This manual is written to supplement the textbook in teaching the material on geology in science classrooms at the high school or junior high school level. The writer feels that teachers, by placing too much emphasis on books and pictures, often miss the opportunity of presenting geological phenomena in their natural setting. Therefore, this manual is dedicated to the presentation of specific examples of geologic phenomena in Oregon. Both economic and common rock forming minerals of Oregon have been included with a brief description of them and some localities where they can be found. Minerals are an essential element in the study of geology because it is through a knowledge of these minerals that rocks may be classified. Economic minerals are an essential element in our national economy because it is through the mining and processing of these minerals that our country is able to keep its present position in the modern industrial age.

The study of fossils is basic to the concept that the plants and animals of the world are constantly changing. Some fossil localities have been included that have yielded large numbers of fossils and which are near transportation. The fossils have been grouped into large classes such as fossil shells, fossil leaves etc.

Land forms which are prominent in the state of Oregon are described with emphasis on their mode of origin. Oregon has an abundance of scenic wonders and it is only logical that its citizens should know something about them.

The final chapter is a summary of this manual and describes some of the ways in which this manual may be used in the classroom. Specific examples and suggestions are made concerning the activities in the sections of the units dealing with geology in the state course of study.
A FIELD MANUAL OF OREGON GEOLOGY
FOR OREGON SCHOOLS

by

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Typed by Margaret Bennett
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The writer desires to acknowledge his indebtedness to all who have assisted him in this problem. He wishes to express his gratitude to the office staff on the State Department of Geology and Mineral Industries for the use of their office space and library. To Professor W. D. Wilkinson, of the department of geology, and to Professor Stanley E. Williamson, director of supervised teaching, the greatest of thanks are due for their assistance and criticisms in the preparation of this manual.
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A FIELD MANUAL OF OREGON GEOLOGY
FOR OREGON SCHOOLS

CHAPTER I

INTRODUCTION

The purpose of this manual is to describe, locate and explain typical examples of Oregon geology that may be of interest and importance to junior high school and senior high school science classes. The writer feels that local geology, which may be seen by every pupil in the class, is often overlooked in the classroom in favor of pictures of strange, and foreign places. The study of the material in this manual should enable both the teacher and the pupil to go into the field better prepared to collect geologic specimens or to observe geologic phenomena.

Only those geologic materials and phenomena which may be found in Oregon are included, and of these materials only the most readily accessible have been listed.
Oregon is a geologic wonderland. It is only logical that its citizens should know something of the background of Oregon's scenic wonders, and something about the economic deposits which are found in Oregon. As world supplies of essential minerals dwindle down to nothingness, and as the Northwest becomes more industrialized, our mineral resources in Oregon will become more and more important.

Nearly everyone has at one time or another carried home with him some unusual or pretty rock. This is the basis for a profitable expenditure of leisure time. In an age which is allowing the individual more and more free time it is imperative that he be able to spend that time in a wholesome activity. The study of geology is one such activity.

The manual, for convenience of presentation, has been divided into five parts: The Plan of The Thesis, Minerals of Oregon, Rocks of Oregon, Fossils in Oregon, and Land Forms in Oregon. In each section there is a brief description of the topic under consideration, followed by some localities where it may be observed or collected. There is a word index at the back of the manual. An appendix gives a description of the township and range method of designating exact localities on a
map. There are two maps included; the first is a generalized map of mineral localities, and the other is a general map of batholithic areas.
A mineral is a naturally occurring inorganic substance having a relatively constant chemical composition and fairly definite physical properties. Minerals are important to the nation as a whole because it was through the mining of economic mineral deposits that our country was able to become the leading industrial nation in the world. Minerals are important to geologists and to rock collectors because the minerals are used to determine the nature of rocks, and also something about their history.

This manual attempts to describe most of the physical and a few of the unique chemical properties of Oregon minerals so that they may be recognized in the field. To describe the minerals properly, certain descriptive words must be used.

Terms Used In Describing Minerals

Physical Properties

Streak. The color of the finest powder of a mineral, or of the mark it will make on a harder surface, such as unglazed porcelain, a clean whetstone, or a fine-cut file (16, p. 271).
Luster. The character of the light reflected by minerals. There are several kinds of luster, as follows,

- **Metallic**, the luster of metals;
- **Adamantine**, the luster of diamonds;
- **Vitreous**, the luster of broken glass;
- **Resinous**, luster of the yellow resins.

When there is a total absence of luster, the mineral is characterized as being dull (36, p. 229).

**Specific Gravity.** The weight of the body divided by the weight of an equal volume of water. Abbreviated to G.

**Hardness.** Resistance to abrasion, or scratching, and is commonly designated approximately by numbers, according to the scale devised by Mohs, as follows:

- **Softest**
  1. Talc
  2. Gypsum
  3. Calcite
  4. Fluorite
  5. Apatite
  6. Orthoclase
  7. Quartz
  8. Topaz
  9. Corundum
- **Hardest**
  10. Diamond

Equivalent hardness

- $2\frac{1}{2}$ Thumb nail
- 3 Copper or silver coin
- $5\frac{1}{2}$-6 Knife blade
- $6\frac{3}{4}$-7 File
- 8-9 Emery wheel

**Cleavage.** The property which some minerals possess of splitting along parallel surfaces in certain directions more readily than in others (36, p. 77).

**Fracture.** Term applied to breaking that does not produce smooth planes as in cleavage.
Chemical Properties

The chemical properties described are simple and require a minimum of equipment to ascertain their presence.

Blow pipe. An eight inch tube of brass or copper used to change a small, luminous flame (alcohol lamp or Bunsen burner flame) into an extremely hot and well directed flame by blowing. This flame may be used to melt particles of minerals, or to examine the composition of the mineral by observation of the flame coloring, or the volatile materials given off by the mineral, or the residue of the mineral after melting.

Acid test for carbonates. To determine whether a mineral contains CO₂, carbon dioxide, or not place a drop of dilute hydrochloric acid (vinegar will do) on the mineral, and if it does contain the carbonate it will effervesce (give off gas bubbles of carbon dioxide).

Heating in an open test tube. Put the powdered mineral in a small test tube (six inch) and heat slowly with a Bunsen burner or other heating element, while holding the test tube slightly inclined so that sublimates may form on the walls of the tube. Volatile substances will be given off which can often be the clue to the mineral under observation.

Flame test. Some minerals on ignition impart to the
flame a distinct color, which is best seen against a dark background. To ignite the minerals scrape some powdered mineral into a Bunsen burner flame by scratching the mineral with a knife or file. The color is imparted to the flame by the element contained in the mineral. Antimony colors the flame greenish blue. Copper colors the flame emerald green.

The minerals have been divided into two types; metallic minerals of economic importance and rock forming minerals.

Economic Minerals Of Oregon

Antimony

Antimony has the unusual property of expanding, rather than contracting, upon cooling which makes it desirable for making type metal alloy, which does not change size when cast. It occurs in Oregon in the mineral stibnite.

Stibnite (Antimony Glance).

Chemical Properties. Antimony Sulfide (Sb₂S₃). Melts in the flame of a match or blowpipe and colors the flame greenish blue.

Physical Properties. Color and streak lead-gray; tarnish black, sometimes iridescent. Luster metallic.
Can be scratched by finger nail, H. = 2. G. = 4.5 - 4.6. Cleavage is perfect in the long direction of the crystal. Fracture is uneven (16, p. 410).

Oregon Occurrences. Baker County. The Gray Eagle Mine which is located five miles east of the town of Baker. NW 1/4 Sec. 7, T. 9 S., R. 41 E. (56, p. 5). See Appendix A for explanation of township and range method of land division.

Jackson County. Jaybird mine is located on the north side of Kinney Creek, a tributary to the Applegate River, in the NW 1/4 of Sec. 14, T. 40 S. R. 4 W. (56, p. 11).

Chromium

Chromium is used as an alloy in making stainless steels. Chromite is the only ore mineral for this metal.

Chromite.

Chemical Properties. Chromium, iron and oxygen (FeCr₂O₄). Shows considerable variation in its composition.


Oregon Occurrences. Curry County. Signal Buttes Group is a wide zone of altered serpentine located about 8
miles due east of Gold Beach. In this area is the Squaw Creek workings, which consist of a 50 foot open cut. The diggings are about two miles west of Selma along the south border of Sec. 31, T. 36 S., R. 13 W. (1, p. 37).

Grant County. Iron King Mine is $3^{3/4}$ miles SE of Canyon City. It is reached by traveling three miles south from Canyon City where a road to the East is taken which terminates in a large quarry in the SE $\frac{1}{4}$ Sec. 20, T. 14 S., R. 32 E. (1, p. 55).

