblende pegmatite. Olivine is present in a few of the coarse hornblende magnetite rocks and increases in amount near inclusions of peridotite.

Granodiorite.—Five bodies of granodiorite crop out in the quadrangle; one underlies Pine Flat on the Illinois River, and another intrudes the northern end of the coarse-grained gabbro mass. A third body was intruded along the eastern diorite-saxonite contact, and underlies Oak Flat, part of Briggs Creek and Red Dog Creek. The fourth body crosses the North Fork of Diamond Creek at the south border of the quadrangle, and trends approximately N. 20° W. along the east side of an equally large mass of black hornblende-rich biotite. The fifth and largest granodiorite body lies at the head of Baldface Creek in secs. 11, 14, 23, and 26, T. 40 S., R. 11.W. This body lies well within the peridotite mass, contains two partly serpentinized pendants of saxonite, and is cut by hornblendite.

The rock is characteristically light gray, and has a medium-grained texture. Plagioclase and quartz are readily recognizable in the hand specimen, and occasionally some potash feldspar can be distinguished. The most common accessory minerals are biotite and hornblende. Muscovite is present in both the Pine Flat and Oak Flat bodies.

Under the microscope the rock shows a hypidiomorphic texture. Plagioclase, either andesine (Ab_{55}) or oligoclase (Ab_{75-85}), makes up from 45 to 60 percent of the rock. It forms subhedral to anhedral crystals which commonly are distinctly zoned. Orthoclase makes up from 10-20 percent of the rock. The feldspar is usually partly fresh, but some gray alteration products are always visible. Quartz is interstitial with the plagioclase and averages about 20 percent of the rock. The quartz is clear in most specimens, but in one collected from the body west of Mud Springs, it is filled with hair-like inclusions of rutile or tourmaline. Plate-like crystals of brown biotite are characteristic accessory minerals in all specimens and make up from 3 to 10 percent of the rock. Hornblende is present in small amount (1 to 8 percent) as bladed crystals which are commonly fibrous and frayed at the ends; the mineral is partly replaced by biotite. Muscovite is present as a trace in most of the rock, but constitutes abo about 5 percent in that from Oak Flat. Colorless garnet, sphene, and apatite are common minor accessories. Most of the granodiorite show effects of slight alteration; the feldspars are slightly saussuritized, and there is some epidote, clinozoisite or chlorite.

Structure of hornblende diorite and related rocks.—The hornblende diorite and gabbro intrusion is of batholithic proportions, and it is strikingly concordant with the regional structure. Both the eastern and western contacts dip east, the western contact being, in general, steeper than the eastern contact. For several miles along its western boundary the intrusion follows a layer of basalt in the Dothan formation, and in several places the changes of strike in the Dothan are followed by similar changes of strike of the diorite contact. Where the diorite intrudes the amphibole gneiss and the volcanic member of the Galice formation to the east, the contacts are for the most part parallel to the planar structures of the older rocks. In many places the planar structures in both the peridotite and the diorite are parallel, and it is reasonable to assume that in such places the diorite came in along the base of the Josephine peridotite sheet. In a few places both the eastern and western contacts are faulted and in a few others they are more or less transgressive, but broadly the structure of the diorite is that of a large sill-like sheet emplaced along the plane of weakness between the Dothan formation and the older rocks; the same plane had been followed earlier by the Josephine peridotite sheet.

The structures within the sill, as well as the areal form and the trace of the contacts of the sill with the rocks into which it has been intruded, show that the whole body dips to the east at a moderate angle which averages about 60°. As the sill has a fairly consistent outcrop width of about 26,000 feet, it probably is about 13,000 to 20,000 feet thick.

The diorite is broken by several types of joints, only a few of which can be analyzed at the present writing.

Cross joints, or Q-joints, perpendicular to the lineation are very common. Most of these cross joints trend about N. 60° W. It should be noted that this direction is nearly, though not quite, normal to the prevalent direction of strike of the foliation. These are tension joints and are present everywhere, even where the rock does not have observable lineation. They are usually vertical or dip at very steep angles.

Two other common directions of jointing almost invariably occur together. They trend north-northwest and northeast, with the acute angle between them pointing northwest and southeast. These two sets of joints dip at moderate angles in opposite directions, and are interpreted as being due to shearing strains set up by compression from a southeast-northwest direction. They rarely, if ever, are filled with dikes but may cut and offset aplite dikes.

Flat-lying joints have been seen near the contacts and where the lineation is well developed. They dip at low angles (5° to 25°) in any direction. Where lineation is viesable the joints are parallel to the foliation, but in several places they have been observed unaccompanied by visable lineation.

Although the diorite is more or less isotropic in its central part, it takes on a distinct foliation as either the eastern or western contacts are approached. This foliation is usually manifested by prismatic hornblende and pyroxene crystals in parallel planes, and commonly the elongate prisms of these minerals are arranged with their long axes parallel, so that a lineation is imparted to the mass.

In general the foliation strikes north-northeast and parallels the contacts. Dips on the eastern border average 45° to the southeast. On the west side the dip is likewise toward the southeast but is usually steeper, between 45° and 60°. In some places near the eastern contact the foliation is drag-folded to a pronounced degree. The impression in the field has been that the planar structure is more perfectly developed along the eastern than along the western contact. So far as could be determined, the lineation lies in the plane of the foliation.

The scale of the map did not permit systematic mapping of the linear structures, although parallelism of the long axes of prismatic minerals was noted where it is conspicuous. The alignment of schlieren is another common and readily determined linear structure and it parallels the crystal lineation.

The other small dioritic intrusions cut the peridotite and other rocks. As these bodies are elongate in their outcrop plans, and their longer dimensions usually agree with the trends of the folds and complementary faults of the region, it may be assumed that the bodies are tabular and have been intruded either as sheets along faults or as sills along bedding.

Dacite porphyry

In the southwestern part of the quadrangle, especially around Sourdough Camp, occur irregular-shaped knob-like masses and plugs of light colored aphanitic to fine-grained rocks. Though varying somewhat in texture, they probably are of about the same composition and are here grouped together under the name of dacite porphyry. The largest body of the dacite porphyry is west of Mud Springs in the valley of Baldface Creek. A large dike of this rock also intrudes the Dothan formation along the crest of the Sourdough anticline, and small bodies cut the peridotite and serpentine. Dikes of dacite porphyry also intrude the granodiorite.

On weathered surfaces the rock is very light colored, chalky white or white stained with limonite. Fresh surfaces show a holocrystalline, generally porphyritic texture and in some specimens a flow structure can be discerned. The phenocrysts are commonly individual rhombs of feldspar, though in some specimens less perfect laths of feldspar are grouped together. They are from 2 to 3 millimeters across. Small water-clear crystals of quartz may be present. The groundmass is very fine-grained to microcrystalline, and is composed of feldspar, quartz, and scattered frayed blades of hornblende or biotite and muscovite.

The rock that intrudes the peridotite on the ridge north of Sourdough Camp is more or less typical of the more coarsely crystalline variety. It is fine- to medium-grained and composed of euhedral laths of plagioclase in trachytic arrangement. In the groundmass are laths (2 - 3 mm. long) of orthoclase, and a small amount of accessory minerals which include biotite and hornblende both of which tend toward euhedral development. This rock is coarser-grained in the central part of the body and has a fine-grained border facies.

Detailed petrographic studies have not been made of these rocks, but their megascopic characteristics allow them to be placed in the dacite group and to be correlated with similar rocks in the Port Orford (Diller 4) and Riddle (Diller 8) quadrangles.

Cretaceous system

Horsetown formation

Sandstone and conglomerate of the Horsetown formation (Shenon 14) crop out in the southern part of the Illinois Valley where they are exposed along the east side of the West Fork of the Illinois River near Waldo for a length of 5 miles and width of about 1½ miles.

Along much of their eastern boundary they are in fault contact with serpentine. To the south they unconformably overlie the steeply dipping Galice formation, and to the west and north they are buried beneath Recent alluvium. On the average the formation strikes N. 30° W. and dips 30° NE. A thickness of about 5,000 feet is exposed.

The lower beds of the Horsetown formation are largely of coarse conglomerate with some interbedded sandstone. The conglomerate is well exposed along the West Fork of the Illinois River at the base of Indian Hill, where it is a chaotic assemblage of rudely cross-bedded boulders, cobbles, and pebbles in a sandy matrix. The boulders, cobbles, and pebbles are well rounded, and consist of vari-colored quartzites, black slate, porphyritic basic and silicia volcanic rocks, altered diabase, a few varieties of granitic igneous rocks and, noteworthily, a few well-rounded cobbles of coarse-grained, bastitic serpentine.

Sandstone makes up the bulk of the formation. It is massive and grayish green where fresh, but during weathering it has a tendency to develop large spheroidal structures, the long axes of which are parallel to the poorly developed bedding. Closer inspection shows some of the small spheroids—2 to 4 inches in diameter—to be concretions of medium-grained micaceous sandstone that have formed about fossil nuclei. The sandstone is remarkably even-grained over considerable areas. Angular quartz and some feldspar grains—for the most part less than 0.10 mm. long—constitute almost 30 percent of the prevailing sandstone, and highly altered chloritized material makes up the remainder.

