THE GEOLOGY OF THE MAURY MOUNTAIN REGION
CROOK COUNTY, OREGON

by

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A THESIS
submitted to the
OREGON STATE COLLEGE

in partial fulfillment of
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degree of

MASTER OF SCIENCE

June 1939
APPROVED:

Professor of Geology
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Field Work and Acknowledgments</td>
<td>1</td>
</tr>
<tr>
<td>Previous Work</td>
<td>2</td>
</tr>
<tr>
<td>Geography</td>
<td>4</td>
</tr>
<tr>
<td>Location and Size</td>
<td>4</td>
</tr>
<tr>
<td>Relief Features</td>
<td>4</td>
</tr>
<tr>
<td>Drainage</td>
<td>7</td>
</tr>
<tr>
<td>Climate</td>
<td>9</td>
</tr>
<tr>
<td>Flora and Fauna</td>
<td>10</td>
</tr>
<tr>
<td>Population</td>
<td>14</td>
</tr>
<tr>
<td>Industries</td>
<td>14</td>
</tr>
<tr>
<td>Roads and Trails</td>
<td>15</td>
</tr>
<tr>
<td>Geology</td>
<td>16</td>
</tr>
<tr>
<td>General Features</td>
<td>16</td>
</tr>
<tr>
<td>Tertiary Rocks</td>
<td>19</td>
</tr>
<tr>
<td>Clarno Formation</td>
<td>19</td>
</tr>
<tr>
<td>Distribution and Topographic Expression</td>
<td>19</td>
</tr>
<tr>
<td>Lithology</td>
<td>20</td>
</tr>
<tr>
<td>Thickness</td>
<td>23</td>
</tr>
<tr>
<td>Age and Stratigraphic Relations</td>
<td>24</td>
</tr>
<tr>
<td>John Day Formation</td>
<td>27</td>
</tr>
<tr>
<td>Distribution and Topographic Expression</td>
<td>27</td>
</tr>
<tr>
<td>Lithology</td>
<td>28</td>
</tr>
<tr>
<td>Thickness</td>
<td>32</td>
</tr>
<tr>
<td>Origin</td>
<td>32</td>
</tr>
<tr>
<td>Stratigraphic Relations</td>
<td>34</td>
</tr>
<tr>
<td>Age and Correlation</td>
<td>34</td>
</tr>
<tr>
<td>Columbia River Lavas</td>
<td>38</td>
</tr>
<tr>
<td>Distribution and Topographic Expression</td>
<td>38</td>
</tr>
<tr>
<td>Petrography</td>
<td>39</td>
</tr>
<tr>
<td>Thickness</td>
<td>43</td>
</tr>
<tr>
<td>Stratigraphic Relations</td>
<td>44</td>
</tr>
<tr>
<td>Mascall Formation</td>
<td>44</td>
</tr>
<tr>
<td>Distribution and Topographic Formation</td>
<td>44</td>
</tr>
<tr>
<td>Lithology</td>
<td>46</td>
</tr>
<tr>
<td>Thickness</td>
<td>48</td>
</tr>
<tr>
<td>Origin</td>
<td>51</td>
</tr>
<tr>
<td>Stratigraphic Relations and Age</td>
<td>51</td>
</tr>
<tr>
<td>Harney Formation</td>
<td>54</td>
</tr>
<tr>
<td>Distribution and Topographic Expression</td>
<td>54</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Plate 1</th>
<th>Index map showing location of Maury Mountain region</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate 2</td>
<td>View of north slope of Maury Mountains showing meanders in Crooked River Valley</td>
<td>8</td>
</tr>
<tr>
<td>Plate 3</td>
<td>Sketch map of Maury Mountain Mine</td>
<td>73</td>
</tr>
<tr>
<td>Plate 4</td>
<td>Geologic sketch map of the Maury Mountain region, Crook County, Oregon</td>
<td>76</td>
</tr>
<tr>
<td>Plate 5</td>
<td>Geologic structure sections</td>
<td>77</td>
</tr>
<tr>
<td>Table 1</td>
<td>Monthly and annual rainfall at Prineville, Oregon 1914-1931</td>
<td>11</td>
</tr>
<tr>
<td>Table 2</td>
<td>Formations of the Maury Mountain region</td>
<td>17</td>
</tr>
<tr>
<td>Table 3</td>
<td>List of fossil leaf species found at the Neidigger ranch</td>
<td>36</td>
</tr>
<tr>
<td>Table 4</td>
<td>Fossils found in Mascall formations of John Day and Crooked River Basins</td>
<td>53</td>
</tr>
<tr>
<td>Fig. 1</td>
<td>Photomicrographs of Clarno hypersthene olivine andesite</td>
<td>23a</td>
</tr>
<tr>
<td>Fig. 2</td>
<td>Photomicrographs of Clarno hypersthene olivine andesite</td>
<td>23a</td>
</tr>
<tr>
<td>Fig. 3</td>
<td>Typical exposure of upper John Day formation Tom Vane Creek</td>
<td>37</td>
</tr>
<tr>
<td>Fig. 4</td>
<td>Occurrence of John Day leaf shales at Neidigger ranch</td>
<td>37</td>
</tr>
<tr>
<td>Fig. 5</td>
<td>Photomicrograph of Columbia River olivine basalt</td>
<td>42</td>
</tr>
<tr>
<td>Fig. 6</td>
<td>Photomicrograph of Columbia River hypersthene andesite</td>
<td>42</td>
</tr>
<tr>
<td>Fig. 7</td>
<td>Section of Crooked River Mascall(?) formation disconformably overlain by Harney rhyolite</td>
<td>49</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Fig. 8</td>
<td>Close-up of Mascall(?) Harney contact in Fig. 7</td>
<td>49</td>
</tr>
<tr>
<td>Fig. 9</td>
<td>Outcrop of Mascall(?), same locality as Fig. 7 showing cross-bedding</td>
<td>50</td>
</tr>
<tr>
<td>Fig. 10</td>
<td>Close-up of Fig. 9</td>
<td>50</td>
</tr>
<tr>
<td>Fig. 11</td>
<td>Outcrop of Harney formation on Camp Creek, showing flat lying character of rim rock</td>
<td>59</td>
</tr>
<tr>
<td>Fig. 12</td>
<td>Contact between black, glassy perlitic rhyolite and overlying reddish-brown rhyolite</td>
<td>59</td>
</tr>
<tr>
<td>Fig. 13</td>
<td>Typical landslide topography on east side of Camp Creek in sec. 6 and 7, T. 17 S., R. 22 E.</td>
<td>66</td>
</tr>
</tbody>
</table>
INTRODUCTION

FIELD WORK AND ACKNOWLEDGMENTS

The field work upon which this report is based was done during the field seasons of 1937 and 1938 in connection with the general reconnaissance study of eastern Oregon carried on by the Oregon State College Geology Summer Camp. During the study of the adjacent Dayville quadrangle, in the summers of 1935, 1936 and 1937, the writer was fortunate enough to be included in the field parties. Many questions arose during the work on this quadrangle, the solution of which were dependent upon a knowledge of the regional geology, and as opportunity afforded, an attempt was made to contribute to this knowledge by a study of the Maury Mountain region.