Copper

Copper occurs in several forms and in a variety of minerals. The minerals which are mined in Oregon for copper are chalcopyrite and chalcocite. Copper occurs in other minerals but in much smaller deposits.

Chalcocite (Copper Glance).

*Chemical Properties.* Copper and Sulfur (Cu$_2$S). Melts easily giving off sulphurous fumes. Globule of copper is formed when fine powder is melted on a charcoal block by the reducing part of the blowpipe flame.

*Physical Properties.* Color and streak are dark lead-gray; tarnish dull black, blue, or green. Luster metallic. $G. = 5.5 - 5.8$. $H. = 2.5 - 3$. Cleavage indistinct and fracture conchoidal.
Oregon Occurrences. Baker County. The Iron Dyke Copper Company (Iron Dyke mine) is located within 300 feet of the town of Homestead on the Snake River (47, p. 60).

Josephine County. Waldo Copper Mine is in the SW ¼ Sec. 36, T. 40 S., R. 8 W. about one mile east of Takilma, near the California border (49, p. 222).

Chalcocite (Copper Pyrites).

Chemical Properties. Copper, Iron, and Sulphur (CuFeS₂). Sometimes contains gold and it is mined in Oregon for its gold content. Imparts a green color to the flame when burned (16, p. 431).


Oregon Occurrences. Baker County. The Iron Dyke Copper Company described under Chalcocite. Copper Queen Mine (Copper Butte) is SW of Crane's mill, near the west edge of Sec. 24, T. 7 S., R. 42 E. It is on a good road eight miles from Keating and 28 miles from Baker (47, p. 47).

Douglas County. Silver Peaks mine is seven airline miles directly south of Riddle in Sec. 23 and 26, T. 31 S., R. 6 W. (49, p. 110).
Lane County. Champion Mine in the Bohemia district, about 35 miles SE of Cottage Grove. The road from Cottage Grove to Bohemia forks at Sharp Creek. Take the road up Champion Creek. Mine is on the narrow ridge between Champion Creek and City Creek in the N $\frac{3}{4}$ of Sec. 13, T. 23 S., R. 1 E. (50, p. 57).

Marion County. Capital mine is about 50 miles ESE of Salem near the town of Elkhorn. The mine is located on the west side of Henline Creek just above water level at a point 100 feet below the bridge on the Little North Santiam which is 1.5 miles by road east of Elkhorn. The area is crossed by the Section line between SW $\frac{1}{4}$ Sec. 28 and NW $\frac{1}{4}$ Sec. 33, T. 8 S., R. 4 E. (50, p. 118).

Gold

Gold was discovered in Oregon in 1851 on a tributary of Jackson Creek near the town of Jacksonville. It is primarily used for decoration and as the basis for monetary systems. The chief ore of gold in Oregon is gold.

Gold.

Chemical Properties. (Au). Is not acted on by any single acid.

Oregon Occurrences. Gold occurs in many parts of the state in both placer deposits (a mass of sand and gravel or other material which results from the crumbling of rocks, which contains particles of valuable minerals such as gold that have been concentrated by water sorting) and in lode deposits. (Lode is used interchangeably with vein. It means a tabular fracture in the earth or rock which has been filled by a later material.)

Baker County. Cornucopia is a mining town 35 miles ENE of the city of Baker. All the producing veins in this area are on Granite Mountain which is 2 - 3 miles NW of the town of Cornucopia in Sec. 19, T. 6 S., R. 45 E. (47, p. 26).

Coos and Curry Counties. Gold is found in the beach sands which at one time were worked for this gold content.

Douglas County. Silver Peaks mine (described under Chalcopyrite).

Jackson County. The placer deposits on Jackson Creek downstream from the highway bridge at Jacksonville are readily accessible. The town itself is a veritable museum with the remains of old frontier buildings and placer workings still to be seen (49, p. 20).

Ashland Gold Mine is located three miles NW of the city. A road to the mine is at Meyer Creek. Vein is
in the E ½ Sec. 12, T. 39 S., R. 1 W. (49, p. 23).

Lane County. Champion Mine (described under Chalcopyrite).

Marion County. Capitol Mine (described under Chalcopyrite).

Iron

This is the most important metal in our economy and it is indispensable to our modern way of life. Limonite is the mineral which gave Oregon the opportunity of having the first iron smelter on the Pacific Coast. There was a smelter at Oswego as early as 1867 and the remains of it may still be seen there (26).

Limonite (Bog Iron Ore, Yellow Ocher).

Chemical Properties. Oxygen, Iron, and Water (2Fe₂O₃ · 3H₂O).


Oregon Occurrences. Oswego. The ore was mined in the face of a high bluff north of the riding academy and below the golf course two miles due west of Oswego. The remains of three tunnels which extended nearly 1,000 feet into the hillside may still be seen (26).
Scappoose. Limonite has been mined in Secs. 3, 10 in T. 3 N., R. 2 W., which are about two miles west of Scappoose, for use as an ore of Iron and for paint pigment (50, p. 31).

Lead

Lead has been known since the beginning of history. The Chinese used it for money before 2000 B.C. (6, p. 527). Today it is used for pipe, storage batteries, cable coverings, etc. In Oregon the only mineral mined for lead is galena.

Galena (Galenite - Lead Glance).

Chemical Properties. Lead and Sulphur (PbS), when melting emits sulphurous fumes. Will melt down to a globule of metallic lead in the blowpipe flame.


Oregon Occurrences. Baker County. Rock Creek mines are four miles up Rock Creek from the town of Haines (47, p. 84).

Lane County. Champion Mine described under Chalcopyrite.
Manganese

Manganese is a very important alloy of iron. Its chief use is in the steel industry where it is used to remove oxygen and sulphur to make a clean, pure carbon steel. The deposits in Oregon are composed of psilomelane and rhodonite.

**Psilomelane.**

Chemical Properties. Manganese and Oxygen \( \text{(MnO}_2 \text{)} \).


**Rhodonite.**

Chemical Properties. Manganese and Silica \( \text{MnSiO}_3 \). Melts easily in blowpipe flame. Rhodonite is considered as the primary mineral from which psilomelane was formed by oxidation.


**Oregon Occurrences.** The minerals of manganese occur in small pockets in Oregon, therefore, the workings are necessarily small.
Coos County. McAdams deposit is three miles east of highway 101; four miles north of Langlois. The county line between Coos and Curry County passes through the deposit in Sec. 20, T. 30 S., R. 14 W. (28, p. 31).

Jackson County. Tyrell Manganese deposit may be reached from Medford by driving 11 miles to Eagle Point on the Medford - Crater Lake highway, then east 11 miles to Lake Creek, and then south five miles on the dirt road to Soda Springs. The large open cut is in the W 1/2 of NW 1/4 of Sec. 10, T. 37 S., R. 2 E. (28, p. 16).

**Mercury (Quicksilver)**

Mercury is the only metal that is a liquid under ordinary room temperatures. It is used in electrical apparatus, munitions, agriculture fumicides and has many other important uses.

**Cinnabar.**

**Chemical Properties.** Mercury and Sulphur (HgS), heated in an open test tube it will give off sulphur fumes and leave globules of mercury on the cool walls of the tube.

Oregon Occurrences. Douglas County. The Bonanza mine is 7.9 miles east of Sutherlin, which is situated on the main highway (99) 14 miles north of Roseburg. The mines are on good roads and lie in Sec. 16, T. 25 S., R. 4 W. (40, p. 130).

Jackson County. The War Eagle mine has been the outstanding producer of mercury in Oregon. The property is located 26.2 miles north of Medford in Sec. 8, 17, 16 of T. 34 S., R. 2 W. (40, p. 113).

Jefferson County. Horse Heaven mine. This mine is 15.9 miles east of Ashwood over a dirt road. The mine was discovered by two school boys during a summer's prospecting trip. It is in Sec. 12, T. 10 S., R. 18 E. (40, p. 89).

Lane County. The Black Butte mine is located 17 miles south of Cottage Grove near the town of Black Butte. The mine is in the NW ¼ of Sec. 16, T. 23 S., R. 3 W. (40, p. 138).