Tertiary system

Arago formation

A prong of the Arago group extends southward into the northwestern corner of the Kerby quadrangle, where it is exposed for 5 miles along the east side of the canyon of the Illinois River. The beds exposed here are referred to as the Arago formation because in this locality they cannot be identified with the subdivisions of the group. They represent a shoreline facies of a marine deposit which accumulated in a shallow arm of a sea that was surrounded by a mountainous shore. The formation is an assemblage of lenticular bodies of sandstone and conglomerate in nearly equal amounts with thin interbeds of shale. It is characterized by poor sorting, cross bedding, and abrupt lateral and vertical variation.

The sandstone is a dirty-green hue, and ranges in grain size from medium through coarse to gritty. The average grain size is 1 to 2 millimeters. The grains are subangular to angular, the sorting is poor, and the entire sediment appears to be poorly washed. Lithic grains, pieces of diorite, sandstone, greenstone, and a little peridotite make up about two-thirds of the sand grains; the remainder are mostly quartz, though a few feldspar crystals and an occasional pyroxene or amphibole grain can be found. The sandstone is loosely consolidated and cementation is poor.

The conglomerate is as poorly sorted as the sandstone. Pebbles an inch or so in diameter occupy the interstices between larger pebbles, cobbles and boulders, the largest of which are over 1 foot in diameter. The material is in general subangular to subrounded; more rarely it is well-rounded. Diorite is the most abundant rock in the conglomerate, but there is some peridotite.

Both black shale and greenish sandy layers are scattered through the formation. The black shale commonly is carbonaceous and may be coaly, owing to the abundance of carbonized plant remains. In at least one place a thin stratum of carbonaceous shale has yielded well-preserved fossil leaves.

The Arago formation overlaps the sedimentary rocks and basalt flows of the Dothan formation, as well as the dioritic rocks and peridotite that intrude them. The floor on which the sediments were deposited appears to have been fairly smooth and rolling. The formation has been only slightly disturbed since deposition, so that in general it dips only about 5° toward the east. In a few places, as near the mouth of Silver Creek, it is gently folded. Normal faulting has depressed small blocks of the formation several hundred feet below the general level of the formation. Other blocks that have been elevated have been partly or completely removed by erosion. At the mouth of Silver Creek the formation is disturbed considerably by a high angle reverse fault that has brought the basalts and sandstone of the Dothan over the Arago. The folding of the Arago near this fault is probably a reflection of the movement along the fault.

The maximum thickness of the Argo formation in the Kerby quadrangle is determinable on the ridge just south of Indigo Creek, where it is about 500 feet. The formation thins rapidly toward the east, wedging out completely in less than half a mile; and southward it thins to about 250 feet near the mouth of Silver Creek.

A fairly persistent layer of conglomerate occurs at the top of the formation; this layer is approximately 75 to 100 feet thick. The sediments below the conglomerate are composed principally of sandstone, with scattered small lenses of conglomerate.

A collection of fossils from just north of Indigo Creek has been studied by Stewart (personal communication). He assigns them to the Arago. Weaver (17) has recently reviewed the Arago formation and assigns it to the upper Eocene.

Old gravels

Within the quadrangle, two areas of rotten gravel are found on an old upland surface of low relief. One area underlies Gold Basin, the other lies to the northeast of York Butte. Both are at an altitude of about 4,000 feet. In his comprehensive study of the physiography of the Klamath Mountains, Diller (3,7) named this surface the "Klamath peneplain" and assigns the planation to the Miocene. Furthermore, he states that " ...the condition which the Wymer beds record is that of the Klamath peneplain just before it was uplifted to initiate the plateau of the Klamath Mountains." Recent work by the writers in the Gasquet quadrangle just to the south of the Kerby quadrangle indicates that the altitude of the surface on which the "Wymer beds" rest is at or below 2,200 feet and does not rise uniformly to the Klamath peneplain surface at 3,200 feet and above. Apparently two distinct surfaces of planation that are separated by a marked change in slope were cut during periods of different base level. It is questionable whether the dating by Diller is valid, but further analysis of this problem must await fuller discussion elsewhere.

About 150 acres of the upland surface called Gold Basin is underlain by a gravel deposit. The full thickness of the gravel down to the weathered surface of the underlying diorite is well exposed in the bluffs along the basin's southern edge at the head of Sluice Creek. The gravel is as much as 110 feet thick in its central part but thins rapidly to the east and west. The gravel, though somewhat decomposed, is more or less firmly cemented, and this condition extends throughout the mass. It has been tunnelled on bedrock for 30 feet. The gravel is very poorly sorted and consists generally of cobblestones and boulders up to 4½ feet in diameter mixed with pebbles and sand. Most of the material is subrounded, although some is subangular and some is well rounded. Hornblende diorite is the most common rock represented in the fragments; other common types are: sandstone and chert of the Dothan formation; metavolcanic rocks, both flows and agglomerates, of the Galice formation; metamorphic rocks, including muscovite schist, quartzite amphibole gneiss, peridotite, pyroxenite, and an occasional quartz pebble. The upper part of the deposit is of finer texture and consists of angular to subangular fragments, mostly less than 1 inch in diameter. Scattered through it are a few large well rounded pebbles. The deposit is capped by reddish soil, and rock decay extends from top to bottom. All types and all sizes of material show much weathering. Near the top of the deposit, cobbles of dense aphanitic volcanic rock, and even cherts are altered to clay. Alteration is less intense at depth but is always present in some degree.

Stratification is hard to see but is sufficiently well developed to show that the beds strike N. 35° E. and dip 35° SE. The deposit is cut by widely spaced vertical joints. Obviously the beds have been tilted toward the southeast, and the whole surface of low relief on which they rest may have been tilted a few degrees in this direction. The formation was laid down by a stream which, according to Diller (7), flowed northward.

Quaternary system

Auriferous gravels of the second cycle of erosion

Small patches of stream gravel have been found on the divides between Onion and Swede Creeks and between Swede and Soldier Creeks. They are in general nearly 1,500 feet below the Klamath peneplain, and from 700 to 2,500 feet above the nearest points of the Rogue and Illinois Rivers between which they lie. Diller (7) called them auriferous gravels of the Second Cycle of Erosion. He pointed out that they are probably related to the gravels of the Old Channel at the mouth of Galice Creek on Rogue River and were probably deposited by the ancestral Illinois River at a time when that river flowed northward from its present course just above the mouth of Six Mile Creek to enter Rogue River just below Galice. Several mining men of long experience in the region report that the Old Channel extends southward beyond Briggs Creek to the neighborhood of Waldo. As this interpretation is tenable, the writers have correlated these gravels with the "Tertiary gravel" (Shenon 14) in the Takilma-Waldo area, and they are fully aware of the fact that such an interpretation requires the Takilma area to have stood about 1,500 feet higher than the saddle between Six Mile Creek and Soldier Creek when the "Tertiary gravel" was deposited.

The mass of cemented gravel of the Old Channel at Column Rock covering an area roughly estimated at 10 acres, caps the terrace on the end of the divide between Swede Creek and Onion Creek. The upper layer of gravel, about 80 feet in thickness, is firmly cemented and forms a prominent bluff from the top of which rises a column of conglomerate that forms a picturesque feature of the region. Another area is exposed in the road cut in the southwestern corner of sec. 36, T. 36 S., R. 9 W.

The pebbles of the upper layer of the mass at Column Rock are generally of tuffs and lavas of the Galice formation with minor quantities of slate of the Galice. These pebbles are subangular and less than an inch in diameter. Some layers show that the stratification is horizontal and that the deposit occupies a shallow valley of gentle slopes cut in bedrock by an ancient stream. The lower 150 feet of the deposit is coarse gravel, so poorly cemented that it does not form ledges on the slope below the bluff. It contains many cobblestones 6 to 8 inches in diameter, which are well rounded, fresh and smooth, without signs of weathering. There are some lava boulders, especially near the bottom, the largest ones being about 4 feet in diameter.

The gravel to the south on the divide between Swede and Soldier Creeks is similar, but the coarse boulder and cobble bed was not seen.

The several bodies of conglomerate in the northwestern part of the Takilma-Waldo district, chiefly on the divide between the East and West Forks of the Illinois River, are evidently the erosion remnants of a once continuous formation which had a maximum thickness of at least 400 feet between Allen and Sailor Gulches. The conglomerate is made up of well rounded cobbles and boulders in a matrix of sandy clay. A few of the boulders are as much as 3 feet in diameter, but most are less than 1 foot in diameter. Weathering has decomposed the formation to such an extent that most of the cobbles fall to pieces when released from the mass. The cobbles and nuclei of boulders that remain firm consist mainly of greenstone, but a few are of chert or other fine-grained siliceous sedimentary rocks. The matrix is abundant and in places, particularly in the lower part of the formation, there are lens-like bodies of sandstone. This formation has been assigned to the Tertiary by Shenon (14).