The writer's attention was first directed to the possibilities of the region under discussion by Dr. W. D. Wilkinson, and an expression of gratitude is here offered him for having suggested such a profitable field of labor. The writer also wishes to thank Dr. E. L. Packard and Miss Jean Bowman, for their willing co-operation and assistance in determining the paleontologic material. Dr. Ethel I. Sandborn generously assisted in the determination of the John Day flora. To Dr. I. S. Allison, Dr. E. T. Hodge and Thomas O'Neill, for their valuable advise and
criticism, the writer expresses his appreciation. Much credit is due the members of the college summer camp for their able and energetic assistance during the earlier field work.

Hearty acknowledgment is here recorded for the aid rendered by the residents and national-forest officers, who freely furnished much valuable information and by whose generosity and thoughtfulness the work was materially furthered.

PREVIOUS WORK

Very little information is available on the Maury Mountain region. The first published record of exploration within this area is found in the letters of Rev. Thomas Condon. In 1864 Capt. John M. Drake took a cavalry regiment into central Oregon to quell an Indian uprising. This group went as far south as the Harney Valley. On their return trip they camped on Beaver Creek, a tributary of the Crooked River. The officers and men collected some marine fossils which were later identified by Condon as Trigonia and other Cretaceous forms. In 1865 or 1866 Condon made collections in the upper Crooked

River Valley and in reporting on this trip, remarked:

"I succeeded this trip in connecting the rocks of the Crooked River with those of the John Day extending over a strip of country 100 miles across. Three rocky systems I have found the same over this stretch of country."

Russell in his travels across southeastern Oregon, traversed the region of the South Fork of the Crooked River, including a reconnaissance of the Hampton and Logan Butte regions, and a traverse down Camp Creek to its junction with the Crooked River. With the exception of the Camp Creek traverse, his observations deal with the area several miles to the south of the region covered in this report.

In 1927, Chaney in his paleobotanical study of the Gray Ranch leaf locality, generalized on the geology of the Crooked River basin.

Hodge visited the region to the west of Post and in 1932 published his observations. This work did not include any comments on the geology of the Maury Mountain region.

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1/ Ibid. pp. 51.
Since the discovery of quicksilver in Crook county several short articles have appeared dealing mainly with the mines and prospects.

GEOGRAPHY

Location and Size. The Maury Mountain region, as described in this report, lies in middle-central Oregon in the eastern part of Crook County. The area represented by the geologic map covers about 400 square miles. It is bounded by longitude 120° and 120° 30' W., and latitude 44° and 44° 15' N.

The region may be reached from the west by a county road which leaves U. S. highway number 28 at Prineville. This improved road enters the area at Post, extends approximately east along the Crooked River to Paulina and eventually joins U. S. highway number 305 at Seneca. A system of forest roads, maintained in good condition during the summer, cross the region from north to south.

Relief Features. The most conspicuous topographic features of the region are the bordering mountainous zones. On the north the Ochoco Mountains, a westward extension of the Blue Mountains, form a geographical boundary and on the south the Maury Mountains bound the area. Ochoco Mountains: The Ochoco Mountains form the largest mountain mass in the region. In plan, the range as a
whole is roughly rectangular in shape, approximately 60 miles long and 30 miles wide. The mountains rise 1000 to 3000 feet above the more open country to the west and south. Much of this range lies between 4000 and 5000 feet above sea level. Prominent peaks are common and occur along the crest of the range which is some 6 miles to the north of the mapped area. Among these are, Spanish Peak, Mt. Pisgah and Lookout Mt., with elevations of 6885, 6790, and 6971 feet respectively.

The southern slopes are gentle with broad divides and streams of rather low gradient, suggesting a youthful topography. So gentle and uniform is this southward dipping slope that it has been interpreted by Buwalda as a remanent of an old erosion surface. Maury Mountains: The Maury Mountains form a somewhat more compact unit than the Ochoco Mountains. In plan, the range is roughly rectangular in shape, approximately 16 miles long and 6 miles wide. It ends in the south-central part of the region in the gentle sloping ridges of Arrowwood Point. The altitude of the summits increases from about 5000 feet in the east at Arrowwood Point to about 6050 feet in the west at Drake Butte.

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Index map showing location of Maury Mountain region, Oregon.
The southern slope of this drainage divide is essentially the same as the Ochoco group. The deeply dissected northern slope is contrastingly different, with short narrow canyons cut by the vigorous headward erosion of the streams. The general ruggedness, steep slopes and sharp divides suggest early maturity of the land forms.

The relief between the highest summits on Drake Butte (6050 feet) and the point where the Crooked River leaves the region (3340 feet) is about 2700 feet.

Drainage. All of the area included in this report drains westward to the Deschutes River through the Crooked River and its tributaries. The southern slope of the Maury Mountains is drained by tributaries of Bear Creek which in turn flows into the Crooked River some 15 miles south of Prineville.

The master stream, the Crooked River, flows westward through the middle of the region in a valley of probable early maturity. Its low water surface is approximately 3633 feet above sea level at the mouth of Beaver Creek, which is near the eastern edge of the region, and 3340 feet at Post, 28 miles downstream. The average gradient in this portion of the river is 10.4 feet to the mile. This gradient, though by no means uniform, is sufficient to keep the stream moving fairly rapidly, but not enough to keep it from meandering. As shown in plate 2, the
View of north slope of Maury Mountains showing meanders in Crooked River Valley.
river wanders aimlessly from one side of the valley to
the other.

The shape of the valley is controlled by the type of
rock in which it is formed. Where it is cut in the re-
sistant Columbia River lava, the valley is commonly nar-
row, V shaped, and without prominent terraces, but where
it is cut in the weak tuffs of the John Day and Clarno
formations the valley may be several miles wide with well-
defined terraces at several levels. Many of these ter-
races are 50 to 100 feet above river level. It is on
these erosional remnants that most of the tillable land is
found.

The tributary creeks of the region are entrenched to
a depth of 1000 feet below the remnants of the Ochoco
erosion surface (?), their valleys being typically V
shaped. Several contain remnants of alluvial terraces
50 to 200 feet above the creek level. The gradients of
the tributary creeks are 100 to 150 feet to the mile.

Climate. The climate of the Maury Mountain region
is semiarid and is characterized by hot, dry summers, and
cold, severe winters. At Prineville, during the period
1914 to 1931 the highest recorded temperature was 103°F.,
the lowest -35°F.

