QM-6

PRELIMINARY GEOLOGIC MAP
OF THE
MEDFORD QUADRANGLE
OREGON

SURVEYED BY
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ISSUED BY
STATE DEPARTMENT OF GEOLOGY
AND MINERAL INDUSTRIES
EARL K. NIXON, DIRECTOR, PORTLAND, OREG.

Base by U. S. Department of the Interior, Geological Survey, 1932-1933.

Scale: 5 Miles; 5 Kilometers

Contour interval 100 feet
Datum is mean sea level

APPROXIMATE MEAN DECLINATION 1937

1939

Geology by Francis G. Wells, B. B. Colley, J. V. Neuman, Jr., R. M. Grantham, W. E. Kennett, P. E. Hotz, E. C. Tabor, Jr., E. J. Tate.

EXPLANATION

QUATERNARY

Qal — **Alluvium**
(Stratified gravel, sand, and silt; also slightly waterworn colluvium)

UNCONFORMITY

Qb(?) — **Late basalt flows in Rogue River Valley**

TERTIARY

Ti — **Later intrusives**
(Diorite sills and basalt dikes)

UNCONFORMITY

Tertiary volcanic rocks

Ta — **Late andesite flows**
(Light-gray andesitic flows)

Tag — **Flow agglomerate**
(Ranges from red flow breccia to ss viscous and vesicular flows)

Twt — **White tuff**
(Fine-grained white rhyolitic tuff)

Tbt — **Buff tuff**
(Buff fine-grained tuff with fragments of flow rock)

Tvf — **Lava series**
(Dominantly dark-gray andesite flows with local layers of tuff and breccia)

Tvs — **Water-worn and water-deposited volcanics**
(Volcanic conglomerates, shales and tuffaceous sandstone with a few interbedded flows)

UNCONFORMITY

Sedimentary rocks — *Eocene*

Teu — **Umpqua formation**
(Buff sandstones, shales, and conglomerate)

UNCONFORMITY

CRETACEOUS

Kc — **Chico formation**
(Greenish to buff arkosic sandstone with local layers of conglomerate)

UNCONFORMITY

MESOZOIC (?)

Intrusive rocks

gr — **Granite**
(Pink or reddish medium-grained rock with orthoclase, quartz, biotite, and hornblende)

gd — **Tonolite and granodiorite**
(Light-gray medium-grained rock with dominant plagioclase, quartz, hornblende, and biotite)

di — **Diorite**
(Dark-gray medium-grained rock with high percentage of dark minerals)

gb — **Gabbro**
(Dark-green coarse-grained dikes)

sp — **Serpentine**
(Weathered rock, fawn-colored; unweathered rock, very dark green; forms red soil)

Metamorphic rocks

ms / mv — **Metavolcanics and metasediments**
(Altered flows, argillites, graywackes, and limestone)

OLDER THAN MESOZOIC

ym — **Younger metamorphics**
(Quartzite, quartz-mica and quartz-amphibole schists, argillites, and marble)

os — **Old schists**
(Highly foliated chlorite, epidote, and sericite schists)

Fault — U, *upthrow*; D, *downthrow*

Strike and dip of sedimentary beds

Strike and dip of vertical beds

Strike and dip of schistosity or foliation

Strike of schistosity or foliation

Strike and dip of joint planes

Strike of vertical joint

Direction of horizontal linear element

Direction of dip of bed

Mine — Prospect — Placer

MS — Mineral, or hot, spring

MINES AND PROSPECTS

1. Quartz lode.	Sec. 7, T. 36 S., R. 2 W.	Gold lode.
2. Conger Quartz	Sec. 18, T. 36 S., R. 2 W.	Gold lode.
3. Old Fort Lane.	Sec. 24, T. 36 S., R. 2 W.	Gold placer and lode
4. Brown prospect.	Sec. 12, T. 36 S., R. 1 E.	Clay, quicksilver
5. Newsleum prospect	Sec. 34, T. 36 S., R. 2 E.	Manganese
6. Tyrrell Mine.	Sec. 10, T. 37 S., R. 2 E.	Manganese
7. Bush prospect	Sec. 9, T. 37 S., R. 2 E.	Manganese
8. Fox prospect.	Sec. 7, T. 37 S., R. 2 E.	Manganese
9. Coon Creek	Sec. 20, T. 37 S., R. 2 E.	Manganese.
10. Coal mine,	Sec. 9, T. 37 S., R. 1 W.	Coal.
11. Hansen Coal Mine.	Sec. 3, T. 37 S., R. 1 W.	Coal.
12. Millionaire Mine.	Sec. 30, T. 36 S., R. 2 W.	Gold lode.
13. Placer mine.	Sec. 36, T. 36 S., R. 3 W.	Gold placer.
14. Placer mine.	Sec. 6, T. 37 S., R. 2 W.	Gold placer.
15. Bailey.	Sec. 1, T. 37 S., R. 3 W.	Manganese.
16. Opp Mine.	Sec. 7, T. 37 S., R. 3 W.	Gold lode.
17. Jacksonville Placer.	Sec. 31, T. 37 S., R. 2 W.	Gold placer.
18. Crater Coal Co.	Sec. 36, T. 37 S., R. 1 W.	Coal.
19. Beeson Mine.	Sec. 15, T. 38 S., R. 1 E.	Coal.
20. Belland Mankins Mine.	Sec. 20, T. 38 S., R. 2 W.	Gold lode.
21. Sterling Mine.	Sec. 28, 33, T. 38 S., R. 2 W.	Gold placer.
22. Shanda Mine.	Sec. 5, T. 39 S., R. 2 W.	Gold lode.
23. (No name)	Sec. 36, T. 38 S., R. 1 W.	Placer.
24. Phillips Mine.	Sec. 36, T. 38 S., R. 1 W.	Quicksilver.
25. Forty-nine Diggings.	Sec. 31, T. 38 S., R. 1 E.	Gold placer.
26. Matters Mine.	Sec. 31, T. 38 S., R. 1 E.	Gold lode.
27. Ashland Mine.	Sec. 7, T. 39 S., R. 1 E.	Gold lode.
28. Shorty Hope Mine.	Sec. 12, T. 39 S., R. 1 W.	Gold lode.
29. Burdic, Ruth & Little Pittsburg Mines.	Sec. 13, T. 39 S., R. 1 W.	Gold lode.
30. Ashland Coal Mining Co.	Sec. 12, T. 39 S., R. 1 E.	Coal.
31. Barron Mine.	Sec. 23, T. 39 S., R. 2 E.	Gold, silver
32. Skyline Mine.	Sec. 30, T. 39 S., R. 1 E.	Gold lode.
33. Abandoned (No name)	Sec. 23, T. 39 S., R. 1 W.	Gold lode.
34. No name; probably belong	Sec. 29, T. 39 S., R. 1 W.	Chromium.
35. to Diller's Applegate group.	Sec. 32, T. 39 S., R. 1 W.	Chromium.
36. Big Shot.	Sec. 22, T. 39 S., R. 2 W.	Gold placer.
37. No name; probably belong to Diller's Horseshoe group.	Sec. 5, T. 40 S., R. 2 W.	Chromium.
38. Ashland Granite Quarry.	Sec. 1, T. 40 S., R. 1 E.	Granite.
39. No name.	Sec. 17, T. 40 S., R. 2 E.	Gold lode.
40. Jeedness & Rhodes.	Sec. 6, T. 41 S., R. 2 W.	Quicksilver.
41. Owned by Phillips.	Sec. 8, T. 41 S., R. 2 W.	Gold placer.
42. Grub Stake Mine.	Sec. 9, T. 41 S., R. 2 W.	Gold lode.
43. No name.	Sec. 10, T. 41 S., R. 2 W.	Gold lode.
44. Sally Anne Chrome Mine.	Sec. 14, T. 41 S., R. 2 W.	Chromium.