Large lumps of carbonaceous silt containing many fragments of wood and leaf impressions were collected by the writers in 1945 from a layer of sandy silt exposed in the bank of gravel in the Rapp diggings of the Old Channel mine above Rogue River near Galice. This gravel resembles closely in degree of weathering the "Tertiary gravel" in the Takilma-Waldo area. The material was examined by

R. W. Brown, (Personal communication) who reports: "The organic material visable to the naked eye, taken from the matrix of this collection, consists of fossil wood of Douglas Fir (Pseudotsuga taxifolia), fragments of bark of Douglas fir or pine, and shredded plant debris of indefinite identity. From the comparatively unaltered condition of the wood I suspect that the remains are of late Tertiary or, more likely, of Pleistocene age."

Llano de Oro formation and bench gravel

Rusty-red clay, sand, and gravel crop out as a terrace around the margin of the Illinois Valley and its tributaries, and within the valley this material occupies almost the entire area between the East Fork and the West Fork of the Illinois River. It rises to an altitude of 1,500 feet around the valley edge, but in the valley bottom has been partially or completely removed by erosion. Shenon (14) named these deposits the Llano de Oro formation after a mine of that name now included in the Esterley mine holdings. He points out that the formation contrasts strongly with the later Pleistocene gravels and assigns it to an early part of the Wisconsin stage of glaciation. The formation is well exposed in the road cuts along U. S. Highway 199, south of the East Fork of the Illinois River.

In the placer workings of the Esterley mine, the deposits consist of alternate lenses of boulders and pebbles and of soft buff silt, but in general, the formation consists of poorly sorted clay and sand with scattered pebbles and cobbles or thin lenses of gravel in sandy silt. Colors are commonly rusty red to buff, and the material is more weathered than the younger alluvium. The formation has a maximum thickness of 100 feet but is commonly less than 50 feet thick. In places the formation has been tilted. It is believed to be of Pleistocene age.

Southwestern Oregon was apparently elevated about 1,500 feet following the deposition of the auriferous gravels of the second cycle of erosion. The streams trenched themselves to grade and were able to widen their canyons in areas where the rocks were easily eroded. It was then that the Illinois Valley was carved out of the sedimentary rocks of the Galice formation and the Applegate group and the rock surfaces of the present high benches cut along other streams. Later, the country to the west of the Illinois Valley was either tilted eastward or raised relative to the region to the east; while the streams to the west were busily cutting box canyons, the Llano de Oro formation accumulated in the Illinois Valley. Hence the gravels on the high benches are probably of the same age as the lower part of the Llano de Oro. Having been deposited by degrading streams, the bench gravels consist of coarse material, sand, gravel, and boulder gravel commonly containing boulders many feet in diameter and do not contain the silt and clay that make up a large part of the Llano de Oro formation. These gravels rarely exceed 25 feet in thickness, although the bench gravel along Josephine Creek is more than 100 feet thick in places and is firmly cemented. It rests on decayed bed rock, as do the gravels found along Althouse Creek and elsewhere.

Glacial moraine

Two deposits of coarse debris, one in a branch of Long Creek (sec. 16, T. 41 S., R. 8 W.), the other in upper Fresno Creek, have been recognized to be glacial deposits. The first is a well developed end moraine at an altitude of 3,000 feet. It has the characteristic form of an end moraine and consists of some subangular boulders of hornblende diorite, and volcanic rocks of the Galice formation but mostly of sandstone of the Galice. The second is a boulder moraine of peridotite piled up in the bottom of the canyon of Fresno Creek at an altitude of 2,850 feet. Both moraines are downstream from glacial cirques. The forms of the cirques and of the moraines show no modification by weathering or stream erosion, so it is assumed that they were formed during the last glacial stage (Wisconsin) when glaciers of alpine type extended down to this altitude.

Alluvium

In general, all the streams west of the Illinois Valley except the very short ones occupying short, steep gulches are flowing in narrow steep-walled trenches that have been cut down from a series of benches at various levels above their beds. The bed-load in these degrading streams accumulates as transient small bars and banks of sand, gravel, and boulders, in places of slack water. The gravel deposits on the lower-level terraces were part of the bed-load and like the alluvium of the present streams, with which they are included, consist of loose coarse gravel and boulders. According to the placer miners, the precious-metal values occur throughout the deposits and are not all concentrated on bedrock. In places the lower terrace deposits merge into each other and into the colluvium of adjoining slopes, and hence all these deposits are mapped as alluvium. It is probable that the placer deposits of Althouse Creek include some material that is of the same age as the bench gravels, but it is not practical to map such materials separately.

The bottoms of many of the small valleys east of the Illinois Valley are filled with colluvium or "slide rock", a jumbled mixture of large and small angular rock fragments, subrounded cobbles and pebbles, and sand. The placer gold which is found in many of these valleys is coarse and rough and is distributed throughout the colluvium, indicating that it has not traveled far.

STRUCTURE

General statement

The dominant structural features of the Kerby quadrangle are indicated by the distribution of most of the rocks as parallel bands trending north-northeast and dipping steeply eastward, and by an anomalous age sequence of rocks from old on the east to successively younger rocks toward the west. Such a distribution can be brought about by overturned isoclinal folding accompanied by high-angle reverse faulting roughly parallel to the limbs of the folds, followed by injection of the igneous rocks along these faults or other parallel surfaces of weakness such as unconformities. All the observed structural data are in harmony with such an hypothesis. Owning to the lack of widespread distinctive lithologic or faunal horizons in any of the formations and the necessary supporting structural data, it has been impossible to work out even the major folds sufficiently to warrant describing them in this preliminary report.

Some of the major reverse faults are well enough known to be named and described. Others undoubtedly exist but are not named because they are largely interpretive and their positions are not known.

Reverse faults

A great zone of faulting enters the quadrangle from the south, in the east slope of the valley of the West Fork of the Illinois River. The trace of this fault zone, which consists of a plexus of braided and bifurcating fault planes, trends north-northeast along the west side of the Illinois Valley. Near Parker Creek a branch swings eastward. This is named the Lime Rock fault. The middle trace is lost under the alluvium of the Illinois River Valley. A western branch enters the peridotite near Parker Creek and its trace follows Josephine Creek, Illinois River west of Eight Dollar Mountain, and the valley of Squaw Creek where part of the displacement follows the serpentine that heads toward Serpentine Point; the other branch follows the band of serpentine to the east into the valley of Clear Creek where it is offset by a traverse fault and continues north-northeast to the Rogue River. This whole group is called the Illinois Valley fault system.

From the southern boundary of the quadrangle to two miles north of Woodcock Creek the Illinois Valley fault system is marked by a zone of severely sheared serpentine. At its southern end in the vicinity of Whiskey Creek and the West Fork of the Illinois River the fault planes lie competely within the peridotite. The zone is concealed beyond O'Brien by the gravels at the mouth of the canyon of Rough and Ready Creek. North of Rough and Ready Creek the fault zone is well exposed and is topographically denoted by steep front, aligned saddles and springs. From here to the end of the zone the upper Galice rocks are brought directly into contact with the peridotite by the fault.

The average strike of the fault is N. 27° E., the dip is at a steep angle to the west, and the relative displacement is reverse, the peridotite having moved up and eastward relative to the Galice block. The amount of displacement cannot be determined but must be several thousand feet.

The branch of the Illinois Valley fault system that trends north from Parker Creek is marked by a zone of crushed and comminuted serpentine that crops out conspicuously in a series of saddles on the spurs between the eastward flowing streams and then follows the upper canyon of Josephine Creek. Partly serpentinized peridotite is not a competent rock and completely serpentinized peridotite is less so, hence shearing stresses tend to be dissipated by many small displacements along planes that horse-tail into the peridotite and cannot be followed in the field. They are concentrated at intervals along the strike in well defined zones, in places several hundred feet wide, of greenish-gray sheared serpentine that are conspicuous in the buff or rusty-red peridotite. Where major shearing followed thin layers of peridotite the whole layer is crushed to form sheared serpentine. It is difficult if not impossible to trace or map the actual component parts of the faulting for several reasons. There can be little doubt, however, that major high angle reverse faulting continues northward following the northnortheast course outlined in a preceding paragraph. The trace of the eastern part of the zone across the ground surface indicates that the zone dips steeply to the east; a western branch has a more northerly trend and dips at low angles toward the east. The net relative displacement is east side up and must amount to several thousand feet.

The Lime Rock fault can be studied best on the ridge east of Kerby especially at the base of Lime Rock where the fault was first recognized and also in the northwest quarter of sec. 9, T. 39 S., R. 7 W. This fault and its numerous offsets can be followed along this ridge and eastward into the Grants Pass quadrangle where it is cut off by a quartz diorite stock. To the west and south the fault is buried under the alluvium in the Illinois Valley but its junction further south with the Illinois Valley fault System is known. Another plane of displacement appears in the serpentine north of French Flat and passes west of Waldo until it enters the Galice formation where it cannot be traced. This fault corresponds in location to the Orleans fault shown on a map by Hershey,(9) and it is probably related to the Orleans fault but, only as one of many faults that bring older rocks against the younger Galice formation.

The Lime Rock fault has been offset by many tear faults that strike from north to 45° west of north and are nearly vertical. The Lime Rock fault dips steeply eastward from 70° to nearly vertical and brings the Applegate group against the upper part of the Galice formation. The relative displacement is south block up and it must amount to several thousand feet.