The average growing season or period free from
killing frosts is 100 days, from June 1 to September 10.
These dates vary from year to year. In 1914 the frost-free period of 96 days ranged from June 21 to September 27. In 1936 the 90 day frost-free period began on June 24 and ended September 24.

As shown in the table, the average rainfall during the period 1914 to 1931, is 7.83 inches. August is generally the driest month, and the first 6 months are usually the wettest. From late June to late August or early September much of the precipitation falls in brief, heavy showers accompanied by electrical storms of varied intensity. During this period storms of several days' duration are rare.

There is a marked local variation in precipitation depending on the altitude and on the amount of protection from the moisture-laden winds coming from the west and southwest. At the higher altitudes snow may fall at any time of the year, and from September to May, much of the precipitation is in that form.

Flora and Fauna. The vegetation varies with the altitude. Below 4000 feet there are few trees, the growth consisting mostly of grasses, herbaceous plants, sagebrush

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and other low shrubs. Although the vegetation is of the semiarid type, it has a distinctive beauty. Grasses spring up after the rains, and in the spring wild flowers of brilliant and varied colors are abundant.

On the mountains sugar-pine and yellow-pine are the chief trees. Fir and tamarack are rare and occur only in moist ravines on the northern slopes. Impenetrable growths of mountain mahogany are common on the sparcer timbered slopes between 4000 and 5000 feet elevation.

The mammals of the region include mule deer, bear, coyotes, beaver, porcupine, various kinds of rodents including ground and tree squirrels, cottontail and jack rabbits, badgers, and several species of rats and mice. The mule deer are the principal attraction for hunters.

**Population.** There are no large towns in the Maury Mountain region. The settlement of Post comprises a few dozen people. The remainder of the population is located on scattered farms along the Crooked River. No census figures are available, but it is significant to note that the average population of Crook county per square mile is 1.1 persons.

**Industries.** The chief industries are farming, stock raising, lumbering and mining.

Sheep and cattle are raised in great numbers commonly from 1,000 to 2,000 to a herd. The usual practice is to
graze them in the higher forested areas during the summer months. Because of heavy snows, grazing at these altitudes during the winter is impossible. Meadow hay for stock feed is the largest agricultural product, but a few other crops are raised.

Lumbering is second to cattle in importance in the region. Although most of the pine timber cut in the area is chiefly for local consumption, large lumbering operations are carried on elsewhere in the Ochoco Mountains. The Ochoco forest supports over five billion board feet of ponderosa pine. This body of virgin timber now being harvested on a sustained yield basis plays an important part in the economic and social life of Prineville. This town maintains two large mills and is one of the principal pine timber export points in eastern Oregon.

The only important mining product is mercury, although some gold, silver, and chromite have been reported in minor amounts.

Roads and Trails. An improved county market road enters the area at Post, and follows the Crooked River eastward to Izee. The higher mountains and rougher country are in the national forest. The Forest Service has built excellent roads and trails so that most of the area is accessible by some means of transportation. There are many roads to ranches, and sawmills, which do not
appear on the maps and are known only locally. Much of
the country, however, is inaccessible to automobile and
one who is not familiar with difficulties of automobile
travel in rough desert country should confine himself to
the main roads or to roads of which he has reliable in-
formation.

Prevailing weather conditions have a marked affect
on all of the roads in the region, and during many months
in the winter they are passable only with extreme dif-
ficulty.

GEOLOGY

General Features. The rocks of the Maury Mountain
region present a complete Tertiary sequence of slightly
folded lavas and soft sediments. The Quaternary deposits
include terrace gravels and valley alluvium.

Table 2 presents a generalized section showing the
sequence and character of the Tertiary and Quaternary
rocks of the area.

The Clarno and John Day formations are exposed be-
neath the Columbia River lava in the western half of the
area.

The Columbia River lava is the most extensive forma-
tion, covering much of the higher plateaus and ridges.
It is reasonably certain that the erosion which produced
<table>
<thead>
<tr>
<th>Age</th>
<th>Formations</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent</td>
<td>Valley alluvium</td>
<td></td>
</tr>
<tr>
<td>Pleistocene</td>
<td>Madras lavas</td>
<td>Andesites and basalts</td>
</tr>
<tr>
<td></td>
<td>Disconform-</td>
<td>Unnamed andesitic lavas of questionable age.</td>
</tr>
<tr>
<td></td>
<td>Pliocene</td>
<td>Reddish tuff beds with pumaceous rhyolite flow.</td>
</tr>
<tr>
<td></td>
<td>Harney</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disconform-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mascal (?)</td>
<td>Yellow and white tuffs and ash beds.</td>
</tr>
<tr>
<td>Miocene</td>
<td>Nonconform-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Columbia</td>
<td>Hard, flinty, fine-grained flows.</td>
</tr>
<tr>
<td></td>
<td>lavas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonconform-</td>
<td>Columnar jointed</td>
</tr>
<tr>
<td></td>
<td>Oligocene</td>
<td>Brilliantly colored tuffaceous sediments with interbedded rhyolite flows.</td>
</tr>
<tr>
<td></td>
<td>John Day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonconform-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clarno beds</td>
<td>Silicified tuffs, with rhyolite and basalts.</td>
</tr>
<tr>
<td>Eocene</td>
<td>Nonconform-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Probable</td>
<td>Slightly indurated torrential gravels.</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crooked</td>
<td></td>
</tr>
<tr>
<td></td>
<td>River canyon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 miles west</td>
<td></td>
</tr>
</tbody>
</table>

1/ Chaney, R. W., op. cit., pp. 51.
the present topography was largely controlled by these resistant Miocene lavas.

The Mascal (?) formation consists of fluviatile material that accumulated in structural basins formed in the Columbia River lava, and overlies these lavas non-conformably.

Disconformably above the Mascal formation is the questionable Harney rhyolite which is lithologically similar to the Rattlesnake formation of the John Day Basin. No fossils have been found in this formation, making an accurate correlation impossible. Both the Harney and the Mascal (?) formations occur in the eastern half of the region.

A series of unnamed andesitic flows of fairly recent origin occur at Arrow Wood Point and at Roba's Ranch in the northeastern corner of the area.

A very small portion of the Madras formation occurs along the western edge of the area in the vicinity of Post. This formation forms a flat-lying rimrock capping the Clarno formation. This rim has been mapped by Hodge as the Madras formation and in order to simplify field procedure, it was mapped as such in this area.

**Tertiary Rocks.**

**Clarno Formation.**

**Distribution and topographic expression.**

The oldest known formation encountered in the region is a chaotic series of rocks dominately volcanic in origin, designated the Clarno formation because of the lithologic similarity to the type locality at Clarno's Ferry named by J. C. Merriam in 1901. Rocks of this formation occupy an area of approximately 90 square miles; extend from the mouth of Lost Creek in a north-westerly direction, to Horse Heaven Creek, and from there northward into the Mitchell Quadrangle. The western half of the Maury Mountains is composed entirely of Clarno lavas with little or no tuff beds. The Crooked River valley is entrenched in the Clarno formation from the mouth of Lost Creek westward.