Zinc

The galvanizing of steel to prevent rust is the main use of zinc. Zinc is almost always found with lead and in Oregon the zinc mineral sphalerite is associated with galena and both are mined primarily for their gold content.
**Sphalerite (Blende, Zinc Blende, Black Jack, Rosin).**

**Chemical Properties.** Zinc and Sulphur (ZnS) yields sulphurous fumes when heated in an open test tube.

**Physical Properties.** Color: yellow, brown, black; also red, green and when pure nearly colorless. Streak white, light to dark brown. Luster is resinous to adamantine. G. = 3.9 - 4.1. H. = 3.5 - 4. Cleavage pronounced in six directions at 60°, 90°, and 120°. Fracture conchoidal (16, p. 421).

**Oregon Occurrences.** It occurs in the same localities as lead.

**Rock Forming Minerals Of Oregon.**

The minerals to be described in this section of the manual are those which are so common that they may be seen in any section of the country. They are the minerals which form the rocks of the earth.

**Common Rock Forming Minerals**

**Orthoclase (Potash Feldspar).**

**Chemical Composition.** Potassium, Aluminum, Silicon, Oxygen. KAlSi₃O₈.

**Physical Properties.** Color white, gray, pale yellow, flesh red, and colorless are common, rarely green. Streak uncolored. Luster vitreous. G. = 2.5 - 2.6.
H. = 6. Cleavage distinct in two directions at $90^\circ$.
Fracture conchoidal to uneven (25, p. 38).

**Plagioclase (Soda-lime and Lime-soda Feldspars).**

**Chemical Composition.** Sodium, Aluminum, Calcium, Silicon, Oxygen, ranging from NaAlSi$_3$O$_8$ to CaAl$_2$Si$_2$O$_8$.

**Physical Properties.** Color white, gray, colorless, green, bluish, reddish. Streak white. Luster vitreous. G. = 2.6 - 2.7. H. = 6. Cleavage distinct in two directions at $90^\circ$. Fracture uneven. May be distinguished by striations (many small, parallel, grooves) on its surface (25, p. 38).

**Pyroxene.**

The pyroxene family consists of several separate minerals which have different chemical compositions, but whose physical properties are similar. These minerals occur for the most part in basalts and gabbros. Augite is the most common pyroxene.

**Chemical Composition.** Calcium, Magnesium, Iron, Silicon, Oxygen. Ca(Mg, Fe)(SiO$_3$)$_2$.

**Physical Properties.** Color bright to dark green, grayish green, black, brown. Streak greenish, brownish, grayish. Luster vitreous, dull. G. = 3.2 - 3.6. H. = 5 - 6. Cleavage distinct in two directions at $90^\circ$, crystals form in the shape of railroad ties. Fracture
Amphibole.

Despite a wide range in chemical composition, all the amphiboles fall into a natural group in which each member structurally and chemically grades into other members. The most common amphibole is hornblende.

Chemical Composition. Calcium, Magnesiu, Iron, Aluminum, Silicon and Oxygen. \((\text{Ca, Mg, Fe, Al}) \text{SiO}_3\).

Physical Properties. Color varies from pure white to black depending on the amount of iron present, usually dark green, black or dark brown. Streak white to gray, green or brownish. Luster vitreous. \(G. = 3 - 3.5\). \(H. = 5 - 6\). Cleavage perfect in two directions which intersect at angles of 125° and 55° forming diamond shaped faces. This fracture distinguishes the amphiboles from the pyroxenes because the pyroxenes have square \((90^\circ)\) cleavages. Fracture uneven and splintery \((35, p. 47)\).

Micas.

This group of minerals is characterized by their ability to be split up into thin, flexible flakes. The minerals range from white muscovite to brown phlogopite to black biotite.

Chemical Composition. The micas are silicates of potassium and aluminum. Biotite also contains iron and magnesium.

**Olivine (Chrysolite, Peridot).**

Olivine is a group name of a family of minerals that occur almost wholly in rocks devoid of quartz. Its home is the basalt and gabbro.

**Chemical Composition.** Magnesium, Iron, Silicon, Oxygen \((\text{Mg, Fe})_2\text{SiO}_4\).


**Quartz.**

Quartz is one of the most common minerals, and may be found in one of its many forms in any part of the state. Silicon and oxygen combine to form silica which in its crystalline form is quartz. Silica occurs in noncrystalline masses containing variable amounts of water which are termed opal. Chalcedony is formed by the dehydration and crystallization of opal.

**Quartz (Rock Crystal).**

**Chemical Composition.** Silica \(\text{SiO}_2\).
Physical Properties. Color white or colorless when pure, but has all colors due to impurities. Rock forming quartz is usually white thru gray to black. Streak white. Luster vitreous, greasy. G. = 2.6. H. = 7. Cleavage indistinct. Fracture conchoidal. Quartz forms characteristic, six sided crystals with pointed, pyramid ends (25, p. 50).

Opal.

Chemical Composition. Silica with water. SiO₂·H₂O.


Chalcedony (Agate, Flint, Hornstone).

Chemical Composition. Silica SiO₂.

CHAPTER III

ROCKS OF OREGON

A rock is composed of a mixture of minerals. In the geologic sense a rock is the material that forms the essential part of the earth's crust, which includes such things as: lava beds, sand deposits, coal beds etc. The three major classes of rocks based on their origin are igneous, metamorphic and sedimentary.

Classes Of Rocks In Oregon

Igneous Rocks

Igneous rocks are formed of solidified molten material (magma). The character of these rocks depends upon both their chemical composition of the magma and the nature in which they cooled.

The chemical composition of the rocks is approximated by a knowledge of the minerals contained in the rocks. Those rocks which contain a large amount of silica as shown by the presence of quartz are referred to as acid rocks. Rocks with very little silica as shown by the presence of olivine are considered to be basic rocks. Rocks composed entirely of olivine are considered to be ultrabasic. There is a perfect gradation between the three types, and this fact makes the naming of an
igneous rock a difficult task even for the petrographer with the aid of his microscope, yet it is common practise to give general names to rocks encountered in the field, based upon their texture and mineral composition.

The nature in which these rocks cooled is attested to by their texture. If the magma were chilled quickly a fine-grained rock will have been formed, but if the magma were cooled slowly a rock mass of crystals large enough to be seen by the naked eye will have been formed.

The following is one classification of igneous rock textures by Pirsson (35, p. 124).

1. Phanerocrystalline. The rock consists of grains large enough to be recognized as individual entities by the unaided eye. Example, ordinary granite.

   (a) Fine-grained. The grains are less than 1 millimeter in diameter.

   (b) Medium-grained. The grains are between 1 and 5 millimeters in diameter.

   (c) Coarse-grained. The grains are greater than 5 millimeters in diameter, or as large or larger than peas.
2. Aphanitic. The rock consists of grains that are too small to be seen by the unaided eye. Example, basalt.

3. Glassy. The rock can be distinctly seen to be composed of glass. Example, obsidian.

**Phaneroocrystalline Igneous Rocks**

**Granites.** Granites are coarse-grained rocks composed of orthoclase and quartz with small amounts of biotite or rarely hornblende. The color grades from white to dark gray depending on the color of the orthoclase and the amount of orthoclase there is in proportion to the amount of dark minerals. Another common color of granite is pink to red caused by a pink orthoclase. Granite is useful for building and ornamental stones.

Oregon Occurrences. Baker County. Large masses are found in this county and a specific example is the Haines Quarry, two miles east of the railway station at Haines (33, p. 18).

Jackson County. Mt. Ashland's peak is composed of granite (57).

Lane County. Near Nimrod on the McKenzie River there is a granite intrusive (42, p. 18).

**Granodiorite.** Granodiorites are medium to coarse-grained rocks closely resembling granites, but
having more plagioclase (recognized by its striations) than orthoclase (without striations). The color grades from light gray to dark gray. The mineral composition of granodiorite is quartz, plagioclase, orthoclase, and some dark minerals.


Jackson County. Hills north and south of Wimer. Hills two miles directly west of Ashland.

Josephine County. The hills northwest and southwest of Grants Pass. At Merlin a granodiorite is exposed in Harris Creek.

Wallowa County. Glacier mountain in the southwestern part of the county.

Diorite. Diorites are coarse-grained rocks composed of plagioclase and dark minerals (biotite, hornblende, augite) with less than 10 per cent quartz. The color of diorites is darker than granites, and grades from gray to dark gray. Greenish or brownish gray is observed sometimes. They are used for building and monumental stones.

Oregon Occurrences. Baker County. Over large areas in the western part of the county.
Douglas County. Diorite is exposed by railroad cuts north of Roseburg.

Jackson County. Hills south of Ashland.

Union County. Southwestern section has exposures of diorite.