Other reverse faults occur to the west. They cannot be traced as far along the strike as the faults just described, but they probably represent major displacements. One can be recognized in the valley of Horse Creek at the Eureka mine and can be followed 3 miles southward into Rancherie Creek. Another crosses the upper drainage basin of the Little Chetco River in a southerly direction. Reverse faults of small displacement are found along the contact of the hornblende diorite with the Dothan formation. These faults probably are the product of renewed movement along the major fault that, prior to the intrusion of the hornblende diorite, separated the Dothan formation from older formations to the east. A reverse fault cuts off the Argo formation in the northwestern corner of the quadrangle at the mouth of Silver Creek. Here a pillow basalt of the Dothan formation has been severely sheared, imbricated and thrust up and over the Arago formation. The fault zone is over 100 feet wide, strikes N. 25° E., and dips 65° to the southeast. The displacement involved in the post-Arago movement is in the order of 200 to 300 feet.

The earliest date of reverse faulting is not certainly known. Folding and reverse faulting involve the peridotite. The intrusion of metagabbro along the strike of the fault in the gulch of Slate Creek and to the north suggests that faulting antedates the intrusion of the gabbro. Both the peridotite and gabbro are older than Horsetown and younger than early Knoxville. Movement has recurred along these faults even until recent times or until just prior to the cutting of the inner box canyons. The box canyon in the valley of Josephine Creek and of other streams west of the Illinois Valley fault system are cut through the bench gravel.

Northwest-trending structures

A normal fault separates the amphibole gneiss and the Dothan formation in the southwestern part of the quadrangle. Its irregular trace trends southeast along the southwest flank of the ridges dominated by Chetco Peak, from the south fork of Chetco River to knob 3890. This fault, here named the Chetco fault, dips at moderate angles to the southwest. The relative displacement along the Chetco fault is north side up and possibly is several thousand feet. The strike of the Chetco fault does not conform to the dominant structural trend of the quadrangle but is parallel to other structures in the southwestern part of the quadrangle. The contact of the peridotite with the amphibole gneiss along the crest of the ridge a few thousand feet to the northeast has the same trend as the Chetco fault, and dips at a low angle toward the northeast. But as the contact bevels the structures in the gneiss it probably represents an erosional surface rather than a fault. A similar northwest trend is shown by the elongation of the hornblende diorite body that crops out to the southeast along the strike on County Line Ridge just north of Cedar Springs; and also by the parallel trend of the axis of Baldface anticline (see Dothan formation structure) which lies to the southwest in the valley of the North Fork of Smith River.

This major difference in structural trends may be restricted to the Dothan formation and the younger igneous rocks intruded into it. In that case a major unconformity would exist between the Dothan and Galice formations, or it may involve the Galice formation. The latter assumption is supported by many measurements of the strike and dip of the Galice volcanic rocks in the drainage basin of the Little Chetco River where they crop out to the north of a band of peridotite several miles wide; these measurements indicate that the trend of the Galice formation swings eastward, but other equally good measurements have the dominant trend to the north. Furthermore, the structure of the Dothan formation in the northwestern part of the quadrangle conforms to the dominant structural trend, and the exploratory reconnaissance mapping of Diller (7) shows that the trend of the Dothan formation is north-northeast, parallel to the trend of the Galice formation, as must be the case if the two formations are conformable. The solution of this important structural problem awaits systematic mapping of the area west of the Kerby quadrangle.

Cross faults

Steep normal faults that cut across all the rocks, folds and reverse faults are a common structural feature of the quadrangle. The strikes of these different faults range from east to north but most commonly are between northwest and west. A few faults have northeast strikes. The faults are vertical or dip steeply either to the northeast or the southwest. They range in length from a few hundred feet to several miles and they involve all the formations from the oldest to the Auriferous Gravels of the Second Cycle of Erosion. The relative horizontal displacement may be from a few hundred to many thousand feet. Most of these faults are tear faults formed during the late stages of isoclinal folding and reverse faults that involved the Galice and Dothan formations and also the peridotite. Similar stresses though of lesser magnitude later faulted the dioritic rocks, and adjustments have taken place along these faults at intervals into the Pleistocene.

MINERAL DEPOSITS

Clay

Most rocks weather to clay, so small amounts of this material are present almost everywhere. No deposit of clay has been found in the Kerby quadrangle that is of good enough quality, in large enough amount, and well located for commercial exploitation. The Macfarlane Brick Plant (59) has operated briefly.

Chromite

More than 22,000 long tons of chromite, most of which came from the Kerby quadrangle, has been produced in Josephine County. The Oregon Chrome mines (42), on the Illinois River, are the largest producer of chromite in the state, and are credited with a production of more than 12,000 long tons. Other properties with a production of 1,000 long tons or more are the Chollard (44) and the Sordy (24); the latter and the Sourdough mine have been described in publications of the U. S. Geological Survey (Wells 19), and other deposits have been described by Allen (1).

Chromite, the only chromium mineral of economic importance, has a dense, black or even bluish-black color, a pitchy luster, and a specific gravity of about 4.5. It occurs as disseminated grains as much as 2 millimeters in diameter, and as aggregates of such grains. It is easily distinguished in the field from the black manganese ores by its higher specific gravity, and from the black minerals of iron or copper by its characteristic chocolate-brown streak when scratched. Commercial quantities of chromite are found only in rocks of the peridotite group, and in southwestern Oregon exclusively in dunite, a rock composed of 95 percent or more of olivine. Peridotite is so extensively altered to serpentine that, whether fresh or altered, it is generally called serpentine by miners. Prospecting for chromite, therefore, can be restricted to the areas of peridotite or serpentine shown on the geologic map.

Accumulations of chromite large enough to be mined may be more or less mixed with the host rock, or they may form dense aggregates of crystals. The first type is called disseminated ore, and the latter massive ore. No large deposits of disseminated ore have been found in the quadrangle. The dense aggregates of massive chromite vary so widely in shape that the writers designate them by the noncommittal term "pod". The contents of such deposits range from a few pounds to hundreds of tons. Pods of chromite have been found in many of the peridotite bodies, but the largest and the most numerous of them have discovered in the peridotite mass that extends from the middle of the north boundary of the quadrangle southwest by south across Pearsoll Peak to Babyfoot Creek. Apparently they are most numerous along the western margin of this mass. Not all the known deposits have been mined out, and it is reasonable to believe that others will be found.

Cobalt

The ore from the Cowboy mine is a copper ore, but contains appreciable quantities of cobalt. The geology of this deposit has been described in detail by Shenon (14).

Copper

About 6,000,000 pounds of copper as well as some zinc, cobalt and gold have been produced from mines in the Kerby quadrangle, and under favorable price conditions more of these metals will be produced from the area. Three different but related types of deposits have been found. The most productive type is found close to the contacts of metavolcanic rocks and peridotite, and most of them are in those metavolcanic rocks commonly called greenstones. These deposits occur as irregular bodies and lenses of massive sulfides that have been deposited in and along fractures of the enclosing rocks. The primary (hypogene) sulfides include chalcopyrite (copper-iron sulfide), sphalerite (zinc-iron sulfide), pyrite, pyrrhotite, and at the Cowboy mine cobaltite (cobalt-arsenic sulfide). A small amount of gold is also present. They are everywhere associated with altered wall rocks and small amounts of quartz and calcite as gangue minerals. The percentages of the different sulfides present vary widely within a given deposit. Only limited parts of the massive sulfide bodies have a high enough content of the sulfides of metals other than iron to be classed as ore, and several of the massive sulfide deposits contain only a few hundredths of one percent of such minerals. Oxidation and sulfide enrichment have been important processes only close to the surface. The largest and most productive deposits of the massive sulfide type are in the Takilma-Waldo district, and have been described by Shenon (14).

Where sulfide deposits of this type are exposed for long periods of time to the action of downward percolating surface waters containing dissolved air, they are oxidized. All of the zinc and much of the iron are carried away in solution. Most of the copper is carried down to the water table, where it is deposited as new sulfide compounds with a higher copper content, and if the process is continued long enough under favorable conditions even native copper is formed. Gold, being insoluble, is left behind, and is increased in relative amount by the removal of the other constituents. Very low grade sulfide deposits on or just below the old upland surface have been enriched to ore by this process. The Cleopatra mine (secs. 3 and 4, T. 18 N., R. 2 E., H. M.) just south of the quadrangle yielded large lumps of native copper. This is the second type of copper deposit. The Turner mine (183) has been enriched in gold.

Vein deposits of pyrite, chalcopyrite, and some sphalerite associated with a great deal of quartz and some calcite are found in shear zones of the dioritic rocks of the quadrangle. They constitute the the third type. Those that have been explored contain enough gold to interest the prospectors. Those that have been examined are composite veins. The Old Glory mine (27) is a good example of this type. Prospectors report deposits in which pyrite and chalcopyrite in small amounts are scattered widely through the diorite, but no such occurrence has been seen by the writers.