PRELIMINARY GEOLOGIC MAP OF THE MEDFORD QUADRANGLE, OREG.

By Francis G. Wells

INTRODUCTION

Purpose

Field work that led to the preparation of this geologic map of the Medford quadrangle was financed by funds allotted to the Geological Survey, U. S. Department of the Interior, by the Public Works Administration for the purpose of studying the ores of manganese and chromium in southwestern Oregon. The principal known deposits of manganese are in the Lake Creek district, in the northeastern part of the Medford quadrangle, and the rocks most likely to contain chromite are in the western part. As knowledge of the geology of an area is essential to an adequate appraisal of its mineral resources, it was at first decided to map the geology of these two areas, and, as the work progressed, it was found feasible to make a preliminary map of the entire quadrangle in one season. The resulting geologic map should serve as a guide to further studies of the mineral deposits in the quadrangle.

Personnel, method, and scope of work

Field work started in late July 1938, and continued into the second week in November. The project was under the immediate direction of Francis G. Wells of the Federal Geological Survey, who was in the field throughout this period. He was assisted during the greater part of the period by Bernard B. Colley, Robert M. Grantham, Preston E. Hotz, James E. Neuman, Jr., William E. Kennett, E. C. Taber, Jr., and E. J. Tate. Hotz and Colley mapped the area south of latitude 42°15' and west of longitude 122°45', Kennett and Taber mapped most of the floor of Bear Creek valley and the area south of latitude 42°15' and east of longitude 122°45', and the remainder of the quadrangle was mapped by Neuman, Grantham, and Tate. Detailed studies of the mineral deposits were made by the writer. As the classification of the rocks shown on this map is based on field studies only, this map and the accompanying descriptions must be regarded as strictly preliminary and subject to modification by further work. After laboratory studies of the specimens collected have been completed it is expected that a final report will be published by the Federal Geological Survey.

Acknowledgments

The writer wishes to acknowledge gratefully the fine spirit of cooperation in which he and his assistants were met during field work by the local inhabitants and by others interested in the district. Although it is impossible to list all of those who contributed aid and information, the following persons were particularly helpful: P. B. Wickham, owner of the Ashland mine; J. W. Opp, owner of the Opp mine; S. S. Bullis, of the California-Oregon Power Company; B. N. Bush; Earl K. Nixon, Director of the State Department of Geology and Mineral Industries, and J. E. Morrison, mining geologist at Grants Pass, of the same Department.

Previous work

Published reports have more or less fully described many of the mineral deposits in the quadrangle, as well as some aspects of the geology. A selected bibliography is given at the close of this report. The only previous geologic mapping in the quadrangle, so far as the writer knows, is recorded on an unpublished map of Bear Creek and Rogue River valley, prepared by Dr. Howel Williams of the University of California. Dr. Williams kindly gave this map to the writer, who used it in his field work.

GEOGRAPHY

Location

The Medford quadrangle is situated in the south-central part of Jackson County, southwestern Oregon. It is bounded by the meridians 122°30' and 123°00' west, and the parallels 42°00' and 42°30' north. Its south boundary is less than one-half mile south of the Oregon-California State line. The quadrangle comprises an area of 850 square miles.

Accessibility

The Southern Pacific Railroad traverses the quadrangle from the southeast to the northwest. U. S. Highway 99 parallels the railroad, and State Highways 62, 234, 238, and 66, as well as many gravel roads, serve the open valleys of the area. Some old mine roads and several roads recently constructed by the Civilian Conservation Corps but not shown on the map, give access during dry weather to much of the mountainous country in the southwest part of the quadrangle. There are also several good Forest Service trails. Except for clearings, the region is covered with bush or dense forest.

Topography

Rogue River crosses the northwest corner of the quadrangle, but the most prominent topographic feature of the area is the broad open valley of Bear Creek, a tributary of Rogue River. This valley extends southeastward across the quadrangle and separates the very rugged mountains to the southwest from the more open but mountainous region to the northeast. The divide between Rogue River and Klamath River lies just north of the southern boundary of the map. The lowest point in the quadrangle, on Rogue River, is 1,167 feet, the highest, the crest of Mount Ashland, 7,530 feet above sea level, a difference of 6,363 feet. A relief of two to four thousand feet and 30-degree slopes are common in the mountain areas.

GEOLOGY AND STRATIGRAPHY

The rocks in the rugged mountains southwest of Bear Creek are nearly all structurally complex metamorphic and intrusive rocks; those in the valley and the more subdued highlands to the northeast are gently dipping sedimentary and volcanic rocks. The oldest rocks in the quadrangle are exposed in the southwest corner and progressively younger rocks are found toward the northeast.

Metamorphic rocks (Pre-Upper Cretaceous)

Old schists

The oldest rocks in the area consist of highly foliated schists that are exposed over an area of about nine square miles in the extreme southwestern corner of the quadrangle. The most abundant type is a medium to dark-green quartz-epidote-chlorite schist, which is the metamorphosed product of volcanic tuffs, or sedimentary rocks with original high contents of ferromagnesian minerals. Another common type is a dark bluish-gray to black graphitic schist, which was probably derived from carbonaceous sediments. There are also a few small masses of a silvery-white sericite schist that contains cubes of limonite pseudomorphic after pyrite. This type may have been derived from some quartz-feldspar rock such as rhyolite or dacite. Color bands are not common in the old schists, and where seen they are usually less than one-half inch wide and parallel to the schistosity. The schists tend to form landslides, and their exact attitudes, therefore, are obscured; but where they are in place they strike northeast by east and dip about 45° to the north.

Younger metamorphic rocks

Unconformably above the schists there is a series of metasedimentary rocks that consists chiefly of quartzites, quartz-mica schist, and quartz-amphibole schist, with lesser amounts of amphibolite and argillite and thin bands of marble. They commonly contain much zoisite and epidote. All these rocks are considerably recrystallized, but they are not as highly foliated as the older schists. They were probably derived for the most part from quartzose sediments with small interbeds of shale and limestone. The amphibolites were probably formed by metamorphosis of basic igneous rocks.