**Gabbro.** Gabbros are coarse-grained rocks consisting chiefly of pyroxenes, amphiboles, olivine and plagioclase. A gabbro is distinguished from a diorite in the hand specimen by the ratio of plagioclase to dark minerals. In the diorite, plagioclase predominates, in the gabbro the dark minerals predominate. This is a basic rock. The color of a gabbro is generally dark: dark gray, brownish gray, or greenish black (35, p. 187).

Oregon Occurrences. Curry County.
Bald Mountain ten miles southeast of Port Orford.

Douglas County. The big hill at the north city limits of Roseburg.

Josephine County. Near York Creek, on the Illinois River.

Polk County. The road from Falls City west to Black Rock passes through an area of gabbro.

**Peridotite.** This rock is composed of olivine and is medium-grained to coarse-grained. It alters easily to serpentine, a greenish, slippery rock (see serpentine in Metamorphic Rock Section). The color of peridotite varies
from dull green to black. The peridotite areas of our state correspond to our greatest mining areas.

Oregon Occurrences. Grant County. The hills directly south of Canyon City.

Josephine County. The mountains west of Kerby are underlain by peridotite.

**Aphanitic Igneous Rocks**

**Rhyolite.** Rhyolite has the chemical composition of granite. It is usually light colored; pink and red predominate, but it may vary from tan to dark purple. Difficulty is encountered in naming the light colored, aphanitic rocks in the field because the individual minerals can not be distinguished in the hand specimen, therefore, the term *felsite* is commonly used for these rocks.

Oregon Occurrences. Deschutes County.

Tumalo Creek three miles west of Bend flows through rhyolite.

Jefferson County. West of Madras on Willow Creek.

Lane County. In the Cascade Mountains along the South Santiam River east of Cascadia; along the Middle Fork of the Willamette River, and along Salt Creek southwest of Oakridge. Most are characterized
by light color and flow banding.

Wasco County. Rhyolite outcrops at the Lady Francis Mine (described under Perlite).

**Andesite.** Andesite is very common in Oregon. It is the chemical equivalent of diorite and would have had the same texture as diorite except that it cooled more quickly; probably as a result of being extruded onto the earth's surface. Most andesites are dark colored; gray, brown, red, green, or nearly black. It is used for road metal and riprap (protective walls for jetties or embankments).

**Oregon Occurrences.** Deschutes County. Andesite is widespread in the area from Bend to Prineville.

Jackson County. Area from Roxy Ann Peak (five miles east of Medford), southeast to headwaters of Walker Creek (three miles east of Ashland).

Wasco County. The Lady Francis Mine (described under Perlite)

The main core of the Cascade Mountains is composed of andesite and all of the major peaks contain large portions of it.

**Basalt.** Basalt is the flow equivalent of gabbro. It is one of the most common rocks in Oregon. The color of basalt is dark gray to black. The quarrying of this
rock for road metal and riprap is one of the most important mining operations in the state.

Oregon Occurrences. There are basalt outcrops in every county of the state, but the most spectacular outcrop is along the Columbia River Gorge.

The major headlands on the coast are basalt. Many of the hills in the Willamette Valley are basalt; examples are: the Salem hills, the cliffs at Oregon City, and Coffin Butte near Corvallis.

In Eastern Oregon many of the buttes are capped by flows of basalt.

**Glassy Igneous Rocks**

**Obsidian.** Obsidian is a natural glass devoid of crystal grains, or nearly so. It has an excellent conchoidal fracture which made it a very valuable material for indian weapons. The color of obsidian is generally black, but it is sometimes red, gray, or brown.


Lake County. Glass Buttes, in the northeast corner of the county, are composed almost entirely of obsidian. Throughout the rest of Oregon it occurs mainly in small flows.
**Perlite.** Perlite is a natural silicious glass which will "pop" or expand to several times its original size when heated. This property makes it a much sought after building material because perlite when expanded is a very lightweight material. Perlite is generally gray or blue gray and is distinguished by its structure which looks like it is formed of groups of small onions (3).

Oregon Occurrences. Lake County.

Perlite may be found near Lakeview.

Wasco County. The Lady Francis mine is on the west side of the Deschutes River about nine miles south of Maupin in the NE 1/4 of Sec. 24, T. 6 S., R. 13 E. (3).

**Pumice.** Pumice is a glass froth. It is formed as a gas-rich, silicious magma comes to the surface of the earth, where the pressure is much less than at depth where magmas form, and the gas expands with tremendous energy whipping the molten lava into a froth. Because of the enclosed gas bubbles in pumice, it is very light and will float. Pumice is used in building materials and as an abrasive.

Oregon Occurrences. Deschutes County.

North of Bend there is a large area covered with pumice.

Klamath County. At Crater Lake and
northeast of that point large deposits occur.

**Tuff.** When molten magma comes to the surface of the earth it is sometimes ejected with tremendous force. Molten material goes into the air in large blobs as big as softballs and larger which when rounded in flight are called **bombs**. The molten rock is also blown into the air in small particles as ash, or cinders; some of these small particles form as glass bubbles which burst as they are carried up into the air. The fragments of these bubbles are called **tuff** which is generally tan colored and sometimes bedded. It is often mistaken for a sandstone. Tuff beds are the home of many fossil deposits in Oregon.

**Oregon Occurrences.** Baker County. There are two quarries near the railway station of Pleasant Valley, 13 miles southeast of the city of Baker (33, p. 38).

Grant County. The John Day river exposes tuff beds in the Picture Gorge, ten miles west of Dayville.

Linn County. Franklin Butte, one mile southeast of Scio has good exposures of tuff. Tuff beds are widespread in the Willamette Valley.

Marion County. The Tuft Stone Company has a quarry in tuff about 20 miles southeast of Salem.
Sedimentary Rocks

Sedimentary rocks are the product of the disintegration of other rocks. As their name implies they have been carried as suspended particles in waters. All rivers carry sediments which they have picked up from the land over which they flowed. They carry these sediments by the force of their currents until they strike a body of still water where they drop them. The ultimate resting place of all sediments is the sea floor, but some deposits form temporarily in large lake basins or along quiet places in rivers.

The sediments are classified in relation to their origin as: clastic, formed from the mechanical disintegration of other rocks, or nonclastic which includes all others, such as coal, limestone, chalk, and mineral spring deposits. Clastic rocks are named according to the size of rock fragment which makes up the largest part of the total rock. Nonclastic rocks are named by the material which composes them.

Clastic Sedimentary Rocks

Shale. Shale is a rock composed of fragments of other rocks which are less than 1/16 millimeter (mm) in diameter (one inch is equal to 25.4 mm. 1 mm = 1/25 of an inch)(34). It is the consolidated
equivalent of clay or mud. Shale is laid down in successive thin layers (beds) usually in deep, quiet water; then it is compacted to form rock by the weight of overlying sediments.

Shales are light colored gray and tan, but may be black because of carbonaceous material. They are distinguished in the field by their tendency to break along their thin bedding planes, and by their crumbling to "bite" size.

Oregon Occurrences. Shales are very common in the Coast Range and are exposed along the roads from the Willamette Valley to the coast.

Harney County. The road from Burns to John Day has outcroppings of sandstone and shale.

Wheeler County. Road cuts made by the Ochoco Highway near Mitchell expose outcrops of sandstone, shale and conglomerates.

Sandstone. Sandstone is the name of the consolidated fragments of rock and mineral whose size is greater than 1/16 mm and less than 2 mm (34, p. 226). When the grains of sandstone are large enough for identification it will be noted that quartz is usually the dominant mineral with flakes of mica, and grains of the dark minerals also visible. Sandstone is compacted sand. Its colors range from light gray to buff; sometimes shades of
red. The processing of sand and gravel for construction purposes is a very profitable business in Oregon.

Oregon Occurrences. The sea coast of Oregon has many outcrops.

Douglas County. Tyee Mountain above Umpqua Ferry.

Grant County. Silvies River region in Harney and Grant counties has large areas of red sandstone.

Wallowa Mountains contain many marine sandstone beds.

Sandstone and shales occur in the same areas.

**Conglomerate.** A conglomerate is any consolidated mass of rounded rock material composed of particles larger than 2 mm in diameter (34,p. 195). It looks like ordinary river gravel, and it should, because it originally was a gravel before compaction.


Multnomah County. At Troutdale on the north bank of the Sandy River. Western Oregon is the main area for this type of rock.

**Breccia.** A breccia is composed of angular rock fragments in a fine-ground mass. It may be formed from
any type of rock, and in various ways such as faulting, or as a mud flow. A typical example of a breccia would be a layer of basalt which had been faulted causing granulation and fragmentation of the rock, thus forming a "fault breccia".

Talus. The accumulations of angular rock fragments at the foot of steep slopes are termed talus.