Gold

Gold was the most important mineral resource of the Kerby quadrangle. Since the discovery of placer gold on the Illinois River in 1851, placer and lode mining have continued with some interruptions to the present day. In the early days they played an important part in the development of the region. The early mining camps Waldo and Allentown nearby, Sevastopol and Pondtown on Canyon Creek at and above its confluence with Josephine Creek, were settlements of several hundred persons. Now it is difficult to find traces of them. The gold output from this area can never be known, for records of the most productive period of placer mining are very incomplete. Shenon estimates gold production from the Takilma-Waldo area at $4,000,000, and any reasonable estimate of production from Josephine Creek and Althouse Creek would raise this figure to over $5,000,000.

Placer

Placer deposits are found on most of the streams. East of the Kerby fault zone these deposits fill the valley bottoms and make the beds of the present streams; west of this zone the streams flow on bedrock except near their sources, and the placers are found on the terraces along them. In the eastern area the gravel deposits that have been mined range in thickness from a few feet to more than 60 feet; the average thickness of gravel in the larger stream is more than 20 feet. In the deeper deposits there are layers of clay, and the gravel consists largely of fairly well-rounded cobbles and pebbles. Some of the deeper placer gravel on the larger streams is still unworked, and may justify drag-line or dredge operations. Shenon (14) has described the placers of this type in the Takilma-Waldo area. The shallow deposits are a jumble of subangular to angular rock fragments.

Most of the shallow placers on the small streams were worked out in the early days. The early miners worked the beds of these streams assuming that the gold would be mainly concentrated in the channels. It now appears that they erred in so assuming, and that the small streams effected little concentration of the gold from the side-hill wash. Paying quantities of gold are recovered in small scale "sniping" operations which are still carried on from the poorly assorted material on the banks of the streams.

In the western area two terrace levels are developed along the larger streams. The rock platform of the lower one is from 10 to 30 feet and the higher one from 80 to 150 feet above the streams. The gravel deposits are from 4 to 30 feet thick. In general they are quite coarse, and boulders up to several feet in diameter are present. On Josephine Creek these deposits are firmly cemented, and only the upper weathered part can be mined by placer methods. The higher terrace gravels probably are the equivalent of the Llano de Oro gravel in the Illinois Valley. The gravel of the Second Cycle of Erosion (Tertiary gravel) has been mined, and in the Takilma-Waldo district has yielded considerable gold and platinum. According to the old miners, the gold recovered from streams that cut gravels of the Second Cycle of Erosion ("Tertiary gravels", called the "Old Channel" by them) has a higher fineness. The old Channel gold runs 967 fine and other placer gold runs 800 to 900 fine.

Lode

Though the larger part of the gold produced in the Kerby quadrangle has been recovered from placer mines, there has been a large production from pockets and lodes.

Very little pocket hunting has been carried on during the past few years, and the writers have had very few opportunities to examine newly opened pockets. The term "pocket" is used in this region to describe any occurrence of free gold in a restricted space. Some of these pockets have no visible roots, but others are obviously associated with veins or veinlets. It follows from the manner of searching for pockets that all those found lie close to the surface. Both Hershey and Ferguson have mentioned that the pockets in the Klamath Mountains in California are formed by supergene processes and therefore must be near the surface. These writers believe that most, if not all, of the gold was brought to the pocket by downward moving groundwater and that the pockets are all on contacts of black carbonaceous slate with more competent rocks. Owing to the nature of pockets and pockethunters, record of all but the largest pockets does not exist, traces of the holes are soon obliterated, and memory of them is gone with the passage of the pockethunter. Hence the following generalizations about pockets are based on fragmentary information. The most productive areas have been the upper part of the basin of Althouse Creek, the basin of Canyon Creek, the west slope of County Line Ridge from Babyfoot Lake to Golden Dream mine, and the ridge between the Illinois River and Josephine Creek, northeast of Fiddler Mountain. These areas are underlain by pre-Dothan rocks, carbonaceous Galice slates are absent, thinly layered tuffaceous and cherty sediments and thin platy siliceous flows are commonly present, and large masses of diorite or more siliceous intrusives are not present. It follows that in the Kerby quadrangle localization of pockets is not effected by carbonaceous slate or by major igneous contacts. Probably contacts between small masses of more competent and less competent rocks are a factor, and the number of pockets that have been found on the ridge tops or high up the slopes indicates that supergene processes have played a part. In conclusion, it may be said that pockets are irregular and discontinuous rich pods of quartz which may have been somewhat enriched by supergene processes. They are similar to the small bodies of rich gold ore, called "hot spots" by the miners, that are found in some of the more continuous quartz veins.

No well defined gold quartz veins such as those developed at the Ashland or Benton mines have been opened up in the Kerby quadrangle. The smaller rudely tabular deposits are of two types: those composed of quartz, free gold and a few percent of sulfide minerals, and those in which the sulfides constitute a large part of the deposit, and contain gold and silver values in the sulfide minerals. The Robert E. mine, described by Shenon (13), is an example of the first; and the Old Glory mine of the second.

Another type of gold deposit is the gossan of large low-grade sulfide deposits from which the sulfide minerals have been removed by prolonged oxidation and leaching. The Turner mine, which has been described briefly by Shenon (14), is an example.

Manganese

The only manganese ore that has been mined in the Kerby quadrangle came from a lens of manganiferous chert in the Dothan formation (Black Beauty prospect, no. 186). The chert lenses in both the Applegate group and the Galice formation are also manganiferous in places. The manganese may be present in the chert as manganese carbonate, rhodochrosite, or as the manganese silicates. The rhodochrosite deposits, where sufficiently rich, form ore, but at present manganese cannot be won economically from manganese silicates. Where the silica has been leached out by downward percolating surface water leaving concentrations of manganese oxide, the residual material may be ore. Therefore chert layers near the ridge tops are more likely to contain exploitable deposits.

Nickel

Nickel in small amounts is present in many peridotite bodies. It occurs in the olivine, the nickel content of which may be as much as one-third of a percent, but is usually much less. Under proper conditions of weathering, the magnesium, most of the silica, and much of the iron is removed from olivine, but the nickel may be fixed by the iron hydroxide that precipitates out of the solution in the groundwater; or it may be fixed as a nickel silicate, garnierite, which is characteristically green. In this way an ore deposit may be formed on and below an erosion surface. A good example described by Pecora and Hobbs (12) is found at Riddle, Oregon. Garnierite has been found in the peridotite along the edge of the Illinois Valley, but no noteworthy deposits of nickel have been found.

Platinum and allied metals

Although the presence of platinum in the placers of Kerby quadrangle was known in the early days of mining, its value was not appreciated and so it was not recovered. Since the turn of the century its value has been generally known, and it is sought with care by placer miners. The platinum of the miner is an alloy of two or more of the six metals--platinum, iridium, osmium, ruthenium, rhodium and palladium. The value of these metals varies: for the last several years palladium has had the least value--about half that of platinum; ruthenium and platinum have had about the same value; and iridium, osmium and rhodium each have had about twice the value of platinum. Precise analytical data for these metals in the "platinum" from southwestern Oregon are scanty, but apparently it runs about 30 percent platinum, 32 percent iridium, 25 percent osmium, 13 percent ruthenium, and little or no rhodium or palladium. The placer deposits near Waldo, along Josephine Creek, and on the Illinois River just below the mouth of Dear Creek, are reported to carry platinum. Little information on the ratio of gold to platinum metals recovered from these placers is available. According to J. T. Logan the ratio of "platinum" to gold in mines near Waldo is 1 to 75.

Pyrite

Pyrite, the disulfide of iron, is found in the Takilma-Waldo district as bodies that contain tens of thousands of tons. Pyrite is sometimes used in the manufacture of sulfuric acid, and if such an acid plant should be constructed economically near enough to these deposits to permit their use, the pyrite would have a market. For a description of these deposits the reader is referred to Shenon (14).

Quicksilver

Cinnabar, the common ore mineral of quicksilver, is found in the northeastern part of the quadrangle on Shaw Creek (Empire, no. 5), in Swede Basin (no. 56), and on the southern boundary of the quadrangle in the valley of Diamond Creek. It is found in rocks of the Galice formation or in igneous rocks that have intruded the Galice and Dothan formations. Most of the quicksilver production in the Pacific Coast States has come from calc-silica rock, a brittle alteration product formed in peridotite and sedimentary rocks of Franciscan or younger age. Therefore, the chances for finding economically minable deposits of cinnabar in the Kerby quadrangle are not good. It should be borne in mind, however, that the Altoona mine, Trinity County, Calif., had a large quicksilver production from Franciscan rocks, and that the Patricks Creek quicksilver mine, 4 miles south of the quadrangle, has had a small production. This mine was discovered in 1943.

Three conditions determine the localization of cinnabar deposits of exploitable size. The deposits are formed (1) near, but not in, major faults, (2) in rocks which are porous and offer a large amount of rock surface to mineralizing solutions; such rocks are porous sandstones, platy schists, slates, and shales with open partings or highly fractured cherts, silicified serpentines, and fault breccias; (3) the deposits are formed from the surface to depths of a few thousand feet. The first two of these conditions can be found in the quadrangle, but whether the third condition prevailed during cinnabar mineralization depends on the age of the mineralization, and the relationship of the present surface to the surface at that time. Both of these facts are still uncertain.