The exact extent, thickness, and age of these younger metamorphic rocks are not known. They are certainly younger than the schists just described and older than the metavolcanic rocks that lie above them.

Metavolcanic and metasedimentary rocks

Lying with slight angular discordance above the younger metamorphic rocks is a thick series of altered volcanic rocks with lens-shaped interbeds of argillite and limestone. The thickness of this series is unknown but is probably many thousands of feet, although its apparent thickness may be exaggerated by tight isoclinal folding.

These metavolcanic rocks are pale green to greenish-gray and show wide variation in texture and structure. The textures range from moderately coarse-grained to fine-grained, and many of the rocks appear to be porphyritic, with phenocrysts of plagioclase feldspar and pyroxene in a microcrystalline groundmass. The feldspars present a more or less cloudy appearance, and have the composition of albite. The pyroxenes are usually altered to hornblende. All the rocks have been more or less chloritized, and in almost every specimen metamorphic minerals, such as zoisite or epidote, are conspicuous. Some of the rocks show traces of flow structures, and vesicular or amygdaloidal structure are common. The abundance of calcite in many of the layers suggests that the lavas flowed into a basin and mixed with limy mud that was accumulating there, and finally consolidated as a vesicular breccia bound together by calcareous matrix. Probably most of these metavolcanic rocks were originally andesitic flows and flow breccias, but some were undoubtedly fine-grained thinly bedded tuff.

The formation as mapped includes some small basic intrusive bodies and here and there a few beds of argillite which it was impracticable to map separately. Most of the argillite beds are lenticular and range from a few feet to a few tens of feet in thickness, but a few are several hundred feet thick and long enough to form mappable units.

The argillites are commonly black, fine-grained, dense rocks with a platy cleavage intermediate between that of slate and schist. In some places they contain narrow bands and small lenses or "eyes" of either sandy material or calcite. Thin lenticular beds of limestone are especially numerous. A few of them are fairly pure but most of them contain clayey and sandy material. Fragmentary organic remains are present in some of the limestones, but no fossils were found by which these rocks could be dated. The argillite is very limy in some places and grade into argillaceous limestone within short distances. Toward what is probably the bottom of the formation, and close to the granitic mass south of Ashland, there is a large mass of argillite that grades downward into more sandy material, now represented by quartzose schist.

With few exceptions the attitude of the metavolcanic rocks is shown only by the interlayering of the flows and argillite, which is paralleled by the most pronounced of the fracture systems, in the metavolcanic area. These rocks dip steeply, in most places to the northwest, and their prevailing strike is east of north.

Intrusive rocks (Pre-Upper Cretaceous)

Serpentine

The name "serpentine" is applied both to a group of minerals and to rocks which consist largely of those minerals. It is in the latter sense that the word is used in the legend of the map. The rocks here mapped as serpentine have been derived from rocks of the peridotite-pyroxenite series. The end members of this series are characterized by the minerals olivine and pyroxene, both of which are readily altered, under certain conditions, to minerals of the serpentine group. Some of the rocks mapped as serpentine are only partly altered pyroxenite or peridotite, but it has been impracticable to map these less altered masses separately. By far the greater part of the masses outlined on the map are serpentine.

The serpentine masses lie within the southwestern portion of the quadrangle. Two large, typical bodies crop out on Big Red Mountain and Little Red Mountain. Most of the areas underlain by serpentine bear little vegetation and their soil is brownish or brick-red. The weathered rock is characteristically a tan or buff color and is called "buckskin" by the local inhabitants. Less commonly it is greenish-gray. Fresh surfaces of these rocks are generally dark green to black, although some are lighter green with a yellowish tinge and have a waxy luster. They consist chiefly of the mineral serpentine in microscopic felted aggregates. Some varieties are dense and fine-grained, with a few large crystals of greenish-gray diallage or enstatite. A less common variety, developed from dunite or olivine rock, is yellowish with a granular texture made up entirely of small grains of serpentine. Rosettes of dark green anthophillite prisms several inches long are conspicuous in some outcrops. Chromite is an accessory mineral in all these varieties and ranges in amount from a few scattered grains and small aggregates or "eyes" to masses large enough to be of economic interest. In all of these varieties, the serpentine rock itself has been partly altered to such minerals as talc and chlorite.

Along faults and shear zones the serpentine is polished and slicken-sided and is cut by seams of serpentine asbestos. The greatest concentrations of chromite commonly occur along these sheared zones.

The original igneous rocks that are now represented by serpentine were intruded into all the metamorphic rocks. Their shapes and their structural relations to the older rocks suggest that many of them are sill-like, but some of the smaller masses occur definitely as dikes.

Quartz diorite and related rocks

Several large, irregular masses of siliceous intrusive rocks are exposed in the western and southern parts of the Medford quadrangle. The largest of these lies south of Ashland and is more than 18 miles long and 10 miles wide. Several smaller bodies, from 1 square mile to 10 square miles in area, crop out elsewhere. The batholith represented by these large and small bodies underlies much of the southwest part of the quadrangle at a rather shallow depth. South of Dutchman's Peak are several extensive areas in which there are anomalous rock types that have probably resulted from the soaking of the local country rock with material from the intruding magma. The abundance of aplitic and granitic dikes in these areas also suggests that an intrusive body lies a short distance below the surface.

The different intrusive bodies represent several distinct rock types and even some individual bodies comprise several types. Quartz diorite is probably the prevalent variety and granodiorite is common; porphyritic granite and diorite are also present but rare. Aplite and pegmatite dikes cut the larger intrusive bodies.

For the most part the granitic rocks are light-gray, even grained, holocrystalline rocks with an average grain size of .05 inch, but one or two occurrences of granite gneiss have been noted. In a few places the texture is porphyritic and small phenocrysts of orthoclase or microcline are imbedded in a granitic groundmass. The dark-colored minerals, either green hornblende or green to light-brown biotite or both, are subordinate in most outcrops. Where both are present the amount of biotite is usually the smaller. The minor accessories include apatite and magnetite, with a few crystals of sphene. Garnets are present in some places.

Diorite.--An elongate body of intrusive rock in T. 40 S., R. 2 W., northwest of Little Red Mountain, near Woodpecker's Spring, has been mapped as diorite. The rock is fine-grained and dark-colored owing to its high percentage of dark minerals. The feldspars are dull and waxy and in a few places a little quartz is visible.

Under the microscope all the feldspar grains are largely altered to kaolin and sericite. The most abundant dark-colored mineral is a green hornblende which is partly altered to chlorite. Scattered grains of epidote are common. Quartz is unusually abundant for a rock with so much hornblende and makes up from 10 to 15 percent of the rock. It is much finer-grained than the rest of the rock and occurs interstitially among the other minerals as a mosaic of small, irregular grains. Whether or not this quartz is primary is not certain.