The problem of distinguishing between the ash and tuffs of the Clarno formation and the very similar John Day series is extremely difficult. Where the lavas predominate, the topography is exceptionally rugged and the formation can be readily determined. When the ash and

tuff beds occur alone, the topography in contrastingly different, with rounded hills and gullied slopes. The presence of fossils simplifies the problem somewhat, but their absence places the determination entirely upon stratigraphic correlation.

**Lithology.**

The Clarno formation of the Maury Mountain region is essentially a volcanic formation. It is composed of clastic tuffs and agglomerates, of varied texture, and massive, coarse-grained lavas.

Due to the confused arrangement of the beds of this formation it is impossible to describe in detail the characteristics of its component parts over a wide area. The following section, however, is considered to be essentially representative of this formation.

Partial section of the Clarno formation on the Crooked River road, 3 miles east of Post in the W.1/2, sec. 15, T. 17 S., R. 19 E.

(Beds horizontal; base of section about 3375 feet above sea level.) Oligocene

John Day formation, top of section.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Rhyolitic tuff, dark reddish-brown, containing pumice fragments</td>
<td>50</td>
</tr>
<tr>
<td>4.</td>
<td>Hypersthene olivene andesite, dark olive green containing striated feldspar phenocrysts</td>
<td>330</td>
</tr>
</tbody>
</table>
The most abundant igneous rock of this formation in the Maury Mountain area is the hypersthene olivine andesite. For this reason, its microscopical characters were studied at great length. **Hypersthene olivine andesite:**

The representative specimens of this type of lava were collected on the western flanks of Maury Mountain and at the mouth of Lost Creek.

Macroscopically, the specimen from Lost Creek has a compact grayish to olive-green color with abundant, small white phenocrysts of feldspar, sometimes stained a bright red by iron oxide. Smaller crystals of greenish-black pyroxene may be detected on close examination.

In thin section, the phenocrysts prove to be plagioclase, rhombic and monoclinic pyroxene, and olivene. Magnetite occurs in subhedral crystals. These minerals occur in a holocrystalline, trachyitic groundmass of small olivene crystals and twinned, lath-shaped microlites of acid andesine.

The feldspar phenocrysts exhibit typical albite twinning. The extinction angles on twinned crystals measure
22 and 21 degrees, corresponding to the extinction angles of an intermediate andesine. A great number of the phenocrysts are broken and irregular, suggesting a deformation of crystals formed previous to eruption. The feldspars are partially altered to sericite along the cleavage cracks.

Light greenish hypersthene, showing distinct pleochroism is fairly abundant. It occurs in short, prismatic crystals with parallel extinction and high relief. Some of the crystals exhibit schiller inclusions of magnetite.

Augite, very feebly pleochroic, with extinction angles of 45 degrees occurs in bold, idiomorphic crystals, octagonal in cross section. Twinning on the orthopinacoid face is common.

Olivene occurs both among the phenocrysts and in the groundmass. This mineral has been spoken of as extremely rare in andesites by many writers. Its presence in rocks has been at times considered sufficient determinative evidence to distinguish magmas of basaltic origin.

Johannsen in discussing the presence of olivene in andesitic rocks says:

"If andesites and basalts are separated entirely on the basis of the kind of plagioclase present, then olivene is not uncommon among the more basic andesine andesites."

The alteration of the olivene is a prominent characteristic in the Clarno lavas of this type. The process of decomposition begins at the surface and extends along the cleavage and fracture lines towards the vertical axis of the crystals. Almost every crystal has been altered and the replacement of the original crystal in many cases has been complete. The final product is a lamellar pseudomorph with essentially the same orientation as the original crystal. By ordinary transmitted light the mineral is a deep reddish-brown, exhibiting distinct pleochroism. These properties correspond with those of Iddingsite.

The groundmass is holocrystalline, consisting of small, lath-shaped crystals of acid andesine, arranged in flow lines in a trachyitic texture. Scattered between these microlites of the groundmass are small crystals of olivene, augite and magnetite.

**Thickness.**

The original thickness of the Clarno formation in this area is not definitely known since it is everywhere unconformably overlain by the John Day beds.

A review of the available literature shows that there is considerable variation in the thickness of this formation. These variations in thickness are due to the fact that the Clarno formation was eroded into prominent hills and valleys before deposition of the John Day beds.
Fig. 1. Photomicrograph of Clarno hypersthene olivene andesite. West slope Drake Butte. X45.

Fig. 2. Photomicrograph of Clarno hypsersthene olivene andesite. Hammer Creek. X45.
Contradictory figures for the thickness of this formation may also be due to the heterogeneous arrangement of the beds. It has been the writer's experience to find that the Clarno formation has suffered considerable faulting and folding in some areas while in others it is comparatively undisturbed.

The maximum thickness observed at the measured section 3 miles east of Post in NW. 1/4 sec. 28, T. 16 S., R. 19 E. was 850 feet. This figure is considerably smaller than the one given by Chaney in which he states the thickness to be at least 1000 and perhaps 1500 feet. The writer was unable to find any section which exceeded 850 feet in thickness. The thickness of the Clarno type section at Clarno's Ferry is quoted by Merriam as not less than 400 feet.

Age and stratigraphic relations.

No diagnostic fossils were found in the Clarno formation during the course of the field work. A number of opalized tree stumps 3 feet in diameter, however, were found at the above measured section 3 miles east of Post.


Although a careful search was made for leaf remains at this outcrop, none were found.

At the Riverside Ranch approximately 3 miles west of the region under discussion, Chaney has found a meager, poorly preserved flora in a tuff near the base of the Clarno formation. He gives the following section:

- 8 to 12 feet, basaltic agglomerate in a coarse grayish-brown tufaceous matrix.
- 7 feet, coarsely bedded grayish-brown tuff with some basalt fragments.
- 3 inches, fine grained ashy tuff containing leaf impressions.
- 10 feet, coarse grayish-brown tuff with some basaltic fragments.
- 25 to 29 feet

The composition of the incomplete flora is as follows:

- Pinus(?) that appears to be pine of the 5 needle type. Quercus furcinervis americans Kn. Sassafras sp. Several large leaves of a species apparently new. Platanus cf. nobilis Newb. Large leaves may be referable to this species. Rhamnus oleburni Lesq.

Chaney says of this flora:

"Enough material has been secured to indicate that it is closely related to flora of the Clarno formation from Cherry Creek and Clarno's Ferry in the John Day Basin."

The Clarno formation of the Riverside Ranch can be traced eastward, thus giving a definite clue to the character of the formation in the Maury Mountain region.
Hodge has traced the Clarno of the type section at Clarno's Ferry south to the Crooked River valley at Post, confirming the existence of the Clarno formation in the Maury Mountain area and its similarity to the type section in the John Day Basin.