Nonclastic Sedimentary Rocks

Coal. The coal in Oregon is of the bituminous and sub-bituminous grade. The sub-bituminous is used chiefly for fuel, and as yet the bituminous deposits have not been mined. Coal is composed of carbon, hydrogen, oxygen, nitrogen and impurities, and has the following physical properties: color and streak black, grayish black or brownish black. Luster dull to brilliant; earthy, resinous. G. = 1.1 - 1.4. H. = 1 - 2.
Bituminous coal splits into cubes but sub-bituminous coal splits only parallel to the bedding planes (35, p. 285).

Oregon Occurrences. Coos County. Alpine Coal Company is located on Highway 101 at the southwest edge of Riverton, which is six miles west of Coquille. Southport Coal Company is five miles south of Marshfield on Highway 101. There is a plank road which goes west 1/2 mile from the main highway.
Mining is in NE 1/4 of Sec. 22, T. 26 S., R. 13 W. (27, p. 7).

Marion County. Waldo Hills Coal Mine. SE 1/4 of Sec. 28, T. 7 S., R. 1 W. The mine is reached via Garden Home Road from Salem east to Pratum, and 3.7 miles east of Pratum on the road to Silverton to intersection with Cemetery Road. Up Cemetery Road 0.9 mile, turn left into Ferris property. Go northeast over the brow of the hill to the headwaters of Beaver Creek where mine is located.

Diatomite. Diatomite is composed of the siliceous skeletons, test (a type of shell) or their siliceous parts of diatoms - microscopic one-celled plants. Its main uses are in filtering and in building materials. Chemically it is composed of over 90% silica (SiO₂). Its physical properties are: color buff to white, H. = 5.5 (the large hand specimen crumbles like chalk, but when rubbed against glass it will scratch it), G. = 2.1 (it will float because it has large pore spaces filled with air). Under a microscope the individual shells are visible (32, p. 18).

Oregon Occurrences. Deschutes County. Atomite Corporation is the main producer in Oregon and is located on the Deschutes River at Lower Bridge which is west of Terrebonne (32, p. 19).
Klamath County. Diatomite is being formed in Klamath Lake at the present time. The beds are said to be ten feet thick.

Malheur County. The road between the towns of Harper and Westfall passes directly through a large outcrop of diatomite three miles north of Harper.

**Limestone.** To be considered a commercial limestone a rock must be composed of at least 80 per cent of the carbonates of calcium and magnesium and be capable of being slaked on the addition of water, after it has been calcined. It is used mainly in the production of cement and plaster, and is also an important fertilizer. Limestones of non commercial purity are fairly common in Oregon. Chemically it is composed of calcium, carbon, oxygen (CaCO$_3$). The most common field test is to put a drop of acid on the rock and it will effervesce. Its physical properties are: color white to dark gray (impurities cause the gray color), H. = 3, G. = 2.7. If the limestone is pure CaCO$_3$, it will be formed of calcite crystals which are white to clear and have the same properties as limestone (34, p. 239).

**Oregon Occurrences.** Baker County. The town of Lime, in the southwest corner of the county, exists primarily for the manufacture of lime from a limestone deposit there (19, p. 7680).
Clackamas County. The Marquam Limestone locality is described under fossils.

Douglas County. At the head of Green Valley six miles northwest of Oakland.

Josephine County. On land of the Rouge River Lime Company in the SW 1/4 of Sec. 19, T. 37 S., R. 6 W. limestone forms a cliff. There is a quarry in this limestone about nine miles southwest of Grants Pass (19, p. 7672).

Polk County. The Buell Lime quarry is described under fossils.

Metamorphic Rocks

Metamorphic rocks are rocks whose original form has been changed. This change may have been brought about by heat, pressure, mineral-bearing water or a combination of these agents. The metamorphic rocks of Oregon are some of the oldest rocks in the state.

Gneiss. Gneiss is a coarse-grained rock that has bands formed of alternating layers of minerals of different colors. It has the same mineral composition as the igneous rock it most closely resembles, i.e., granite gneiss, gabbro gneiss, etc. The minerals in the rock are crudely aligned (14, p. 44).
Oregon Occurrences. Jackson County.
Gneiss are found along the Rouge River in Josephine, Jackson, and Curry counties (14, p. 44).

Wallowa County. Gneiss are found in the Wallowa Mountains.

Marble. Marble is formed by the recrystallization of limestone. In many cases it is very difficult to distinguish between the two, but marble is heavier, has larger crystals, and is more dense than limestone. Marble can be easily scratched with a knife, and it will effervesc with the addition of vinegar or other dilute acid. The color of marble is most often white to gray or black, but it can be found in almost any color.

Oregon Occurrences. Josephine County.
A marble quarry is in the center of Sec. 31, T. 38 S., R. 5 W. This locality is 15 airline miles directly south of Grants Pass.

Wallowa County. The Black Marble quarry five miles southwest of Enterprise.

Serpentine. Serpentine most often forms from the alteration of basic rock. The color is light to very dark green. It fractures easily and has a greasy, slippery feel on the fractured surfaces. Serpentine is not a hard rock and is easily scratched with a knife.
Oregon Occurrences. The serpentine localities are similar to the Peridotite localities.

Coos County. Iron Mountain, 18 miles east of Port Orford is composed largely of serpentine.

Douglas County. The valley of the Little River at Peel is cut into serpentine.

Grant County. The hills directly south of Canyon City.

Josephine County. The mountains west of Kerby.

**Schist.** The schists are a group of metamorphic rocks that have a finer texture than gneisses, and are composed of a series of thin crystalline layers called *folia*. The layers are not continuous as in sedimentary rocks and they are generally crumpled. The rock mass will readily split along these layers, but this surface will be rough. Schists have formed from shales or extrusive igneous rocks (17, p. 225).

Oregon Occurrences. Schists are more widespread than gneisses, but they only occur in the same general areas as gneisses do in Oregon.

Curry County. Colebrooke Butte six miles north of Ophir is predominately formed of schist.

Douglas County. A schist is exposed six miles east of Roseburg on the road up the North Fork
of Deer Creek.

**Slate.** Slates form from shales, muds, or tuffs. They readily split into thin, smooth-sided layers. The individual grains are about the size of the grains in shales. The color of slates are generally dull; green, black, or reddish. Because of its ability to split into thin layers it is much used as a roofing material in the East.

Oregon Occurrences. Josephine County.

Along Waldo, Slate, and Galice creeks.
### Igneous Rocks

<table>
<thead>
<tr>
<th>Acid</th>
<th>Basic</th>
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<tbody>
<tr>
<td>Orthoclase</td>
<td></td>
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<td>Orthoclase and Plagioclase</td>
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<td>Plagioclase</td>
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- **Quartz in Abundance**
- **No Quartz**
- **Olivine**

- **GRANITE**
- **Rhyolite**
- **DIORITE**
- **Andesite**
- **GAEBRO**
- **Basalt**

- **PERIDOTITE**

### Sedimentary Rocks and Their Metamorphic Equivalents

<table>
<thead>
<tr>
<th>Unconsolidated</th>
<th>Consolidated</th>
<th>Metamorphosed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud, Clay</td>
<td>Shale</td>
<td>Slate, mica schist</td>
</tr>
<tr>
<td>Sand</td>
<td>Sandstone</td>
<td>Quartzite, quartz schist</td>
</tr>
<tr>
<td>Gravel</td>
<td>Conglomerate</td>
<td>Conglomerate schist</td>
</tr>
<tr>
<td>Shells, Lime ooze</td>
<td>Limestone</td>
<td>Marble, calcareous schist</td>
</tr>
<tr>
<td>Leaves, Peat</td>
<td>Bituminous Coal</td>
<td>Anthracite coal, graphite</td>
</tr>
<tr>
<td>Diatom shells</td>
<td>Diatomaceous Earth</td>
<td>(15, p. 399)</td>
</tr>
</tbody>
</table>
A fossil is defined as any trace or remains of any living thing that has been preserved in the rocks. This term includes the tracks or trails of animals, the impressions of plants, and any of the actual remains of plants and animals such as, bones, teeth, shells, silicified wood, frozen flesh, etc.

Fossils are most often found in sedimentary rocks. Very few fossils, outside of the fossil tree casts in the lavas near Bend, have been found in igneous rocks, because these "fire rocks" are so hot that they burn away all traces of the plants or animals which would be enclosed in them. Metamorphic rocks may have had fossils in them but because of the movements in the rocks the fossils have become very difficult to distinguish.