Silver

No deposits rich enough in silver to warrant mining have been found in the quadrangle. The copper deposits and the gold deposits carry so small an amount of silver that it can only be considered a minor by-product.

Zinc

Sphalerite, the zinc-iron sulfide, is common in the sulfide deposits of the Kerby quadrangle. Formerly, owing to the low price of zinc, the sphalerite-rich parts of the deposits were not ore and therefore were not mined except insofar as was necessary in order to mine high-grade copper ore. For the same reason, there are no assay data for zinc content, and the tenor of zinc in these deposits is not known.

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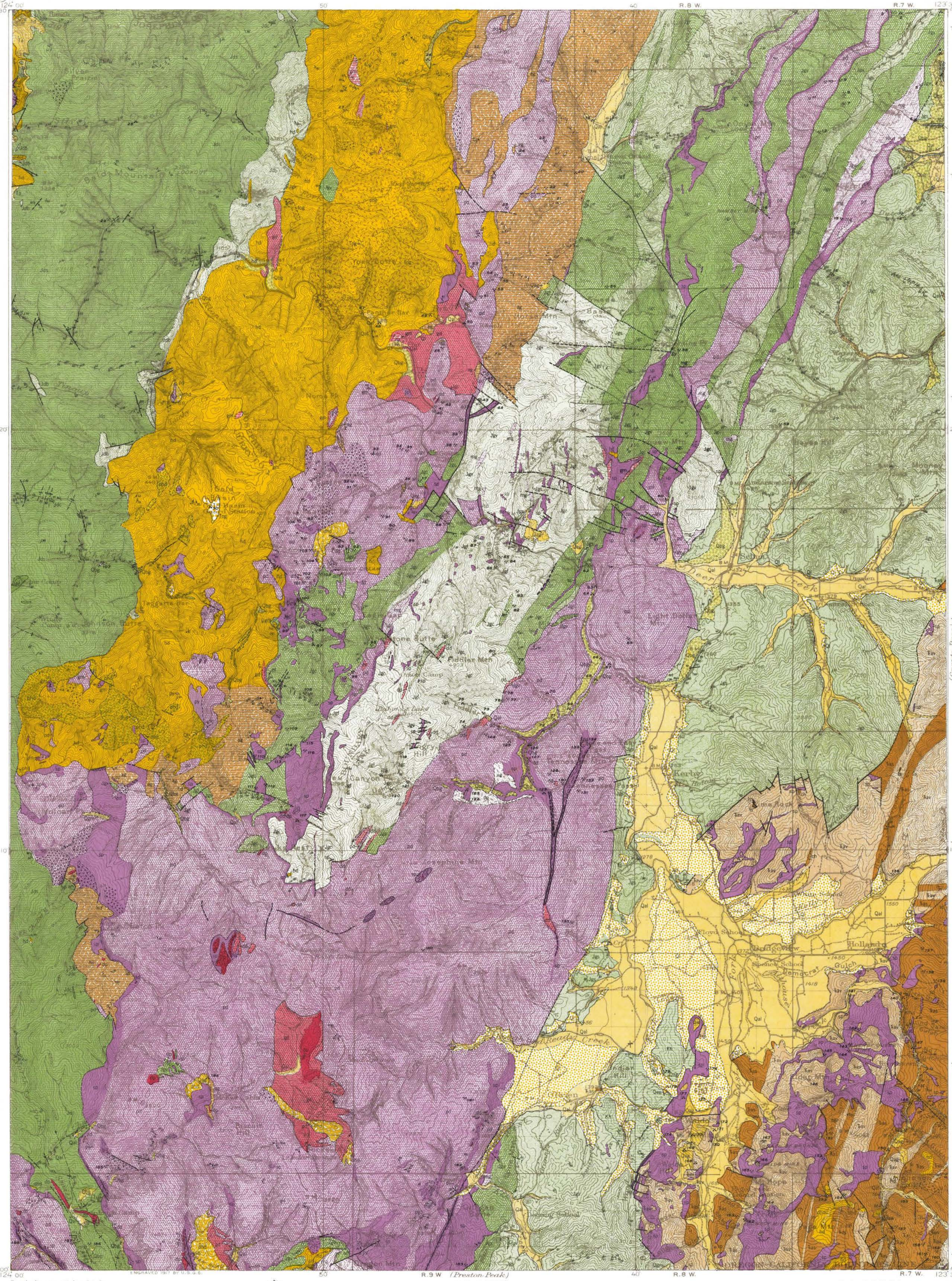
GPO WFSO 10-25-48 2100 8-U04

PRELIMINARY GEOLOGIC MAP OF THE KERBY QUADRANGLE OREGON

SURVEYED BY
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

ISSUED BY
STATE DEPARTMENT OF GEOLOGY
AND MINERAL INDUSTRIES
F. W. LIBBEY, DIRECTOR, PORTLAND, OREGON



Base by Department of the Interior.
U. S. Geological Survey, 1915

APPROXIMATE MEAN DECLINATION 1915

Scale 1:96,000

Contour interval 100 feet
Datum is mean sea level
1948

Geology by F. G. Wells,
G. L. Bell, F. W. Cater, Jr.,
P. E. Hotz, and H. L. James.
Surveyed 1940-1941 and 1945-1946
Geologic drafting by Ellen B. Bennett

EXPLANATION

QUATERNARY

Recent

Qal Alluvium
(Stratified gravel, sand, and silt, in part of fluvio-glacial origin)

Pleistocene

Qgm Glacial moraine

Qbg Bench gravels
(Poorly sorted gravel, merges with alluvium in places; on benches as much as 100 feet above the present streams)

UNCONFORMITY

Ql Llano de Oro formation
(Poorly sorted clay and sand with small rock fragments and lenses of gravel)

Qag Auriferous gravels of the Second Cycle of Erosion
(Stream gravels. Poorly sorted subrounded cobbles and pebbles in a sandy matrix. In part decomposed, in part cemented)

UNCONFORMITY

TERTIARY

Miocene or Pliocene

Tog Old gravels
(Cobbles, pebbles, and sand on upland surfaces above 4,000 feet. Coarser material partially decomposed, whole mass firmly cemented)

UNCONFORMITY

Eocene

Ta Arago group, undivided
(Heterogeneous buff-green coarse sand and grit with lentils of gravel and of carbonaceous shale)

UNCONFORMITY

CRETACEOUS

Lower Cretaceous

Kh Horsetown formation
(Grayish green arkosic sandstone weathered buff in upper part. Coarse well-indurated conglomerate and interbedded sandstone lenses near base)

UNCONFORMITY

JURASSIC OR CRETACEOUS

Late Jurassic or early Cretaceous

Intrusive rocks

Dacite porphyry
(White to pink fine-grained rock generally contains feldspar phenocrysts; in dikes and bosses)

gd Granodiorite
(Granitoid light-colored rock, containing hornblende, biotite, and visible quartz)

gm Gneissic migmatite
(Gneissic rock around borders of diorite intrusions and included roof pendants)

hd dhd phd Hornblende diorite and related rocks
(Medium to coarse grained rock with gneissic banding; light gray phase with little hornblende, hd*; dark phase with much hornblende,* dhd*; diorite pegmatite,* phd*)*

dd Dolerite and related dikes
(Dark-colored, fine-grained rocks with diabasic or intersertal texture forming dikes in or near peridotite or serpentine)

mg Metagabbroic complex
(Dark gray, medium grained, altered rock, forming small masses in peridotite or elongate intrusions adjacent to it)

og cog fog Olivine gabbro
(Dark colored rock containing bluish feldspar, pyroxene, and olivine; coarse-grained facies, cog*, and fine-grained facies,* fog*, separately mapped in north part of area)*

sp Serpentine
(Completely serpentinized peridotite broken by shearing into small blocks or an aggregation of curved or bellied shiny translucent plates from yellow through olive green to black in color)

py Pyroxenite
(Dark green rock made up largely of coarse crystals of orthorombic pyroxene)

pd Peridotite
(Green medium-grained rock consisting of olivine with or without other mafic minerals; weathered rock buff to rust-colored. In places largely altered to serpentine but not crushed)

JURASSIC

Upper Jurassic

Jdb Jdc Jds Dothan formation
(Massive indurated sandstone and thin layers of black or dark gray shale with a few conglomerate layers of small chert pebbles. Some lentils of chert Jdc*; also some interlayered dense basalt,* Jdb*, in various shades of green or rusty red, in part with amygdaloidal or pillow structure or with flow breccia)*

Jgs Jgc Jgv Jgf Galice formation
(Dark gray to black fine-grained to dense, thinly layered rocks generally with slaty cleavage, a few medium-grained sandstone beds up to 3 feet in thickness and some thin layers of grit, Jgs*. Also large thickness of andesitic flows mainly porphyritic with breccias and tuffs,* Jgv*; in places special phases are separately mapped or indicated by letter symbols: felsitic and amygdaloidal phase,* Jgf*; agglomerate tuffs and thin flows,* Jgc*)*

UNCONFORMITY

EXPLANATION
CONTINUED

TRIASSIC (?)