The base of the Clarno formation was not found within the area mapped, but it does occur about three miles west of Post, where it unconformably overlies a series of gravels of questionable Cretaceous age. On the basis of lithology these gravels are very similar to the Cretaceous sediments underlying the Clarno formation at Mitchell. Because the outcrop is limited and contains no fossils, it is only possible at this time to assume that these gravels are Cretaceous and not merely another member of the Clarno formation.

The unconformity separating the Clarno formation from younger rocks, of either John Day beds or Columbia lavas, is a pronounced stratigraphic break. It is difficult in the field however, to find this contact between the Clarno and the John Day beds as it is almost always obscured by erosion and slumping. When the Clarno is not regularly overlain by the John Day series, it is capped by

Columbia lavas.

**John Day Formation.**

**Distribution and topographic expression.**

Exposures of the John Day formation which cover an area of approximately 20 square mile are restricted almost entirely to the central portion of the region along the Crooked River. The only exceptions are the outcrops along Parish and Bear Creeks on the southern flanks of the Maury Mountains. A small patch of John Day containing only the lower red beds and the upper cream-colored tuffs with a rhyolite capping occurs near the top of the Clarno section 3 miles east of Post. At this point the middle John Day is missing. An isolated patch of lower John Day occurs on the Pine Creek road in the S. ½ sec. 24, T. 17 S., R. 19 E. No John Day beds have been found East of the North Fork of the Crooked River in this area.

Erosion produces a topography characterized by rounded, mud-covered hills in the Lower John Day. "Hoodoo and organ-pipe" forms are present in the bad-land structure of the middle division. This formation, like the Clarno formation, is noted for its brilliant and varied colors.

The name "John Day" is that given by Merriam to

---

rocks of similar age and lithology in the John Day valley some 75 or 80 miles to the north.

**Lithology.**

The John Day beds are composed almost exclusively of volcanic ash and tuffs. Locally thin rhyolitic flows, insignificant in volume, lie on top of the series. The rocks are porous and low in specific gravity. The harsh, gritty texture of the hand specimen signifies the angularity of the constituent fragments. In the coarse-grained specimens, the pumice shards, glass fibers, and feldspar fragments are easily recognized, indicating the tuffaceous character of the rocks. **Rocks of the lower John Day:** The lower "red beds" are most commonly tuffaceous shales occasionally alternating with buff or white ash. Macroscopically the hand specimens show angular and elongated crystals of feldspar which are remarkably fresh. The groundmass when dampened with water can be reduced to a clay paste. For this reason it was difficult to prepare suitable thin sections for microscopic examination. A few, rather poor sections were prepared by baking the fragments in balsam prior to grinding.

The tuffaceous structure becomes apparent under the microscope. Most of the rock consists of cellular devitrified glass and bubble fragments. Much of the ground-
mass has suffered kaolinization. The feldspar laths show characteristic albite twinning and have extinction angles of acid oligoclase. They are scattered in minor amounts throughout the kaolinized groundmass. Grains of quartz, augite and magnetite occur in very small amounts. The magnetite has been altered to hematite, which accounts for much of the red coloration of the beds.

It is difficult to accurately classify this specimen due to its decomposed state, but the presence of the acid plagioclase and the rareity of quartz indicates a tuff of andesitic nature.

Fragments of gypsum, locally abundant, are found in the wash from the gullied slopes. Thin layers of a black to grayish-black, earthy, manganese dioxide with fragments of plagioclase form conspicuous black bands a few inches thick. Similar black layers are found in the lower John Day beds at Bridge Creek in the John Day Basin.

Dense, fine-grained white to gray siliceous shales containing a fossil flora occur near the base of the beds. These shales, which range in thickness from 2 to 10 feet, are more resistant than the ash beds, and form prominent hills and ridges. An analysis of a leaf shale
specimen found in Chaney's Gray ranch locality is quoted here because of its lithologic similarity to the John Day shales of the Maury Mountain region.

"The shale is made up of microcrystals of sanadine feldspar up to 0.03 millimeters in diameter and volcanic glass fragments varying in diameter from 0.005 to 0.23 millimeters, with 95% of the grains below 0.02 millimeter; the larger grains, 0.05 to 0.23 millimeter in diameter, are commonly stringy and bubbly, with fine appendages. This material is firmly cemented by a hydrous silica mixed with exceedingly fine, pumice-like material. The laminated character of the shale and the fine appendages on the larger glass fragments may both be taken as indicating its deposition in quiet water."

Rocks of the Middle John Day: The rocks of the middle division are dense, fine-grained, resistant blue-green tuffs interbedded with light green to drab loosely compacted ash beds.

A typical hand specimen of this division exhibits a surface harsh and gritty to touch. White ash and feldspar fragments can be detected. The rocks are considerably fresher and more resistant than the lower "red beds". They fracture sub-conchoidally when broken.

Microscopically the rock consists of feldspars

showing albite twinning. Extinction angles correspond with those of basic andesine. Small amounts of augite, magnetite and apatite are present.

The bulk of the rock is composed of devitrified glass fibers, bubble walls, and pumice shards, showing aggregate polarization under crossed nicols.

The green material that gives the rock its characteristic color occurs as cloudy masses in the devitrified glass. It is difficult to obtain definite optical properties save that the mineral is light green in color and, at times, shows a faint pleochroism. The material is so finely dispersed throughout the rock that it generally appears isotropic under crossed nicols. This green coloration may be due to ferrous iron since a powered portion of the specimen when heated in an open tube changes to a brick-red color.

The lack of quartz and the presence of the acid plagioclase indicates the andesitic nature of this specimen. Rocks of the Upper John Day: The material forming the main part of the Upper John Day consists of buff to cream-colored, ashy, tuffaceous deposits. Petrographically the rocks are very similar to the blue-green tuffs of the middle division.

Under the microscope, the vesicular, angular glass fragments, somewhat devitrified, constitute the main
portion of the rock. Laths of andesine showing albite
twinning are distributed throughout the groundmass, as
are small quantities of augite, magnetite and apatite.
Some secondary calcite occurs as filling in the vesicular
glass.

The tuffs of the Upper John Day as well as those of
the Middle division are of andesitic origin.

Thickne

The thickness of the John Day formation varies consid-
erably over the area; the total thickness probably not
exceeding 3000 feet. The Lower red beds are approximately
1500 feet thick; the Middle division is relatively thin
with a maximum thickness of 300 feet. The Upper beds are
well represented with at least 2000 feet present.

The variations in thickness at different localities
is due, for the most part, to post Oligocene erosion.

At Logan Butte, 4 miles south of the southern
boundary of the area, the total thickness of the John
Day beds is given by Osmont \(^1\) at approximately 3000 to
4000 feet.

Origin.