Many different types of fossils have been discovered in Oregon. The sedimentary beds of the John Day valley in the region of the Picture Gorge have yield fossil bones of an extinct pig -- the Oreodont. Leaves and even pollen from plants of ages past have been discovered in many parts of the state. The history of an ancient sea that covered most of Oregon is written by the fossil shells of the animals who lived in it.
This manual includes those fossil localities which are readily accessible and which have produced large numbers of fossils. In some cases the fossils will cover the surface of the rocks enclosing them and can be easily seen without any need for digging. But, in other cases the fossiliferous beds will have become covered by a few inches of overburden and in order to get at the fossils you will have to dig.

**Fossil Localities**

**Baker County.** Fossil leaves are found one mile south of Tipton station on the Sumpter Valley Railroad in both banks of the first railroad cut south of the station. Tipton is four miles northeast of Austin, Grant County, and twelve miles southwest of Sumpter (55).

Fossils are also found at Martin's Bridge on Eagle Creek, which is about twelve miles northwest of Richland in the center of N 1/2 of NW 1/4 Sec. 21, T. 7 S., R. 44 E. (55).

**Benton County.** Shells have been found in the old quarry 1/4 mile due west of Monroe. The quarry is 50 yards NW of the first 90° curve in the road which strikes west from Monroe to Muddy Creek valley (55).

**Clackamas County.** Shells have been found in the Marquam Limestone quarry. To reach the Marquam Limestone
quarry from Marquam take the road east past the school for 1.6 miles. Two right angle turns may be safely passed, but on the third such turn is a narrow gravel road going north (the main road turns south) this road leads directly to the quarry about .3 of a mile from the main road. Location on map is NW 1/4 of Sec. 2, T. 6 S., R. 1 E. (29).

Columbia County. The Pittsberg bluff locality is located five miles north of Vernonia on state highway 47. Fossils of snails and clams are found in the bluff along the highway just north of the bridge over the East Fork Nehalem River (51).

Coos County. About seven miles east of Coos Bay in a small quarry west of the mouth of Daniels Creek, shells are found beneath a limestone lens and above a conglomerate. The quarry is in the NE 1/4 of Sec. 35, T. 25 S., R. 13 W. (51).

Crook County. At Logan Butte, a landmark near the head of Camp Creek and approximately fifty miles southeast of Prineville, is a series of green colored tuffs which contain the remains of fossil pigs. (Camp Creek flows into the Crooked River.) (51).

Curry County. Fossil clams and snails are found five miles north of Port Orford at the mouth of Elk River and northward for about a mile in the cliffs at sea level (51).
Douglas County. North of Comstock, at the railroad cut near the one-mile post, fossil leaves have been found in a layer of rock 15 feet above the railroad tracks (55).

At Glide, which is about 13 miles NE of Roseburg, fossil shells are found in a dirty sandstone beneath the bridge over Little River (51).

Jackson County. Fossils are found in a bank about 50 yards south of the Southern Pacific Railroad bridge over the Pacific Highway at the northern city limits of the town of Ashland. In the NE 1/4 of NW 1/4, T. 39 S., R. 1 E. (51).

Josephine County. Fossil snails and other sea shells are found along the banks of Logan Cut, which is two miles north of Waldo on the north and east section lines of Sec. 9, T. 40 S., R. 8 W. The cut starts at the north end of French Flat and drains northwest into Rough and Ready Creek (51).

Lane County. The sandstone beds in the quarry on Kelly Butte, which is two miles east of Eugene about 60 feet above the Willamette River in the NE 1/4 of Sec. 34, T. 17 S., R. 13 W., contain fossil shells (55).

Fossil shells are found on the north side of Skinner's Butte where the road cuts penetrate a light colored sandstone. Skinner's Butte is the large hill in the north central part of Eugene (55).
Lincoln County. Near Newport (200 yards north of the north jetty in a bluff facing the ocean) marine beds contain the fossil shells of clams and other sea animals which once lived in an ocean that covered this area (51).

There are several layers of sedimentary rocks exposed along the beach between Beverly Beach and Spencer Creek which contain fossil shells of clams and snails. This location is eight miles south of Depoe Bay and 5 1/2 miles north of Newport in the sea cliff at the ocean beach, which is only 0.1 mile from U. S. highway 101 at this point.

Linn County. Sea shells are found on the southwest side of Petterson's Butte about halfway up on the mountain. The butte is about 15 miles SE of Albany and three miles SW of Lebanon in the SE 1/4 of the SE 1/4 of Sec. 19, T. 12 S., R. 2 W.

A famous fossil leaf locality is "on the southern and western slopes of Franklin Butte, which is one of the low western foothills of the Cascade Mountains" (38, p. 1). Franklin Butte is 1/2 mile southeast of Scio. The fossil leaves and wood are found in a light tan tuff which is exposed on the sides of the butte.

Marion County. The Looney Butte Locality, where fossil shells have been found, is 9.0 miles south of the intersection (on the south city limits of Salem) of the
truck route and highway 99E. The shells must be dug out of a small road cut in the north side of the butte in the N 1/2 of Sec. 23, T. 9 S., R. 3 W. The road goes by Looney Butte school and joins the road from Salem to Jefferson.

**Multnomah County.** About 5 1/2 miles up the Sandy River from Troutdale in the NW 1/4 of NW 1/4 of Sec. 10, T. 1 S., R. 4 E. is a large outcrop of gravel and a two foot thick bed of carbonaceous material in the north bank of the Sandy River. There are two thin zones of fossil leaves in this bed (51).

On the old Columbia River highway between Moffett Creek and Tanner Creek, about 1/2 of a mile west of Bonneville is a metal card in the cliff which marks the site where a ginko leaf was found. (The ginko tree once was native to this country but became extinct in ages past. A single living ginko tree was found in a Chinese temple, where it was worshiped because of its unusual character. From this one tree, other trees have been propagated and one now lives at this location.) Fossil leaves may still be found in the sandy gravel near the base of the cliff.

**Polk County.** Fossil shells are found at the Buell Lime quarry, which is 2 1/2 miles west of Buell on State Highway 22. Buell is 12 miles northwest of Dallas and six miles southwest of Sheridan. The quarry is easily seen
from the highway. It is south of the highway by a little creek.

Fossil shells were found in a yellowish orange sandstone at the road junction immediately west of the Valley View School. This school is approximately eight miles south of Monmouth, and 12 miles north of Corvallis, on Suver road 2 1/2 miles west of its junction with U. S. Highway 99 W. (51).

Wallowa County. In the Black Marble Quarry, which is about five miles southwest of Enterprise in the east side of Sec. 19, T. 2 S., R. 44 E., corals and clams have been found. The quarry is on a rather narrow steep road.

Wasco County. "Leaf impressions and a few imprints of fruits occur in a lens of light-colored, fine sandy tuff about ten feet thick; this lens lies at about the middle of a 30 foot outcrop on the south bank of Chenoweth Creek, just west of the point where the stream flows out onto the terrace of the Columbia River" (9, p. 290). This is in the west-central part of Sec. 29, T. 2 N., R. 13 E., about 2 1/2 miles northwest of The Dalles.

Washington County. Fossil leaves are found in the south bank of the Nehalem River, under the bridge which forms part of Dolling Dam just above the town of Timber (51).
Fossil shells of clams and snails are found in the abutments of the high railroad trestle over the Vernonia Buxton Highway 8.3 miles south of Vernonia in the hillside (51).

At the east end of Sunset Tunnel on the Wolf Creek highway is a fossil shell locality (51).

**Wheeler County.** At the town of Clarino, on the John Day River ten miles east of Fossil, Oregon, in the cliffs on the east bank of the river are found fossil leaves and their impressions (8, p. 2).

**Yamhill County.** The Gaston (Boos) quarry in Sec. 22 of T. 1 S., R. 4 W., 2 1/2 miles northwest of Gaston, which is on the Southern Pacific railroad between McMinnville and Forest Grove, has outcrops which contain fossil clams. The quarry is situated on a ridge which forms the northern boundary of Wapato Lake (51).
CHAPTER V

LAND FORMS

Mountains

The most conspicuous land forms in Oregon are its mountains. These mountains may be classified according to their origin as; volcanic, residual, folded, or faulted.

Volcanic Mountains. The Cascade Range is composed of massive flows of andesite and basalt, but its most prominent peaks are former volcanoes. These volcanoes were formed as both lava and ash were expelled from their craters; making them composite cones. When only ash is expelled from a crater that volcano is known as a cinder cone, and when lava is the only expelled material the cone is referred to as a lava cone. The composite volcanoes in the Cascade Range are from north to south: Mt. Hood, Olallie Butte, Mt. Jefferson, Three Sisters (all that remains of Mt. Multnomah (20), an ancient peak of tremendous size that was destroyed by a volcanic explosion), Maiden Peak, Diamond Peak, Crater Lake (formed in a manner similar to Three Sisters), and Mt. McLaughlin (18, p. 265).