Ras Rav ar qt ch ls Applegate group
(Altered lava flows, flow breccias, and pyroclastic rocks, mostly of basic composition with some intrusive rocks, Rav*. Also tuffaceous sediments,* Ras*: argillite,* ar*; quartzite,* qt*; chert,* ch*; and limestone,* ls*)*

AGE UNKNOWN

ag Amphibole gneiss
(Banded crystalline rocks made up of dark colored hornblende-rich layers and light colored siliceous layers. May be altered equivalent of sediments in Applegate group)

cf (Jdb) Contact facies
(Baked or recrystallized Jurassic rocks near intrusive contacts; letter symbols in parentheses indicate original unit)

Landslide

Highly sheared rock
(Dashed lines indicate direction of shearing)

Contact
(Dashed where approximate, dotted where inferred)

Fault, showing dip
(Dashed where approximate, dotted where inferred; U, upthrown side; D, downthrown side)

Axis of anticline, showing direction of plunge

Axis of overturned anticline

Axis of syncline, showing direction of plunge

Strike and dip of beds

Strike of vertical beds

Strike and dip of foliation

Strike of vertical foliation

Strike and dip of joints

Strike of vertical joints

Lode mine or prospect
(Number refers to list on margin of map)

Placer mine
(Number refers to list on margin of map)

MINES AND PROSPECTS

CHROMITE DEPOSITS

10.	Salt Rock	Sec. 6, T. 36 S., R. 7 W.
11.	Cobalt Blue	Sec. 6, T. 36 S., R. 7 W.
22.	Nigger-Elkhorn	Sec. 24, T. 36 S., R. 9 W.
24.	Briggs Creek (Sordy)	Sec. 14, T. 36 S., R. 9 W.
25.	Name unkown	Sec. 23, T. 36 S., R. 9 W.
31.	Chrome King No. 1	Sec. 36, T. 37 S., R. 10 W.
32.	Chrome King No. 3	Sec. 36, T. 37 S., R. 10 W.
33.	Name unknown	Sec. 30, T. 37 S., R. 9 W.
34.	Dirty Face	Sec. 29, T. 37 S., R. 9 W.
35.	Peach	Sec. 29, T. 37 S., R. 9 W.
36.	Chromite occurrence	Sec. 32, T. 37 S., R. 9 W.
37.	Deep Gorge Chromite	Sec. 32, T. 37 S., R. 9 W.
38.	Upper Hammon	Sec. 28, T. 37 S., R. 9 W.
39.	Shade Chromite	Sec. 21, T. 37 S., R. 9 W.
40.	Robbin Prospect	Sec. 21, T. 37 S., R. 9 W.
41.	Black Beauty	Sec. 21, T. 37 S., R. 9 W.
42.	Oregon Chrome Mine	Sec. 21, T. 37 S., R. 9 W.
44.	Name unknown	Sec. 22, T. 37 S., R. 9 W.
45.	Name unknown	Sec. 15, T. 37 S., R. 9 W.
46.	Black Rock Chromite	Sec. 9, T. 37 S., R. 9 W.
51.	Gallagher Chrome	Sec. 3, T. 37 S., R. 9 W.
52.	Cavyell Horse Mt.	Sec. 3, T. 37 S., R. 9 W.
53.	Jim Fisher Chrome	Sec. 34, T. 36 S., R. 9 W.
55.	Cavyell Horse Creek	Sec. 34, T. 36 S., R. 9 W.
57.	Black Rock Chromite	Sec. 9, T. 37 S., R. 8 W.
58.	Black Bear	Sec. 9, T. 37 S., R. 8 W.
60.	Horseshoe Lode	Sec. 33, T. 37 S., R. 8 W.
61.	Squaw Creek Chrome	Sec. 4, T. 38 S., R. 8 W.
64.	Griffin Chromite	Sec. 18, T. 38 S., R. 8 W.
90.	Placer	Sec. 5, T. 38 S., R. 9 W.
91.	Name unknown	Sec. 6, T. 38 S., R. 9 W.
92.	Name unknown	Sec. 2, T. 38 S., R. 10 W.
94.	Saddle	Sec. 2, T. 38 S., R. 10 W.
96.	Babyfoot	Sec. 25, T. 38 S., R. 10 W.
99.	Bowser	Sec. 22, T. 38 S., R. 10 W.
101.	Hanscum	Sec. 14, T. 38 S., R. 10 W.
102.	Marguerite and Uncle Sam	Sec. 11, T. 38 S., R. 10 W.
103.	Olive B.	Sec. 12, T. 38 S., R. 10 W.
104.	Marcella	Sec. 12, T. 38 S., R. 10 W.
105.	Harry B.	Sec. 11, T. 38 S., R. 10 W.
106.	Pearsoll Peak	Sec. 2, T. 38 S., R. 10 W.
111.	Name unknown	Sec. 10, T. 39 S., R. 10 W.
113.	Bailey Chromite	Sec. 3, T. 39 S., R. 10 W.
114.	Little Boy No. 1	Sec. 3, T. 39 S., R. 10 W.
115.	Little Boy No. 5	Sec. 2, T. 39 S., R. 10 W.
116.	Little Boy No. 4	Sec. 2, T. 39 S., R. 10 W.
128.	Name unknown	Sec. 12, T. 39 S., R. 9 W.
130.	Name unknown	Sec. 12, T. 39 S., R. 9 W.
133.	Name unknown	Sec. 6, T. 39 S., R. 9 W.
144.	Collard (Golconda) Mine	Sec. 17, T. 40 S., R. 7 W.
152.	Valen prospect	Sec. 31, T. 40 S., R. 7 W.
159.	Pony Shoe	Sec. 15, T. 41 S., R. 7 W.
163.	Owens	Sec. 11, T. 41 S., R. 8 W.
176.	Eslerley Chrome Mine	Sec. 22, T. 40 S., R. 8 W.
181.	Name unknown	Sec. 21, T. 39 S., R. 9 W.
182.	Dick and Dick Reynolds	Sec. 33, T. 40 S., R. 9 W.
185.	Sour Dough	Sec. 36, T. 40 S., R. 11 W.
187.	Irene. Chromite	Sec. 10, T. 41 S., R. 11 W.
188.	Winton Mt. Chrome	Sec. 9, T. 41 S., R. 11 W.

COPPER DEPOSITS

12.	Onion Falls	Sec. 2, T. 36 S., R. 8 W.	
17.	Buckeye Mine	Sec. 30, T. 36 S., R. 7 W.	
88.	United Copper Mines Co.	Sec. 4, T. 38 S., R. 9 W.	
89.	Calumet	Sec. 5, T. 38 S., R. 9 W.	Copper, gold lode
112.	Henshaw Claim	Sec. 10, T. 39 S., R. 10 W.	
143.	KerbyQueen (Sowell) Mine	Sec. 17, T. 40 S., R. 7 W.	
145.	Elephant Ducommun	Sec. 18, T. 40 S., R. 7 W.	
146.	Spence	Sec. 19, T. 40 S., R. 7 W.	
162.	Cowboy Mine	Sec. 11, T. 41 S., R. 8 W.	
165.	Lilly	Sec. 35, T. 40 S., R. 8 W.	
166.	Waldo Mine	Sec. 36, T. 40 S., R. 8 W.	
167.	Queen of Bronze Mine	Sec. 36, T. 40 S., R. 8 W.	
168.	Cameron Mine	Sec. 34, T. 40 S., R. 8 W.	