The John Day formation is composed almost entirely
of volcanic ash which appears to have accumulated locally
under lacustrine conditions, but, in general, is of
aeolian origin. The source of the volcanic ash of this

\(^1\) Osmont, V. C., Univ. Calif. Bul. Dept. Geol., Vol. 2,
no. 9, pp. 285, 1901.
formation is unknown. It might well have come from the south in the vicinity of Logan Butte where there exists a great thickness of these beds.

Lacustrine conditions probably prevailed at least in part of the Lower John Day time for in the vicinity of Niedigger's Ranch there is a large accumulation of fossil leaves. The mineral fragments of these leaf bearing shales do not appear to have suffered much from working over, hence they were probably deposited by pyroclastic showers in quiet water.

The lowermost portions of the Lower division are non-fossiliferous and contain much sandy material. It is entirely possible that these beds represent reworked Clarno tuffs which have accumulated from the erosion of the nearby Clarno hills. There are no gravels in these reworked beds, and their similarity to the present day accumulations in streams draining Clarno slopes, would indicate that gravels should be lacking, because the recent deposits consist only of sands and muds.

The deposits of the Middle and Upper John Day beds accumulated under different conditions. The streams and lakes that existed during Lower John Day time disappeared for the most part, and deposition took place under more arid conditions. Great showers of pyroclastic material
accumulated over the area at irregular intervals. Between these intervals when perhaps only small quantities of volcanic ash were falling, the region was inhabited by mammals which browsed on the grasses growing on these Upper Oligocene plains. Deposits of fluviatile origin are locally common, but not as prevalent as in the Lower division.

**Stratigraphic Relations.**

Unconformities within the John Day beds may be and likely are present, but they have long since been obscured by the slump and wash from the easily eroded slopes.

The base of the John Day beds is separated from the underlying Clarno formation by an unconformity which is easily detected when not obscured by the products of erosion. A minor unconformity separates the Upper John Day from the overlying Columbia River lava.

**Age and Correlation.**

Collections of Upper John Day vertebrate material made at several localities on Tom Vane Creek in secs. 12 and 13, T. 17 S., R. 20 E. have been examined by Miss Jean Bowman. Her identifications are as follows:

- Turtle
  - *Stylemys*, sp. indet.

A portion of the plastron, showing the anterior lip of the inguinal notch (inguinal
scute) for the left leg, including the posterior portion of the abdominal scute and the lip edge of the femoral scute.

Mammals

Small camelid or oredont. Fragments of teeth belonging evidently to a small camelid.

Notocyona (cf) latidens (Cope)
Fragment of the right lower jaw bone including the molar (M₁) and a portion of the premolar (P₄). Possibly a small canine should be included.

Dinohyus (?)
One molar, a crown of a premolar and several fragments of teeth of a large Enteledont.

Hypertragulus, sp. indet.
Several lower jaw fragments with well preserved cheek teeth.

Also numerous fragments of indeterminable teeth, joints, bones, and turtle materials were included in this collection.

Table 3 contains a list of fossil leaf species found in the Lower John Day shales at the Neidigger Ranch. This list, although incomplete, compares favorably with the Gray Ranch and Bridge Creek collections, placing the age of the Neidigger leaf shales at


2/ Chaney, R. W., op. cit. pp. 78.

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quercus clarnensis</td>
</tr>
<tr>
<td>Typha lesquereuxi</td>
</tr>
<tr>
<td>Alnus carpinoides</td>
</tr>
<tr>
<td>Sequoia langsdorfii</td>
</tr>
<tr>
<td>Ulmus brownellii</td>
</tr>
<tr>
<td>Carpinus grandis</td>
</tr>
<tr>
<td>Plananus aspera</td>
</tr>
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<td>Ostrya oregoniana</td>
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<tr>
<td>Myrica diforme</td>
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<td>Salix californica</td>
</tr>
<tr>
<td>Quercus consimilis</td>
</tr>
<tr>
<td>Rosa hilliae</td>
</tr>
<tr>
<td>Crataegus newberryi</td>
</tr>
<tr>
<td>Corylus macquarrii</td>
</tr>
</tbody>
</table>
Fig. 3. Typical exposure of Upper John Day formation, Tom Vane Creek.

Fig. 4. Occurrence of John Day leaf shales at Neidigger Ranch.
Middle Oligocene.

**Columbia River Lavas.**

**Distribution and topographic expression.**

One of the most extensive geological formations in Oregon is the Columbia River lava. Igneous rocks of the same age, character and mode of origin cover large parts of Washington, Oregon, northern California and western Idaho. In the Maury Mountain region this lava covers an area of about 120 square miles.

The Columbia River lava makes a gently southeastward-tilted plateau in the northern part of the area, extending from Horse Heaven Creek on the west to Rabbit Valley and Roba Ranch on the east. The main portion of the Maury Mountains which includes Drake Butte and Tower Point is composed of rocks of this formation. Camp Creek and the South Fork of the Crooked River flow in valleys entrenched in this formation. In all probability, at the time of the extrusion of these lavas, they extended over nearly if not all of the region discussed in this report.

The Columbia River lava is more resistant to erosion than any other formation in the area and hence exerts a profound influence upon the topography. Many of the prominent physiographic landmarks are composed of this formation, namely Gerow Butte, Lookout Mountain, Lutsy Point,

**Petrography.**

The Columbia River lava is composed of many flows, ranging from 20 to 80 feet in thickness. Generally the flows are separated by red scoriaceous zones at the top and bottom.

The structural features of the lava as observed in the field are similar to most basaltic formations. The pronounced columnar structure is present in both dykes and flows.

There are two principal varieties of lava in this series—olivine basalt and hypersthene andesite.

The olivine basalt, which constitutes 80 percent of the flows, is a dark gray to gray-black dense rock with or without phenocrysts of olivine in an aphanitic, finely vesicular to dense groundmass. The differences in the conditions of cooling of each of the flows have given rise to a textural diversity, the extremes of which grade gradually into each other. One extreme is a dense, flinty basalt with a glassy base, and the other is a holocrystalline rock with ophitic to granular texture. Mineralogically, these various flows are remarkably similar.
In thin section, the essential minerals in order of abundance, are calcic labradorite, augite and olivene. Magnetite and apatite occur as accessory minerals in varying amounts. Glass containing fine, dust-like fragments of magnetite forms an essential part of a large majority of the specimens. It gives the lustrous black color to the rock. The secondary minerals are, chlorite, which occurs as a dark-green stain surrounding the augite, and hematite found along the weathered edges of the rocks.

The plagioclases occur in two sizes and hence two generations, the first being more basic than the second. The larger crystals are tabular and appear as rectangles in thin section. Albite twinning is common. Extinction angles measured normal to the 010 face range from 34 to 38 degrees. Inclusions of clouded glass and magnetite are prevalent in the large feldspars. The second generation plagioclases occur as elongated, lath-shaped microlites in the glassy varieties; in the holocrystalline rocks they are lath-shaped as well as skeletal and irregular forms filling the interstices between the microlites. Albite twinning parallel to the elongation is present in the laths and in some of the skeletal forms. Inclusions are absent in the smaller feldspars.