Smaller mountains which once were active volcanoes are
Mt. Tabor in Portland, Pilot Butte near Bend, Paulina Mountains and many small cinder cones in that area.

**Residual Mountains.** A residual mountain is formed from a land mass by erosion, or wearing away of earth material. A mountain formed in this manner is composed of rock which is more resistant to erosion than surrounding rocks. In eastern Oregon the countryside is dotted with buttes, and hills which have a capping of a volcanic lava which resists erosion and thus keeps its original elevation while the rest of the area is worn away. Some of these buttes are: Haystack Butte, Juniper Butte, in Jefferson County ten miles north of Bend.

In Southwestern Oregon the Siskiyou Mountains as a whole are residual, but the best examples in that area are the Table Rocks ten miles northwest of Medford.

In the Willamette Valley some examples of residual mountains are: Mt. Scott, Kelley Butte, Rocky Butte, and the West side hills in Portland; the Salem hills at Salem; Petterson Butte near Lebanon; Coffin Butte north of Corvallis; Skinner's Butte in Eugene.

**Folded Mountains.** The most striking example of folded mountains in Oregon is the entire Coast Range. This mountain system is composed of a series of sedimentary rocks over 10,000 feet thick which have been folded from their original flat lying, sea level position into a range which
in places is over 4,000 feet high. The evidence that these mountains actually have been folded by some immense force is to be had by driving through these mountains from the Willamette Valley to the coast. The attitude of the sedimentary beds in the roadcuts shows that these originally flat lying beds have been warped into a series of anticlines (upfolded beds) and synclines (downfolded beds).

Faulted Mountains. Faulted mountains are those mountains that owe their elevation to a vertical movement of the earth along a fault plane (rent or tear in the earth along which there has been movement). These mountains have a striking characteristic in common; which is their abrupt rise above other land masses. This abrupt rise is usually in the form of a towering cliff, termed a fault scarp, on one side of the mountain. Excellent examples of faulted mountains in Oregon are:

The Wallowa Mountains in Northeastern Oregon with their fault scarp well defined south and west of Enterprise. Steens Mountain in Southeastern Oregon with its scarp on the east side is just one of many faulted mountains in this area, others are: Fort Klamath scarp, Winter Rim, and Abert Rim.
Life Cycle Of Rivers

If a large land area has been elevated high above sea level, and if rivers form on this area, there will begin a process of erosion by stream action which has as its ultimate goal the reduction of the entire land mass to sea level. In working toward this goal the streams carve the land into various topographic shapes which for purposes of comparison and study have been termed youthful, mature, and old. The same river, in different portions of its course, may be passing through all phases of this cycle of erosion.

Youthful area is one in which the rivers flow rapidly in sharp V-shaped valleys. The upland areas show poor drainage patterns and the main streams have few tributaries. Rapids and waterfalls may still occur along the stream because it has not had time to erode extensively. An example in Oregon is: Crooked River and the Deschutes River from Bend to the Columbia River.

Mature Topography is characterized by well developed stream patterns; deep, broad valleys, and extremely rugged terrain. Examples in Oregon are: The Rouge River, The Santiam River above Sweet Home, Nehalem River in the Cascades.

Old Age. When the stream erodes the rugged valleys
into broad, flat, plain-like areas the stage of "old age" has been reached. Old age streams move slowly, in a tortuous, meandering (a series of looping turns) course. It easily overflows its low banks and, thus, is subject to a great many floods. An example in Oregon is: The Willamette River above the falls at Oregon City to the city of Eugene (42, p. 32).

The Coast Range area in Lincoln County, Lane County, and Douglas County was at one time a peneplain, with old age, meandering streams flowing on its surface. The area was later raised several hundred feet and the streams became entrenched. The meandering course of the Alsea River may easily be seen from a topographic map. Other streams that show entrenched meanders are: Siuslaw River, Smith River, Yaquina River, and the Siletz River.

**Waterfalls**

The waterfalls along the Columbia River have been popular stopping spots for many tourists. The falls owe their origin to the fact that the Columbia with its great volume of water has been able to erode a deep gorge in the basalt, but the tributaries because of their small size have been unable to keep up the pace. Therefore, the tributaries have been left as "hanging valleys."

Another type of waterfall is the one formed as a
stream flows over a particularly resistant bed of rock onto a more easily eroded one. The resistant rock is eroded into relief and a falls is formed. Examples in Oregon are:

The Willamette River at Oregon City flowing over basalt.

The Silver Creek Falls near Salem also flowing over basalt.

The Salt Creek Falls are located ten miles NW of Odell Lake on State Highway 58, near the crest of the Cascades.

Glaciers

A glacier is defined as "a stream of ice and snow, formed in a region of perpetual snow, and moving down a slope or spreading of its own weight." In Oregon we have only to look at the Cascade Mountains to see the remains of some glaciers which at one time were very extensive. In the Ice Age the glaciers reached down the mountains many miles more than they do at present, and some of the glaciers may have terminated on the slopes of the Willamette Valley. The largest glacier in Oregon is Collier Glacier on the North Sister, but there are many other glaciers on peaks in the Cascades; Mt. Hood, Mt. Jefferson, Three Sisters, etc.
Work Of The Winds

Running water is not the only agent of erosion. This statement is attested to by the "dust bowl" of the Middle West. In Oregon there are numerous examples of the ability of the wind to move large sections of the earth's surface. The two areas where this work may best be observed are in central Oregon 90 miles southeast of Bend in the north part of Lake County and on the Oregon beaches where the wind has blown large quantities of sand into mounds called sand dunes. These large hills are slowly moving in the direction of the prevailing winds in the area from Seaside to Astoria; from Newport to Waldport; and from Florence south to Coos Bay.

Lakes

Lakes are natural depressions in the land surface that are filled with water. The interesting problem which confronts the geologist in accounting for a specific lake is: "How did this depression form?"

Basins Produced by Volcanic Activity. The best example of this type of lake basin is Crater Lake, which occupies the crater of an extinct volcano. Another example of a crater lake is Paulina Lake, which is about 25 miles south of Bend.
Some streams and their valleys have been dammed by lava flows. This is the origin of the basin for Davis Lake, which is near the summit of the Willamette Pass.

The surface of lava flows are often irregular, giving rise to large, natural depressions. Waldo Lake, in Lane County near the Willamette Pass, occupies one of these natural basins (42, p. 54).

**Basins Produced by Diastrophism (earth movement).** In Southeastern Oregon the most prominent ridges and mountains have been formed by movement on fault planes. These movements of the rock have made depressions at the base of the large fault scarps, and these depressions are now lakes. Examples in Oregon are: Summer Lake, Lake Abert, and Klamath Lake.

**Basins Formed Along the Sea Coast.** Sand bars are formed where streams meet the sea. When the sand bar becomes large enough it dams the mouth of the stream forming a lake. This same effect may be accomplished by ocean currents which sweep along the beach, or by the movements of sand dunes. Examples along Oregon beaches are:

Lakes Whoahink and Siltcoos were formed when their stream valleys were blocked by sand dunes. These lakes are just south of Florence, on the Oregon Coast.
Basins Formed by the Actions of Glaciers. Glaciers are efficient agents of erosion. They carve the mountain masses into characteristic glacial forms and carry the debris from this carving to the lower slopes where it is deposited in a heterogenous mass termed a moraine. Both the carving of the mountains and the deposition of moraine form basins. From the carving of the mountain cirques are formed. A cirque is a steep-walled amphitheater-like recess in a mountain wall caused by the "plucking" of large boulders from this wall (36, p. 76). The glacier plucks these boulders by freezing to them and then moving downhill. Cirque lakes are common in the Cascade Mountains, one such lake is Mirror Lake located about eight miles southwest of Government Camp.

The best example in Oregon of a lake formed by the damming of a valley with glacial moraine is Wallowa Lake in the northeastern section of the state (12, p. 85).

Basins Formed by Abandoned Stream Channels. When a river changes its course in a valley, it most generally leaves a depression which was its former channel. When this depression is in the form of a loop or meander, the term oxbow lake is used. There are many lakes in the Willamette Valley which now occupy former stream channels; some of these are: Colorado Lake and Horseshoe Lake between Albany and Corvallis; Humbug Lake, and Lyden Lake
between Salem and Independence; Clear Lake, Hubbard Lake, Horseshoe Lake south of Dayton; and Skookum Lakes south of Newberg.