GOLD DEPOSITS

1.	Big Four Placer	Sec. 26, T. 35 S., R. 7 W.	Placer
2.	Name unknown	Sec. 28, T. 35 S., R. 7 W.	Placer
3.	Contact	Sec. 28, T. 35 S., R. 7 W.	Lode
4.	Flanagan	Sec. 35, T. 35 S., R. 7 W.	Placer
6.	Havens Claim	Sec. 10, T. 36 S., R. 7 W.	Lode
7.	Name unknown	Sec. 5, T. 36 S., R. 7 W.	Lode
8.	Name unknown	Sec. 5, T. 36 S., R. 7 W.	Lode
13.	Murray Mine (Britton Manganese)	Sec. 7, T. 36 S., R. 7 W.	Gold and manganese lode
14.	Name unknown	Sec. 28, T. 36 S., R. 7 W.	Lode
15.	Lucky Spot	Sec. 29, T. 36 S., R. 7 W.	Lode
16.	Freckles Placer	Sec. 32, T. 36 S., R. 7 W.	Placer
18.	Ramsey Mine	Sec. 24, T. 36 S., R. 8 W.	Lode
19.	Barr Mine	Sec. 7, T. 36 S., R. 8 W.	Placer
20.	Name unknown	Sec. 13, T. 36 S., R. 9 W.	Placer
21.	Elkhorn Placer	Sec. 24, T. 36 S., R. 9 W.	Placer
26.	Metz Mine	Sec. 32, T. 35 S., R. 9 W.	Placer
27.	Old Glory Mine	Sec. 12, T. 36 S., R. 10 W.	Lode
28.	Dunbar Placer	Sec. 12, T. 36 S., R. 11 W.	Placer
29.	Cobalt Group	Sec. 25, T. 36 S., R. 11 W.	Gold-Copper lode
30.	Gold Basin Placer	Sec. 32, T. 37 S., R. 10 W.	Placer
43.	Eureka Mine	Sec. 22, T. 37 S., R. 9 W.	Lode
47.	PantherCreek MiningCo.	Sec. 1, T. 37 S., R. 10 W.	Placer
48.	Placer Mines Co.	Sec. 6, T. 37 S., R. 9 W.	Placer
49.	Gold Blanket	Sec. 5, T. 37 S., R. 9 W.	Placer
50.	Red Dog Placer	Sec. 4, T. 37 S., R. 9 W.	Placer
54.	Swede Creek Placer	Sec. 34, T. 36 S., R. 9 W.	Placer
62.	Revell Placer	Sec. 7, T. 38 S., R. 8 W.	Placer
63.	Anderson (Holiday)	Sec. 18, T. 38 S., R. 8 W.	Placer
66.	Name unknown	Sec. 19, T. 38 S., R. 8 W.	Placer
67.	Golden Princess	Sec. 30, T. 38 S., R. 8 W.	Placer
68.	Independence Placer Goshen Placer Foster Placer	Sec. 30, T. 38 S., R. 8 W.	Placer
69.	Sutter(Norton Huff) Placer	Sec. 36, T. 38 S., R. 9 W.	Placer
70.	Name unknown	Sec. 25, T. 38 S., R. 9 W.	Placer
71.	Bear Placer	Sec. 36, T. 38 S., R. 9 W.	Placer
72.	Gold King	Sec. 36, T. 38 S., R. 9 W.	Lode
73.	Moody	Sec. 34, T. 38 S., R. 9 W.	Lode
74.	Billy Neil (Sego Tomek)	Sec. 33, T. 38 S., R. 9 W.	Lode
75.	Name unknown	Sec. 33, T. 38 S., R. 9 W.	Placer
76.	Al Blasson	Sec. 35, T. 38 S., R. 9 W.	Lode
77.	Blue	Sec. 35, T. 38 S., R. 9 W.	Lode
78.	McGrath	Sec. 26, T. 38 S., R. 9 W.	Lode
79.	Pocket Knoll	Sec. 26, T. 38 S., R. 9 W.	Lode
80.	Name unknown	Sec. 22, T. 38 S., R. 9 W.	Lode
81.	Name unknown	Sec. 17, T. 38 S., R. 9 W.	Lode
82.	Name unknown	Sec. 17, T. 38 S., R. 9 W.	Lode
83.	Name unknown	Sec. 17, T. 38 S., R. 9 W.	Lode
84.	Name unknown	Sec. 11, T. 38 S., R. 9 W.	Lode
85.	Name unknown	Sec. 11, T. 38 S., R. 9 W.	Lode
86.	Williams and Adylott	Sec. 11, T. 38 S., R. 9 W.	Lode
87.	Black Bear	Sec. 3, T. 38 S., R. 9 W.	Lode
93.	Becca & Morning Group	Sec. 1, T. 38 S., R. 10 W.	Lode
95.	Summit Group	Sec. 19, T. 38 S., R. 9 W.	Lode
97.	Peck Placer	Sec. 23, T. 38 S., R. 10 W.	Placer
98.	Peck Mine	Sec. 23, T. 38 S., R. 10 W.	Lode
100.	Hustes Mine	Sec. 14, T. 38 S., R. 10 W.	Lode
107.	Red Ore Placer	Sec. 11, T. 38 S., R. 11 W.	Placer
108.	Name unknown	Sec. 26, T. 38 S., R. 11 W.	Lode
109.	Name unknown	Sec. 34, T. 38 S., R. 10 W.	Lode
110.	Name unknown	Sec. 3, T. 39 S., R. 10 W.	Lode
117.	Placer	Sec. 14, T. 39 S., R. 10 W.	Placer
118.	Bill Ward	Sec. 7, T. 39 S., R. 9 W.	Placer
119.	CanyonCr.Cons. GoldMines	Sec. 5, T. 39 S., R. 9 W.	Lode
120.	Winters and McPherson	Sec. 7, T. 39 S., R. 9 W.	Lode
121.	Bowden Prospect	Sec. 8, T. 39 S., R. 9 W.	Lode
122.	Name unknown	Sec. 10, T. 39 S., R. 9 W.	Lode
123.	Name unknown	Sec. 10, T. 39 S., R. 9 W.	Placer
124.	Lucky Spot	Sec. 3, T. 39 S., R. 9 W.	Lode
125.	Freckles Placer	Sec. 2, T. 39 S., R. 9 W.	Placer
126.	Name unknown	Sec. 2, T. 39 S., R. 9 W.	Lode
127.	Alta, Oro Fino	Sec. 2, T. 39 S., R. 9 W.	Lode
129.	Silver Nugget	Sec. 12, T. 39 S., R. 9 W.	Placer
131.	Roseburg and Fidelity	Sec. 7, T. 39 S., R. 8 W.	Lode
132.	Payday	Sec. 7, T. 39 S., R. 8 W.	Lode
134.	Free and Easy	Sec. 6, T. 39 S., R. 8 W.	Lode
137.	Connar and Connacher	Sec. 34, T. 39 S., R. 7 W.	Lode
138.	Portland Group	Sec. 3, T. 40 S., R. 7 W.	Lode
139.	Name unknown	Sec. 3, T. 40 S., R. 7 W.	Lode
140.	Atlas Gold Dredging	Sec. 19, T. 40 S., R. 7 W.	Placer
141.	Leonard	Sec. 8, T. 40 S., R. 7 W.	Placer
142.	Horse Shoe	Sec. 17, T. 40 S., R. 7 W.	Lode
147.	Name unknown	Sec. 15, T. 40 S., R. 7 W.	Lode
148.	Allhouse (Run Gulch)	Sec. 27, T. 40 S., R. 7 W.	Placer
149.	May Queen (Apple) Placer	Sec. 27, T. 40 S., R. 7 W.	Placer
150.	Lone Star (Maiden) Mine	Sec. 33, T. 40 S., R. 7 W.	Placer
151.	Name unknown	Sec. 30, T. 40 S., R. 7 W.	Lode
153.	Name unknown	Sec. 6, T. 41 S., R. 7 W.	Lode
154.	Name unknown	Sec. 5, T. 41 S., R. 7 W.	Lode
155.	Name unknown	Sec. 3, T. 41 S., R. 7 W.	Lode
156.	Johnson	Sec. 9, T. 41 S., R. 7 W.	Placer
157.	Name unknown	Sec. 9, T. 41 S., R. 7 W.	Placer
158.	Name unknown	Sec. 10, T. 41 S., R. 7 W.	Lode
160.	Pony Shoe	Sec. 14, T. 41 S., R. 7 W.	Lode
161.	Frog Pond (Mountain View)	Sec. 15, T. 41 S., R. 7 W.	Lode
164.	Lyttle Mine	Sec. 1, T. 41 S., R. 8 W.	Lode
169.	High Gravel Placer	Sec. 34, T. 40 S., R. 8 W.	Placer
170.	Daisy	Sec. 34, T. 40 S., R. 8 W.	Placer
171.	Name unknown	Sec. 27, T. 40 S., R. 8 W.	Placer
172.	Merrill Placer	Sec. 27, T. 40 S., R. 8 W.	Placer
173.	Platerica Mine	Sec. 27, T. 40 S., R. 8 W.	Placer
174.	Bailey Group	Sec. 33, T. 40 S., R. 8 W.	Placer
175.	Eslerley Placer	Sec. 22, T. 40 S., R. 8 W.	Placer
177.	Deep Gravel	Sec. 21, T. 40 S., R. 8 W.	Placer
178.	Deep Gravel Mine	Sec. 21, T. 40 S., R. 8 W.	Placer
179.	FryGulch	Sec. 28, T. 40 S., R. 8 W.	Placer
180.	Alberg	Sec. 32, T. 39 S., R. 9 W.	Lode
183.	Albright (Turner) Mine	Sec. 15, T. 41 S., R. 9 W.	Lode
184.	Bald Eagle	Sec. 17, T. 40 S., R. 10 W.	Placer

MISCELLANEOUS DEPOSITS

59.	McFarlane Brick Plant	Sec. 34, T. 37 S., R. 8 W.	Clay
9.	Max Campbell	Sec. 5, T. 36 S., R. 7 W.	Manganese lode
23.	Elkhorn Manganese	Sec. 13, T. 36 S., R. 9 W.	Manganese lode
186.	Black Beauty (Taggert)	Sec. 11, T. 41 S., R. 11 W.	Manganese lode
65.	Nickel Chromium Group	Sec. 20, T. 38 S., R. 8 W.	Nickel lode
135.	Wood Cock	Sec. 36, T. 39 S., R. 9 W.	Nickel lode
5.	Empire	Sec. 3, T. 36 S., R. 7 W.	Quicksilver lode
56.	Quicksilver Swede Basin	Sec. 1, T. 37 S., R. 9 W.	Quicksilver lode
136.	An occurrence of sulphides	Sec. 28, T. 39 S., R. 7 W.	