The altered condition of this rock, which is similar to that of the granodiorite in the southwest corner of the quadrangle, suggests that both bodies may belong to an earlier intrusive period than the larger granitic body at Ashland.

Quartz diorite.--Quartz diorite, a light gray granitic rock composed essentially of sodic plagioclase and quartz, with minor quantities of biotite or hornblende or both, is probably the commonest granitic rock in the area and forms a large part of the stock south of Ashland. A sample taken from a roadcut on the west branch of Long John Creek contains about 55 percent of comparatively fresh plagioclase feldspar (andesine), 15 percent of quartz, and 30 percent green hornblende with a small amount of brown biotite.

Granodiorite.--The granodiorite is generally lighter gray and coarser grained than the quartz diorite and contains a smaller quantity of dark minerals. Its average composition is about 63 percent feldspar, 20 percent quartz, and 17 percent biotite and hornblende. Its orthoclase content, which may be as much as 25 percent, distinguishes it from the quartz diorite. The plagioclase is nearly all sodic oligoclase. These feldspars, as a whole, are practically fresh although the orthoclase is slightly altered in places. In some specimens both the potash and soda-lime feldspars show faint zonary banding. Hornblende and biotite occur together or singly.

Inclusions, which have a wide range in size and degree of assimilation are abundant in places both in the granodiorite and quartz diorite.

The intrusive body on the southwest border of the quadrangle consists of granodiorite that is more strongly altered than any of the others. Its plagioclase is commonly fresher than its orthoclase but all the feldspars are much altered to sericite. This rock is definitely darker than the other granitic bodies because of its greater content of ferromagnesian minerals. The characteristic dark mineral is green hornblende, which, like biotite, has been altered to chlorite. Small grains of epidote are scattered through it.

Granite.--An elongate stock of granite is exposed along the southwestern edge of the quadrangle. Another smaller mass crops out on Cinnabar Trail and a porphyritic granite caps Mt. Ashland. The latter has not been distinguished from the granodiorite on the map. The body on Mt. Ashland is a white porphyritic granite and has an average grain size of .05 inch. The phenocrysts are microcline and orthoclase and have an average length of .25 inch though individuals up to 1 inch in length are present. The rock also contains a small amount of plagioclase (albite) and quartz. The characteristic dark minerals which amount to less than 5 percent are greenish biotite with a small amount of green hornblende.

The granite on Cinnabar Trail is a light pink rock of even grain (.25 inch). The orthoclase grains are dull, do not show cleavage and under the microscope are seen to be largely altered to sericite. A little soda-lime oligoclase is present. Though quartz is not abundant it is sufficiently so to justify calling the rock a granite. In addition to pale green to pale brown biotite and a few flakes of muscovite there are small amounts of chlorite and scattered grains of epidote formed through alteration of the original constituents. Under the microscope a few small grains (.007 inch) of colorless garnet were detected.

The granite weathers deeply to a granular soil. In some roadcuts friable material is found as much as 30 feet below the surface, but in other places the rock is but little altered.

Dikes and veins

A few dikes of dark green, usually rather coarse-grained basic rocks occur in the area. The dike rocks are predominantly gabbroid types, but they range from basic pyroxenite through diorite to quartz diorite. Near Brick Pile Ranch a dike cuts the serpentine and suggests that all the dikes are post-serpentine. Narrow aplitic dikes ranging from a few inches to several feet in width cut all the rocks. They are cut in turn by numerous pegmatitic dikes and veins. Quartz veins are most numerous in the vicinities of the larger granitic masses but they also occur in all the other types. Most of them are barren, but a few contain small amounts of sulphides and gold.

Age relations of the intrusive rocks

This intrusive complex is pre-Cretaceous in age and is intrusive into all the rocks in the metamorphic complex. It is probably related to the general period of batholithic intrusion that took place during the Jurassic period in the Pacific Coast region. The sequence of intrusion has not been worked out in detail in this area, but in general the intrusion of peridotite bodies was probably the earliest and was followed by that of the basic dikes, followed in turn by the quartz diorite, granodiorite, granite, and, finally, the aplite and pegmatite dikes.

Sedimentary rocks (Upper Cretaceous and Tertiary)

General statement

The sedimentary rocks in the Medford quadrangle comprise a series of sandstones, shales, and conglomerates of both marine and continental origin, which range in age from the Cretaceous to Tertiary. Exposures of these rocks are confined almost entirely to the Bear Creek and Cottonwood valleys, where they rest with marked angular unconformity on the older rocks to the west. There are a few isolated outliers in the more mountainous region west of Bear Creek.

Chico formation

The Chico formation occupies small areas along the west edge of Bear Creek and Cottonwood valley, and other isolated patches, which are scattered many miles to the west, give evidence of the formerly great extent of the formation. It has a maximum thickness of 600 feet.

This formation is fairly uniform in texture and composition and consists of a hard, fine-grained, greenish-gray, arkosic sandstone with local lenses of coarse conglomerate and sandy shales. The sandstone is very well bedded and well-cemented. Individual layers range from a few inches to several feet in thickness. The weathered sandstone and the soil derived from it are characteristically deep brownish-red. This color and the fact that the sandstone breaks up into smooth-surfaced tabular blocks of various sizes, help to distinguish the Chico formation from the overlying sandstone of the Umpqua formation. Throughout this area the sandstone of the Chico formation is fossiliferous. The most important genera found were Ammonoidea, Trigonia, and Ancella, all clearly indicative of Cretaceous age.

The conglomerate has been observed only in lenses near the base of the Chico formation at a few localities near Jacksonville. It consists of ill-sorted but well-rounded pebbles and a few cobbles, which are composed mainly of metamorphic rocks, although they include granitic rocks and white vein quartz as well as argillites and metavolcanics. Placer gold has been mined from some of these conglomerate lenses.

At the northern boundary of the city of Ashland, where the Southern Pacific track crosses U. S. Highway 99, a dark-brown sandy shale is exposed in a roadcut. The rock is massive and it breaks into small irregular fragments. Small calcareous fossil remains are found in this rock. A somewhat similar exposure is in a roadcut in the SW¼ sec. 13, R. 2 W., T. 38 S. Here the sandy shale contains numerous dark-gray limestone concretions as well as fragmentary fossil remains and is interbedded with sandstone.

Umpqua formation

The Umpqua forms the floor of most of Bear Creek valley from Siskiyou, where it is faulted against the volcanic rocks of the western Cascades, north to Rogue River. Its western boundary is almost coincident with U. S. Highway 99, and its eastern boundary follows the trend of the foothills of the Cascade Mountains. Most of the area north of Rogue River is underlain by the Umpqua formation, and though gravel deposits form the surface near Rogue River a few outcrops in the bed of this stream indicate that the formation is everywhere present beneath them. It also crops out in an irregularly bounded area 2 or 3 square miles in extent near Colestin, as well as in an area which lies about 2 miles farther south between U. S. Highway 99 and the Southern Pacific tracks. The formation has a maximum thickness of approximately 8,000 feet.