Oswego Lake occupies the old channel of the Tualatin River.

**Plains And Plateaus**

Plains are defined as areas of level, or nearly level, land (36, p. 310). Plateaus are similar to plains in being flat areas, but ordinarily plateaus are areas of considerable elevation. One of the largest plateau regions in the world is the Columbia Lava Plateau in Eastern Oregon. This plateau was produced when lava flows formed in sufficient depth to obliterate all previous major irregularities in the surface.

Some plains are formed when rivers produce wide, flat, valleys. Such a plain is the Willamette Valley above Oregon City to Eugene.

**Caves**

There are three distinct causes for the formation of caves in Oregon; the solution of limestone by ground water, the breaking out of fresh, molten lava from a shell of cooled lava, and the erosion by wave action of the sea cliffs along zones of weakness.
Limestone is soluble (will dissolve) in plain water (13 parts per million), but it is even more soluble in water containing carbon dioxide (1000 parts per million). The ground water that comes in contact with the limestone in the earth contains carbon dioxide from the air and carbon dioxide from decaying plants. As the ground water passes through the limestone it dissolves the limestone leaving a cave or cavern. The Oregon Caves, in southwestern Oregon 25 miles south of Grants Pass, were formed in this manner.

**Lava caves, or tunnels,** are formed after the outer crust of a lava flow has cooled. The outer crust becomes rigid, but the interior part of the flow continues to grow by the addition of more molten lava. Pressure is built up inside the lava "skin" until finally it bursts and the molten lava flows out. The cooled outer shell keeps its shape because of its rigid nature; therefore, an arch, or cave, is formed. Some easily accessible lava caves are on U. S. Highway 97, ten miles south of Bend.

**Ice caves** in this region were formed in a manner similar to the lava caves. The presence of ice is explained by Swartzlow as caused by active circulation in winter and little circulation in summer. The water seeps into the caves from the earth's surface. "During the cold months the surface air increases in density and
naturally migrates to lower levels. In doing so, it displaces warmer air that may be present. This process repeats itself until the temperature at the bottom of the cave reaches or passes the freezing point of water. During the summer months the warm surface air expands and rises, but the cold air adjacent to the ice is not displaced; thus the summer-time is a season of minor circulation" (52). The rock acts as an efficient insulator, and, once formed, the ice remains in the lava cave.

**Erosional caves.** Where there are zones of weak or jointed (cracked) rock, waves quarry or erode much more rapidly than in more resistant or less jointed areas. Waves have eroded along the intersection of two fault planes at Sea Lion Point, and have formed a large cave. This cave is inhabited by sea lions throughout most of the year. It is located about ten miles north of Florence in Lane County.
CHAPTER VI

HOW TO USE THE MANUAL

For The Teacher

The teacher may find this manual helpful if the material in it is used to enumerate specific examples in Oregon of the various geological terms encountered in science textbooks. It may be interesting to note that the Sahara Desert in Africa has large areas in which the wind has pushed the sand many miles in the form of sand dunes, however, it will probably be more interesting to the class to know that right here in Oregon there are fine examples of the work of the wind in our own coastal areas and in Central Oregon.

When new geological terms are to be used by the class, it may be advisable for the teacher to look in the word index of this manual to locate some Oregon occurrences.

The manual may be used as a reference book for classroom activities. In the state course of study it is suggested that in the sixth grade during the study of unit two, "What Do The Rocks Tell Us About Plants And Animals?" (45, p. 49), a field trip to a fossil bearing area should be taken if possible. The chapter entitled Fossils in this manual is devoted primarily to the description of
fossil localities that are close to roads and have produced large numbers of fossils. In using this manual as a basis for information concerning a field trip, it would be advisable to preview the field trip and actually visit the area yourself before taking a group into the field. Some fossil localities are only small banks on the sides of roads, and might easily be overlooked. Many of the sedimentary beds are covered by a few inches of soil which must be scraped off to expose the fresh, fossil bearing beds below. In unit eight, "How Is The Earth's Surface Changed," in grade six (45, p. 57) there is an opportunity to use this manual to good advantage. This unit deals with rocks, minerals, and soils. The sections of this manual dealing with rocks and minerals give a brief description of the rock or mineral and some characteristic property. Rocks are so abundant that a collection of them may be easily acquired, and would make an interesting project for the class. Mineral and rock sets may be secured from the State Department of Geology and Mineral Industries, 702 Woodlark Building, Portland 5, Oregon.

The chapter entitled Land Forms in this manual may be used as a reference during the construction of a relief map of Oregon for a class activity in unit two of the eighth grade (45, p. 76). When studying the surface features of Oregon, it may be of help to the pupils in the
class to point out specific examples of old age river valleys, fault scarps, folded mountains, etc. Examples of land forms and their localities may be found in chapter five of this manual.

A basic concept to be taught in grade nine is, "Rock Layers With Their Fossils Are Pages Of The Earth's History," (45, p. 88). There is no better method of developing this concept than to transport the class to an actual fossil locality; to let them do their "reading of the page" with a pick or shovel.

For The Junior Geologist

One of the most interesting types of hobbies is the collection of minerals and rocks. Some people in Oregon have transformed this hobby into a profitable business. The mineral localities mentioned in the manual may be used as a starting point from which the ambitious "rock hound" may secure mineral specimens for the building of a large collection.

If rocks are picked up in the field, they may be named with some degree of accuracy by consulting the table of rock classification in the rock section.

On hiking trips or motor trips wherever you may go you will be able to observe the topographic features of
the region. You will make yourself a more interesting travelling companion by being able to identify these forms, or to speculate on the manner in which they were formed.
"In order to describe exact localities, the state of Oregon has been divided into quadrangles, essentially six miles square, known as townships. This division of the land is based on measurements from a chosen principal meridian and a chosen standard parallel of latitude called a base line. The townships are further subdivided into 36 sections. The sides of sections are termed section lines. Townships are numbered beginning at the intersection of the base line and the principal meridian, and going East, West, North, and South. It is customary to designate these divisions as ranges East and West, and townships North and South. (The numbers indicating the township or range are generally found on the outside edge of the map in the middle of the range or township.) In Figure 1, the township marked A, consisting of 36 sections, is described as 'township 2 North, range 4 West' or 'T. 2 N., R. 4 W.' (This is the intersection of the two lines in the northeast corner of the township. The intersection of the principal meridian and the base line designates the shaded township, which is township 1 South, range 1 West, or T. 1 S., R. 1 W.)
Figure 1
Method of Designating Townships and Ranges

"Sections are numbered as shown in Figure 2. Parts of sections are described as in Figure 3. Since a section (square mile) consists normally of 640 acres a quarter section contains 160 acres, 1/2 of a quarter section contains 80 acres, etc.

Figure 2
Method of Numbering Sections Within a Township
"On account of the northward convergence of meridians, townships are not always exactly six miles across, nor are sections always just one mile wide. To compensate for this convergence, there is often a slight offset of section and township lines in adjoining townships where they meet along the range lines. In the surveying of sectionized land all excesses and deficiencies due to convergence are placed, as far as possible, in the northern and western quarter-sections of the township." (17, pp. 796-797)

The chosen principal meridian in Oregon is the Willamette Meridian, which runs north and south $3\frac{3}{4}$ miles west of Portland, and the base line is the Willamette Base line which runs through the middle of Portland. The spot where the land survey of Oregon was started (the intersection of the principal meridian and base line) was
chosen so that the original surveys of these two important lines would be below the Columbia River, and west of the Willamette in order to eliminate the need for setting any large part of the base line in water. If the base line had been run for any distance over the water, it would have been inaccessible to later surveyors. A stone marker now commemorates the spot where a cedar post was placed by the first Surveyor General of Oregon, J. B. Preston, to mark the place to which all land in Oregon has reference. (39).
APPENDIX B

GENERALIZED MINERAL LOCALITIES MAP

STATE OF OREGON

DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES

STATE OF OREGON

DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES
The map labeled Batholithic Intrusions is from a generalized map by Dr. Edwin T. Hodge, professor of geology at Oregon State College (21).

This map shows the general location of the batholiths (large intrusive masses of igneous rock with no observable floor or bottom) that occur in Oregon. In and around these areas are to be found all of the types of igneous rock described in this manual, and almost all of the metamorphic rocks of Oregon. It is interesting to note also that these areas supply most of the primary, metalliferous, mineral deposits in the state.
APPENDIX C

BATHOLITHIC INTRUSIONS
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