The augite is of the light-green variety, non-
pleochroic, showing second order birefringence and positive character. In the hypocrystalline rocks, the augite occurs in two generations. The first generation occurs as prismatic, euhedral and subhedral phenocrysts with inclusions of magnetite. The edges of these larger crystals are altered to chlorite. The second generation augite is less euhedral, unaltered and is free from inclusions.

Olivene in euhedral to sub-hedral and rounded crystals occurs in minor amounts. The crystals are rarely large enough to be macroscopically prominent. As a rule the olivene is altered and at times entirely replaced by a lamellar, deep reddish brown, slightly pleochroic mineral, resembling iddingsite.

Magnetite occurs in variable quantity, sometimes exceeding the olivene in amount. In the glassy basalts it is thoroughly disseminated throughout the groundmass in fine, dust-like particles. In the more crystalline basalts it is in subhedral, square grains.

Elongated, hexagonal prisms of apatite are scattered through the groundmass in lesser amounts, never exceeding 5%. It is usually quite fresh.

The hypersthene andesite is much less abundant than the olivene basalt. Macroscopically the rocks are very dark gray to black, extremely dense and glassy, and break
Fig. 5. Photomicrograph of Columbia River olivene basalt.

Fig. 6. Photomicrograph of Columbia River hypersthene andesite.
with a conchoidal fracture. The rocks are so fine-grained that it is impossible to identify any minerals in the hand specimen.

In thin section the rocks show a hyalopolitic texture of unoriented lath-like or needle-like crystals in a glassy base. The component minerals in order of abundance are glass, acid andesine, magnetite and hypersthene.

The plagioclases are elongated and twinned on the albite law; they occur as minute laths rarely more than 0.1 of a millimeter in length, distributed in the glassy groundmass.

Micro-phenocrysts of hypersthene in thin, stout prisms, show parallel extinction and marked pleochroism.

The magnetite is more abundant than the hypersthene and occurs as a fine dust in the glassy base.

**Thickness.**

It is not possible to state with any degree of certainty the original thickness of the formation since subsequent erosion has reduced it greatly. Considering the later erosion and the irregular surface upon which the Columbia River lava was extruded, it is apparent that the thickness of the formation varies widely from place to place. In the canyon of the North Fork of the Crooked River, the lavas exposed are about 1500 feet thick. Ten or twelve miles to the west there is only 50 feet of lava.
exposed capping the hills at Post. On the flanks of Maury Mountain probably 1500 feet is present.

**Stratigraphic Relations.**

The Columbia River lava is separated from the John Day formation by a slight unconformity. In some localities the bedding of the two are parallel, in others, the John Day beds show a gentle folding discordant with the lesser dips of the Columbia River lava. There is some evidence indicating that locally the uppermost John Day beds were eroded and in places removed prior to the eruption of the Columbia lava. The section of middle John Day on Tom Vane Creek in sec. 14, T. 17 S., R. 20 E. is capped by Columbia River lava denoting an intervening period of erosion.

Where the Columbia River lavas overlie the Clarno formation, the unconformity is conspicuous. The Clarno topography at the time of the outpouring of the fluid Columbia lava was one of prominent hills and valleys.

**Mascall Formation.**

**Distribution and topographic formation.**

The deposits to which the name "Shaw" formation is locally applied are found only in the middle-eastern part of the region, covering an area of approximately 10 square miles. Most of the outcrops are on one or the other side of the Crooked River, extending from the junc-
tion of its North Fork eastward into the Dayville quadrangle.

The "Shaw" formation was first described and named by Lupher. Its occurrence at Shaw Table in the Dayville quadrangle is considered the type locality.

For reasons which will be discussed fully in the following pages, the writer will hereafter refer to this formation as the Mascall(?) formation.

This formation is extremely soft and easily eroded. The characteristic light-yellowish to buff colored slopes are of such prominence to be visible for miles. Since this material is loosely consolidated, it rarely gives exposures adequate to demonstrate the continuity of the beds for any considerable distance. Determinations of thickness are exceedingly difficult for the same reason.

The Mascall formation was first described and named by Merriam for its occurrence at the Mascall Ranch, four miles west of Dayville and some 35 miles to the northeast of the outcrops of the Maury Mountain region.

1/ Lupher, R. L., Personal Communication, 1936.
Lithology.

The Mascall(?) formation consists of a heterogeneous series of semi-consolidated sandstones, conglomerates, fine-grained tuffaceous sandstone, fine-grained tuffs, sandy shales and locally, lenses of fine, light-blue ash. The many lithologic types interfinger and grade laterally into one another, so that no one section is in a strict sense representative of the whole. The sections that follow, however, indicate the general character of the formation.

Partial section of the Mascall(?) formation on Teeters Road in the N. E. 1/8 sec. 3, T.17 S., R. 21 E.

(Beds dip 4\(^{7}/_{8}\) N. 65 W.; base of measured section is about 3341 feet above sea level. No Columbia River lava exposed.)

Pliocene Harney formation, top of section

<table>
<thead>
<tr>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Vitric tuff, dark brown, massive, consisting of fragments of pumice and glass bubbles up to (\frac{1}{4}) inch in diameter in fine-grained matrix............</td>
</tr>
<tr>
<td>13. Vitric tuff, cream-colored, massive, composed of glass fibers, bubbles, and cellular pumice..</td>
</tr>
<tr>
<td>12. Volcanic ash, light-blue, massive, fine-grained, containing a few pumice fragments (\frac{1}{2}) inch in diameter and a small quantity of water worn obsidian pebbles..........................</td>
</tr>
<tr>
<td>11. Concealed; fine-grained, massive, cream-colored tuff in part.................................</td>
</tr>
<tr>
<td>10. Tuffaceous sandstone, light-gray, fine-grained, rudely crossbedded, composed largely of waterworn quartz grains less than .104 mm in diameter..........................</td>
</tr>
</tbody>
</table>
9. Tuffaceous sandstone, light-gray, fine-grained, varved laminae 1 to 2 mm. thick......................... 1/4

8. Concealed; in part, tuff, cream-colored, massive, fine-grained.......................... 103

7. Pebby sandstone, buff-colored, coarse-grained, friable, composed largely of quartz sand, obsidian, chert and quartzite pebbles................. 88

6. Tuff, cream-colored, massive, fine-grained....... 63

5. Sandstone, white to buff, coarse massive, friable, composed of waterworn quartz grains up to 3 mm. in diameter, grains of chert, quartzite, and opal also present............................. 54

4. Tuffaceous sandstone, cream-colored, massive, fine-grained.......................... 37

3. Volcanic ash, light-blue, massive, fine-grained, dominately glass fibers, bubble fragments and pumice shards........................................ 2

2. Concealed; in part, tuffaceous sandstone, white to cream, massive, fine-grained, composed of fresh irregular quartz grains, splinters of glass fibers and pumice shards..................... 119

1. Tuff, cream-colored, rudely bedded, contains black, scoriaceous slag inclusions 1 to 2 mm. thick.......................... 48

Base of slope and bottom of measured section

Thickness of measured section 740

Partial section of the Mascall(?) formation, 2 1/2 miles west of Fauling in N.E. 1/4 sec. 7, T. 17 S., R. 22 E.