The Umpqua formation is predominantly a medium-grained sandstone, though shaly and conglomerate layers are present. The color of the sandstone ranges from white to light brown. Pale yellowish brown or buff is the most common. The sandstone weathers to a sandy soil of the same color, differing in this respect from the underlying Chico formation which characteristically weathers red. The sandstone is mostly massive but locally shows distinct bedding. The outcrops weather to rounded irregular surfaces and the sandstone in the upper part of the formation as well as the conglomerate layers form bluffs. Commonly a very few well-rounded quartzite pebbles an inch or less in diameter are scattered through the sandstone and they can almost always be found in the overlying soil.

The grains of the sandstone range from fine to coarse, and are angular to subrounded. They are poorly cemented and the sandstone can be easily dug with a pick. The sandstones contain much volcanic material, partly crystalline and partly glass, and some of it could properly be called tuff. Muscovite is a characteristic constituent and is conspicuously abundant in some outcrops. North of the Umpqua River the sandstone is shaly and of dirty gray color. It is cut by joints into blocks, and the sandstone within the blocks scales off to give a surface like that of a frayed onion. Near the base of the formation the sandstone is shaly, and zones of interlaminated beds of shale or mudstone and sandstone from a fraction to 6 inches in thickness are found in the upper part of the section. The shale is usually dark gray or black and is carbonaceous. Lenses of thin platy coal several feet thick are also found. Conglomerate lenses are commonly interbedded in the sandstone throughout the entire thickness of the formation. They consist of ill-sorted, well-rounded pebbles to cobbles of granitic, metamorphic, and volcanic rocks.

Several fossil-leaf localities have been found in the Umpqua formation, and in two places poor casts of mollusca have been observed. The outcrops are too poor and discontinuous to permit the measurement of a stratigraphic section.

Intercalated between the sedimentary beds are several sill-like bodies of diorite porphyry and a few intercalated flows or sills of basalt and rhyolite. Cross-cutting bodies of rhyolite, many of which are too small to be mapped, are also present. Most of these igneous bodies form ridges owing to their relatively great resistance to erosion. Single bodies are less than a mile long, and few are more than a few hundred feet thick.

The formation apparently rests disconformably upon Chico. In the northern part of the area the formation grades into the overlying volcanics of the Western Cascades, but to the south it is apparently separated from them by an angular discordance.

Volcanic rocks (Tertiary)

Water-laid volcanic rocks

In the northern part of the Medford quadrangle the Umpqua formation grades upward into a sedimentary formation that consists entirely of stratified volcanic fragmental material. It contains many agglomerate and conglomerate layers. The pebbles, cobbles, and boulders (as much as 3 feet in diameter) in the conglomerate layers are well-rounded to subrounded and consist entirely of volcanic rock, mostly andesite and rhyolite. Conglomerates are well exposed in Cottonwood Valley in the southern part of the area, where they form cliffs. Within the formation are some local sandy beds and a few layers of well-bedded hackly shales that resemble the upper part of the Umpqua formation in color, composition, and structure, and imply that the Umpqua grades upward into the stratified volcanic formation. The formation also contains many rudely bedded layers of explosive volcanic material, most of which is of olive-green color and contains fragments as much as half an inch in diameter. In some places andesite flows are interbedded with the sedimentary material. A conspicuous example is found along the east side of Cottonwood Creek (T. 41 S., R. 1 E.) where flows are interbedded with conglomerates. The flows generally weather spheroidally. Most of the rocks in this formation weather readily but some of the conglomerates form bold cliffs. Likewise some massive layers of tuffaceous agglomerate resist erosion well and form cliffs or cap some erosion remnants that extend above the main level of the Medford Valley. Large weathered blocks of agglomerate in many places are scattered over surfaces underlain by this formation. Although these stratified, water-worn volcanics apparently rest conformably on the Umpqua formation in the northern part of the area, to the south they are separated by an angular discordance. The thickness of the volcanic formation varies greatly from place to place but the maximum is about 2,000 feet.

Lavas of the Western Cascades

Almost all of the triangular area that lies east of a diagonal drawn from the northwest to the southeast corner of the Medford quadrangle is covered by 3,000 to 5,000 feet of volcanic flows and flow breccias, interbedded with fragmental products of explosive volcanic action. This series comprises a great variety of volcanic rocks, including dense andesite, platy porphyritic andesite, vesicular and scoriaceous rock, glassy rock or vitrophyre, blocky flow-breccias, and direct products of explosive eruptions ranging from bomby agglomerates to fine-grained white tuff. Welded tuffs are also present and not readily distinguished from old lava flows. This assemblage of rocks has been called the volcanics of the Western Cascades by Callaghan. Outcrops are not sufficiently large nor closely spaced to show to what extent the color, textural, and structural differences observed in scattered outcrops represent horizontal and vertical variations in one rock unit or to what extent they distinguish different rock units; furthermore, different types of rock look much alike after thorough weathering, and they are deeply weathered throughout much of the area. Though natural outcrops give the impression that flows predominate, examination of artificial cuts along Highway No. 66 shows that here at least fragmental material is more abundant than flow rock. Hence it has been impossible to differentiate and map individual flows or even groups of flows. The colors of the flows range from black through purplish-and pinkish-grays to white, and all the structures found in flow rocks are present. The most common type is a dark gray, dense rock with small phenocrysts of augite or feldspar, or both. Most of the flows are from 10 to 100 or more feet thick and individual flows are commonly platy. Some very vesicular and amygdaloidal layers contain agates. Some of these agates, which weather out of the enclosing rocks and accumulate in the residual soil, are rudely spherical, hollow in the center, and as much as 8 inches in diameter.

Interbedded sedimentary rocks.--Well-beded sandstone, bedded volcanic shales, some of them carbonaceous, and bedded sandy tuffs are interbedded with flow rocks and breccias in places, and show that local shallow basins must have existed intermittently throughout the volcanic period. In the northeastern part of the area are several tuff beds and a flow breccia that are so distinctive, thick, and persistent that they have been mapped separately. With these exceptions single beds of tuff or breccia are apparently of small extent and in general not more than a few feet thick although a few may be as much as 50 feet thick.

Thin-bedded, fine-grained tuff layers are exposed in some places. An especially interesting deposit of very thinly laminated, carbonaceous, tuffaceous shale containing leaf prints is exposed at Shale City. Other layers are exposed in cuts along State Highway 66 and Dead Indian road.

White tuff.--A layer of chalky, white, rhyolite tuff that forms cliffs has been mapped in the northeastern part of the quadrangle from sec. 29, T. 35 S., R. 2 E., to Lost Creek, T. 37 S., R. 2 E. It is probably that some of the tuff in the vicinity of Shale City (T. 38 S., R. 2 E.), is at the same horizon. The tuff layer is about 250 feet thick and in most places does not show distinct bedding but breaks off in flakes or thin slabs. It is uniformly fine-grained and of siliceous composition. Leaf prints were found in this tuff at one place. Below the chalky white tuff and separated from it by about 300 feet of platy andesite flows and agglomerates is a bed about 300 feet thick of massive dirty-yellow tuff consisting of some angular fragments in a rhyolitic tuff matrix. This layer shows bedding in the upper part, in the lower part it grades into flow breccia. This layer could not be traced continuously and was not found south of Little Butte Creek.

Rogue River Valley flows

Two mesas in the northwestern corner of the quadrangle are conspicuous topographic features of Rogue River Valley. These mesas are capped by a basalt flow about 125 feet thick. The basalt is a grayish-black, dense, rock with elongate feldspar phenocrysts slightly less than one-quarter inch in length, and larger rounded phenocrysts of augite. Small pseudomorphs of iddingsite (?), a dark red mineral with submetallic luster, are abundant. The rock is characterized by short, irregular joints and by vertical joints that cut the flow from top to bottom. The occurrence of this flow as erosion remnants of a larger horizontal flow, the appearance of its top, which resembles a slightly weathered original surface, and the absence of the alteration products that characterizes the older lavas suggest that this flow does not belong to the volcanic rocks of the Western Cascades but forms part of the younger volcanic rocks of the High Cascades.

Later intrusives

Intrusive diorite and basalt cut all the rocks except the flows in the Rogue River Valley. The diorite occurs as sills, stocks, and dikes, which seem to be most abundant along the east and north side of the Medford Valley, where they usually have topographic expression as knobs. In one locality—east of upper Kenutchen Creek—the sandstone and shale beds of the Umpqua formation have been nearly turned on edge around a large diorite intrusion.

The basalt dikes, which are younger than the Tertiary volcanics, can best be observed on the north side of the valley of the south fork of the Little Butte Creek, southwest of Heppsie Mountain. Here they cut the tuff layers in the Tertiary volcanics. Most of them are nearly vertical, trend N. 35°-55° W., and are one to two feet thick.

Alluvium

Deposits of sand, gravel, and silt sufficiently thick to justify mapping are exposed in Rogue River Valley, the lower valleys of Bear, Jackson, and Griffin Creeks, the upper valley of Poormans and Stirling creeks, and Little Applegate River. The other streams of the area flow on bed rock or on slide rock. The stratified alluvium in the valley of Rogue River and of Bear Creek and its tributaries is 65 feet thick in places but it rarely exceeds 20 or 30 feet in most of the area mapped. It consists of layers of rounded to subrounded gravel and layers of sand and silt. Placer gold has been recovered from this gravel near Jackson and Ashland. The deposits in Poormans and Stirling creeks are chaotic assemblages of large angular rock debris, subrounded cobbles and pebbles and sand and might be called colluvium. They range from 10 to 15 feet in thickness to as much as 60 feet in the headwaters of Stirling Creek and have yielded several million dollars in placer gold.

Structure

Folds

The layered rocks of the Medford Quadrangle fall into three major structural groups: (1) the older metamorphic, (2) the metavolcanic and metasedimentary, and (3) the Cretaceous and Tertiary sedimentary, with which the Tertiary volcanics may be included. Metamorphism has almost obliterated the original bedding of the old schists, leaving some color-banding as the only evidence of its former presence. Such color-banding appears to be conformable to the planes of schistosity in general and it is therefore inferred that the schistosity does not depart widely from the original bedding planes. The schistosity is complex. On the southeast side of the larger granodiorite stock (T. 40 S., R. 1 E.) it parallels the contact, as it does along the western margin of the stock. Apparently it has a synclinal structure from Siskiyou Gap to Donamore Peak. The axis of this syncline trends northwesterly.

The strike of the metavolcanics and metasediments is dominantly N. 20° E, but ranges from N. 5° E. to N. 40° E. Individual beds dip steeply both to the southeast and northwest, and in many places they are vertical. Such variations in dip suggest close folding, but it has been impossible to demonstrate either repetition of beds or to identify tops and bottoms of beds. More detailed study of a larger area is needed to solve the complex structure of these rocks. Closely spaced fracture cleavage, which parallels the bedding, is present in the metasedimentary rocks.

South of Rogue River the Cretaceous and younger rocks strike northwestward and dip at low angles to the northeast. North of Talent they dip at angles of less than fifteen degrees, but to the south they steepen to as much as thirty-five degrees. The dip of the Tertiary volcanic rocks, which is in the same direction as that of the Tertiary sedimentary rocks, could not be measured accurately. It nowhere exceeds fifteen degrees and apparently does not increase to the south. It would seem, therefore, that the southwestern part of the quadrangle was differentially raised prior to the accumulation of the Tertiary volcanics.

North of Rogue River the Tertiary sandstones apparently strike about east-west and dip from five to seven degrees to the south. These measurements may not be precise because it is difficult to obtain accurate strikes and dips in this area, but there is no doubt that the pronounced northwest structure and northeast dip found south of Rogue River do not extend into this area.

Faults

The pre-Chico rocks of the Medford quadrangle are strongly folded and faulted. Sufficient evidence to serve as a basis to delineate faults has been found in only a few places, but planes of dislocation are commonly observed in excavations and mine workings. They indicate not only the abundance of small faults but also the probability that there are many more large faults than are drawn on the map. Two sets of faults are revealed in mines. One set trends N. 25° to 60° E. and dips from 40° to 70° E. to the southeast. The other set trends at right angles and is vertical, or nearly so. It is in these faults that the quartz mines of the region occur. Fracturing is present everywhere in these rocks and parallels the two fault directions.

The faults shown in the Tertiary volcanic area are so poorly defined that it has been impossible to determine their dips or the magnitudes of their displacements. Other faults, smaller than those mapped, are doubtless present. Probably the large landslides observed in many places are related to faults.

Structural data in the granodiorite and other intrusive rocks are not sufficient to serve as a basis for any generalization.

MINERAL DEPOSITS

Clay

At many places the pyroclastic beds of the Tertiary volcanic series have been altered to clay. Some altered tuffaceous material in sec. 19, T. 38 S., R. 3 E. has been shipped to Portland and used in making fire brick. Material from the Brown quicksilver prospect (No. 4) has been tested and proves to be fairly plastic clay with a drying shrinkage of 4 percent and a total fire shrinkage of 7 percent. At Hobart Butte in southern Lane County a large deposit of refractory clay has been opened in the altered Calapooya formation. This formation is similar to the Tertiary volcanic rocks in the Medford Quadrangle and it is possible that similar deposits may be found where these volcanic rocks are intensely altered.

Chromium

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, and occurs as disseminated round grains as much as 2 mm. diam., and as aggregates of similar grains. It is easily distinguished in the field from the black manganese ores by its greater specific gravity and from the black minerals of iron or copper by its characteristic chocolate-brown streak when scratched. Commercial bodies of chromite are found only in rocks of the peridotite group. 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 serpentine shown on the geologic map. Although in other parts of the world economically valuable concentrations of chromite are reported to occur as segregations that accumulated during an early stage of the crystallization of peridotite masses, no deposits of such origin were observed in the Medford quadrangle. All of the deposits observed are directly related to fracture or shear zones. At every deposit the serpentine or altered peridotite has been somewhat broken by two intersecting sets of fractures, along all of which there is evidence of at least slight shearing. The deposits are lenticular, with their long axes in the direction of the dominant set of fractures, which everywhere trends a little east of north.

The concentrations of chrome are roughly lens-shaped and pinch out along their strike and in depth. Contact with the wall rocks is abrupt. The evidence seems to bear out the opinion, recently suggested by J. E. Allen, that the chrome deposits in southwestern Oregon are the result of later injection of chromite which was concentrated during or soon after the original emplacement of the peridotite.

Most of the ore is massive, but small amounts of serpentine occur among grains of chromite in places. In some exposures clots of chromite two or three milimeters in diameter are set in a ground mass of serpentine, and are called "leopard" ore. In a few places the ore has a banded or streaked character with richer bands separated by leaner or barren serpentine.

Coal

Deposits of coal have been found in the Umpqua formation along the east edge of Bear Creek Valley from east of Ashland to east of Talent, a distance of 15 miles, and are known to occur both to the north and south of the Medford Quadrangle. It was impossible to trace any one bed of coal for more than a thousand feet along the strike. The coal beds, though not continuous, probably occur at about the same horizon. The beds that have been developed do not exceed 12 feet in thickness and are made up of bands of good coal, generally 6 to 8 inches but locally a foot thick, which are separated by coaly shale. The coal breaks out in blocks and contains considerable sulphur. Diller noted an improvement in the quality of the coal toward the north (down the dip) and suggested prospecting in that direction. Normal faults of small throw are common. At the mine east of Ashland (No. 31) lava flows were found in the mine and their presence renders the extent of the coal beds at this point a matter of doubt. The only mine that was open during the summer of 1938 was that of the Crater Coal Company (No. 18). Coal has been intermittently mined from this locality since 1917 or earlier. Other prospects, numbered 10, 11, 19, 31, are shown on the map.

Gold

Gold is the most important mineral resource of the Medford Quadrangle. Since the discovery of placer gold in Jackson Creek during the autumn of 1851 placer and lode mining has continued with some interruptions to the present day. The gold output from this area can never be known, for records of the most productive period of placer mining are very incomplete, but those best informed believe that it is valued at several million dollars.

Placer deposits are found only in the area west of U. S. Highway 99. They are closely related to the present streams, along which they form terraces or bars. Though the upper valleys of some of the streams in the area are too narrow and their gradients too steep to permit the accumulation of placer gold, most of the stream beds have been panned and gold has been recovered from many of them. "Sniping", or small scale discontinuous operations, is still carried on in many creeks, but, with the exception of upper Stirling, Poorman's, Anderson, and Wagner creeks, it is questionable whether much profitable placer ground still remains. Stirling Creek has been mined from its mouth to a point above the confluence of Hopkins Creek, and drilling by the present owners shows that the gold continues upstream from this point. The gravel in Stirling Creek is ill-assorted and contains boulders as much as 8 feet in diameter. There is evidence of 2 levels of gold concentration in Stirling Creek. Hydraulic operations now in progress on the lower part of Poorman's Creek may eventually mine this stream to its source.

It has long been known that some of the gravel channels at the base of the Chico formation contain placer gold. The old placer miners in the region believe that one of these old channels extended from the vicinity of Anderson Butte northwest by north across upper Stirling and Poorman's Creek. They report that gold was recovered from Cretaceous gravel at the head of Poorman's creeks. and old workings in Cretaceous gravel on top of the ridge west of the Opp mine lend support to these statements.

Though it is probable that the larger part of the gold production of the Medford Quadrangle has been derived from placer mines, future production will be mostly from lodes. With the exception of Barron Mine, which will be discussed later, the gold veins are confined to the pre-Chico rocks of the western part of the quadrangle. Gold quartz veins are found in all the older rocks with the exception of serpentine, and there is no apparent relation between wall rock and tenor of ore. These veins have various orientations, but the dominant directions are from N. 60° W. and from N. to N. 30° E. Their dips range from vertical to 40°. The veins consist of one or more lenses of quartz which occur along strong and continuous fractures but rarely exceed a few hundred feet in length. In many veins crushed rock material more or less continuously fills the fractures between the quartz lenses. The ore material is generally less than 3 feet wide and consists of mineralized quartz or crushed rock material that lies between the vein walls. Seams and irregular masses of chloritic material are commonly present in the quartz. Most if not all of the gold is free. Much of it is not accompanied by sulphides, but in some veins sulphides may constitute as much as three percent of the ore. Pyrite and pyrrhotite are the most common sulphides. Galena and sphalerite are irregularly distributed, mostly in very small amount, and in a few places, outside the Medford Quadrangle, they are the principle sulphides. From 60 to 90 percent of the gold is free milling and the remainder is recovered from the sulphide concentrates. Only in a few places does oxidation extend below a depth of a hundred feet, and there is some evidence that some rich "pockets" are primary and not the product of surface enrichment. That the ore does persist in depth in some places is shown by the Ashland Mine where ore has been mined 900 feet down the dip and the gold content on the lowest level is as high as, if not higher, than on the 400-foot level.

There is little basis for a forecast of future development of gold mines in this area. The large number of veins known to exist would lead to the expectation of some valuable ore bodies, but the facts that the surface has already been rather thoroughly explored and that most of the ore bodies already mined have extended only to shallow depths are decidedly unfavorable. It should be borne in mind, however, that with few exceptions prospecting has been confined to a random search for rich pockets. Wherever such a pocket has been uncovered it has been mined and operations have ceased. Abortive searches have yielded no body of systematic observations on which further exploration could be based, and no attempt has been made to develop large bodies of low-grade ore. The persistence of gold in depth at the Ashland Mine implies that systematic search may develop ore in depth at other mines. The evidence of faulting and the many quartz veins along the margin of the granodiorite stock west and south of Ashland indicate that it is a favorable area for prospecting. Strong, persistent faults that contain quartz with sulphide or gossan should be explored, and exploration should be guided by systematic sampling.

The Barron mine has been described recently in Bulletin 893 of the U. S. Geological Survey. It indicates the type of deposit that may be found in the Tertiary volcanics. The ore is "base" and consists of sulphides, chiefly sphalerite and galena, with a little cherty quartz. The occurrence of sulphide veins with chalcedonic quartz is very different from that of the quartz veins with free gold characteristic of the Ashland and other mines in the pre-Chico rocks.

Manganese

Two types of manganese deposits are found in the Medford Quadrangle; rhodonite-bearing veins and lenses along bedding or cleavage planes, and deposits of oxides and hydroxides of manganese, which fill open spaces. The rhodonite deposits occur only in the pre-Cretaceous rocks of the western part of the area, and are best illustrated by Bailey's prospect (No. 15). Rhodonite, a manganese silicate, has a vitreous luster, is commonly pink, and can not be scratched by a knife. In all these veins the rhodonite from the surface to a depth of several feet has been partly or completely changed by weathering to black manganese oxides. As no economic method of obtaining manganese from rhodonite has been devised, deposits of this mineral have no commercial value at present.

Deposits of manganese oxide filling open spaces are found in the Tertiary volcanic rocks of the eastern part of the Medford Quadrangle. All found thus far lie within the Lake Creek district, an indefinitely bounded area that includes the drainage basin of Little Butte Creek east of Eagle Point and the contiguous area just north of the Medford Quadrangle. Outcrops of manganiferous material are scattered throughout the district and the rocks that contain them are commonly colored dark red by iron oxide. The larger deposits are confined to one member, composed in part of flow breccia, and in part of tuff and breccia of explosive origin, and to fault breccia close to this member. Although the manganese was deposited mainly in cracks and irregularly shaped cavities, it has clearly replaced some of the enclosed rocks to a minor degree. In the upper part of the breccia member most of the oxide masses are soft and sooty and in the lower part they are rather hard and compact. Most of the harder material probably consists of manganite with minor quantities of pyrolusite and other oxides. A small part consists of psilomelane. Soft but coherent wad of low specific gravity occurs in places throughout the breccia and powdery or sooty varieties of wad are found generally in cavities in the upper part. A soft, brown, unidentified oxide composed of bronzy-lustered scales is widely distributed in small amounts. Locally kaolin, calcite, gypsum, barite, zeolites, and a trace of gold, are associated with the manganese minerals. In most places the material exposed at the surface is estimated to contain from .5 to 3 percent of manganese, but at the Tyrrell Mine (No. 6) and at Newstrom Prospect (No. 5) irregular masses of several tons are known to contain from 10 to 20 percent. Owing to the comparative softness of the tuff it is very easily separated from the harder manganese oxides by gravity separation, but the soft manganese minerals of low specific gravity may be difficult to recover.

The main factor in the localization of ore is the presence of permeable rocks with openings of any kind. Obviously the breccia member is the most favorable place for prospecting and the most favorable places within this member are along faults. This structural control is best illustrated by the Tyrrell mine.

Although these conditions have accounted for the largest deposits, prospects are present in vesicular flows (for example, the Vestal and Black prospects north of the quadrangle), but they are also in the same general part of the volcanic series as the breccia member.

A complete explanation of origin would be premature at present, but certain inferences are appropriate. The character of the altered rocks implies that solutions permeating the volcanic series leached manganese and silica and transferred them to openings mainly in the breccia member. Whether the leaching took place at some distance from or within the breccia member is not clear. The prevalence of iron oxide that has discolored the breccia and other rocks in and around the deposits implies that the solution that brought the manganese oxidized but did not remove much of the iron. The more soluble manganese could have been removed from this rock but the amount of manganese is too great to be accounted for by such local leaching.

Although the manganese deposits have doubtless been modified by circulating groundwater derived from the present surface, the facts enumerated above seemingly imply that the major concentration of manganese took place prior to the formation of this surface. This inference is supported by the facts that the manganiferous layer is overlain in places by unaltered flows and that erosion has been too rapid to permit much concentration of manganese just below the present surface.

The Newstrom (No. 5) and Tyrrell Mine (No. 6) are the two most promising prospects in the area. Other prospects are the Brown (No. 4), Just (No. 7), Fox (No. 8), and Coon Creek (No. 9) prospects.

Mineral springs

Mineral springs are numerous in the Medford Quadrangle. The mineral waters belong to two chief classes, the Colestin and Soda Springs waters, which are dominantly carbonate, and the lithia and sulphur springs, which are chloro-carbonate. The springs are related to faults and issue from Chico and younger rocks.

Oil

The Chico and Umpqua formations are the only rocks exposed in the Medford Quadrangle in which oil might be expected to occur. These formations crop out in a narrow band about 5 miles wide and 30 miles long in Bear Creek and Antelope Valleys and dip gently toward the northeast. No anticlines are present in the area of outcrop and no oil shows are known. Some wild-catting has been done and, although no record of the wells could be obtained, it is said that no shows of oil were found.

Quicksilver

The Medford Quadrangle embraces part of a quicksilver belt that extends from southern California to Morton, Washington. Here, as elsewhere in the belt, the quicksilver deposits are found in or near volcanic rocks. Cinnabar is the chief ore mineral of quicksilver and is easily recognized by its brilliant red color and bright red streak when scratched. Because of its very high specific gravity it can be readily separated from enclosing rock or gangue by panning. It occurs almost without exception in rocks, which, either because they are porous like sandstones, laminar like schists and shales, or highly fragmented like cherts, silicified serpentinous rocks and fault breccias- have presented a large amount of surface to the spreading mineralizing solutions. Such features are present in the breccias and tuffs of the Tertiary volcanics, the sandstones of the Chico and Umpqua formations, and the old schists, all of which are favorable to the deposition of quicksilver. One deposit of quicksilver (No. 40) has been found in the old schists of the Medford Quadrangle, and others are known just to the west in the Grants Pass Quadrangle. One deposit of quicksilver (No. 4) has been found in the volcanics, but none have been found in sandstone, though cinnabar occurs in sandstone in the Meadows, 6 miles north of the quadrangle. Quicksilver has been mined from faults in the metavolcanics south of Talent (No. 23). No deposits of cinnabar are known in the serpentines, nor are any to be expected except in faults because the rock is not brittle. No deposits have been found in the granitic rocks.

Quicksilver deposits are characteristically spotty in distribution and only a few guides for the prospector can be given. In the region north of the Medford Quadrangle quicksilver deposits in volcanic and sedimentary rocks are commonly associated with "iron ribs" (branching veinlets of siliceous iron oxide), which have been so resistant to erosion that they stand out like ribs on the weathered surface. Besides "iron ribs", bleached and altered volcanic rocks may indicate the presence of quicksilver. Zones of faulting along which active or extinct hot springs occur are also favorable places to prospect. In any of these placesore that contains less than 5 pounds of cinnabar to the ton may not show visible cinnabar and its presence can only be proved in the field by panning.

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