(Beds horizontal; base of section about 3670 feet above sea level)

2. Tuff, massive, gray-white, contains pumice fragments 1 inch in diameter, obsidian pebbles, glass and bubble fragments..................... 34

1. Concealed.................................................. 20
Columbia River lava underlying Mascall(?) formation, bottom of measured section.

**Thickness of measured section**

Pebbles and gravels from conglomerate lenses in several horizons of this formation were examined but none seemed to be derived from the Columbia River lava. Most of the pebbles were quartzite, cherts, opal and chalcedony. It is possible that some of the lower conglomerate members contain basalt pebbles because of the time of deposition of the Mascall formation in this region, streams were actively eroding the Columbia River lava surface. Unfortunately, however, the Mascall (?) formation is so badly leached and oxidized that it is impossible to accurately identify most of the gravels. It is not uncommon to find highly decomposed gravels which can be readily cut with a pocket knife.

A few diatoms were found among the finer sediments but not in sufficient numbers to enable an accurate determination of species.

**Thickness.**

The original thickness of the Mascall(?) formation is not known, for it is everywhere unconformably overlain by lava. The maximum thickness observed was 775 feet in the N. E. ¼ sec. 3, R. 21 E., T. 17 S. The deposits de-
Fig. 7. Section of Crooked River Mascall(?) formation disconformably overlain by Harney rhyolites.

Fig. 8. Close-up of Mascall(?) - Harney contact in Fig. 7.
Fig. 9. Outcrop of Mascall(?), same locality as Fig. 7, showing cross-bedding.

Fig. 10. Close-up of Fig. 9.
crease in thickness to the east. A measured section in the N. E. ¼ sec. 7, R. 23 E., T. 17 S. shows a total thickness of 155 feet. Wilkinson has recorded thicknesses of 300 to 350 feet in the Mascall(?) formation of the Dayville quadrangle.

Origin.

The Mascall(?) formation is of lacustrine origin and was deposited in a structural basin in the Columbia River lava. This lake received detritus from the Crooked River and its tributaries. Much of the material came from as far east as the Suplee Paleozoic area, as evidenced by the abundance of chert and quartzite pebbles.

Deposition of these beds continued until the basin was entirely filled and the level of the river raised enabling it to pour over the western obstruction and continue its course.

Stratigraphic Relations and Age.

The Mascall(?) formation of the Maury Mountain region is separated from the underlying Columbia River lava by a structural nonconformity and from the overlying Pliocene rhyolites by a disconformity.

In discussing the Mascall(?) fauna of this area, the

1/ Wilkinson, W. D., Personal communication, 1938.
possibility of mixture with faunas of overlying sediments must be considered. The probability of transported vertebrate remains from the Pliocene Harney formation coming to rest on the mud-covered Mascall(?) slopes offers a serious paleontologic problem which makes an exact age determination of the Mascall(?) formation exceedingly difficult.

Teeth and single bones, most of which were detached from the matrix rock, comprise the greater part of the collections made in this area.

It is impossible to record systematic descriptions of these fossils, as they were taken from the writer several years ago and sent to California for accurate determination. Up to the time of writing, no report has been received concerning these forms.

Fortunately, in collecting the fossils, sufficient field notes were recorded which enabled the writer to compile a table comparing the fossils found in the Mascall(?) formation of this area with those recorded by Merriam and Sinclair as being included in the Mascall formation of the John Day Basin.

It is of interest to note that several specimens of *Merychippus isonesus* (Cope) were found in place in the Mascall(?) formation of the Dayville Quadrangle. This should constitute sufficient evidence for the correlation of the John Day Mascall and the Crooked River Mascall(?) formations since this particular specimen has never been found in any formations other than those of Middle Miocene.

In numerous references to the Mascall formation exposed in the John Day Basin, the age has generally been conceded to be Upper Miocene. The following statements would seem sufficient evidence for the acceptance of the Mascall(?) beds of the Crooked River Basin as Upper Miocene in age.

1. 60 percent of the Crooked River Mascall(?) fauna is found in the Mascall beds of the John Day Basin.

2. Several specimens of *Merychippus isonesus*, a Middle Miocene form, were found in place in this formation in the Crooked River Basin near Paulina.

3. On the basis of lithology, the Mascall formations of both the John Day and Crooked River Basins are strikingly similar.

**Harney Formation.**

**Distribution and topographic expression.**

The Harney formation is found only in the eastern and southeastern part of the region, covering an area of
approximately 35 square miles. It extends inter­
ruptedly along the entire eastern edge of the area; the western
boundary is the North Fork of the Crooked River. A con­siderable thickness of this formation occurs along Camp
Creek in the W ½ sec. 31, T. 17 S., R. 22 E. The major
portion of the divide between Camp Creek and the South
Fork of the Crooked River is composed of Harney rhyolites.

The name is taken from the Harney Basin in south­
eastern Oregon, where rocks of this age were described by

1/ Lupher.

The Harney formation in this area is essentially
flat-lying with little or no general dip in any direction,
forming prominent table lands and mesas. The mesas are
erosional remnents of widely extended sheet of rhyolitic
lava as evidenced by the same flat-lying table lands to
the South and East.

The surface of this formation is commonly covered
with flat, rhyolitic flagstones and a very limited soil,
capable of supporting only the sparsest of grasses.

Lithology.

The Harney formation usually presents two, well­
marked divisions with no distinct plane of separation

1/ Lupher, R. L., Personal communication, 1936.
between them. The upper portion of the flow is a massive, lithoidal rhyolite of brown to reddish-brown color, containing angular and plate-like fragments of pumice. At its base it passes abruptly into a more massive layer which appears to be black shale but on close examination, proves to be a black, extremely glassy rhyolite with perlitic structure.

A few small crystals of feldspar are the only minerals distinguishable by the unaided eye in the lithoidal rhyolite.

Microscopically, magnetite occurs in a few small grains, and rough prisms of spatite are distributed sparcely throughout the groundmass or are found as small inclusions in the feldspar. The quartz is developed only in the groundmass and occurs as a brownish red interstitial material. The feldspar phenocrysts show euhedral outlines and Carlsbad twinning, typical of orthoclase.

The black, glassy lava underlying the rhyolite, whose petrographical characters were just discussed, is a dense, aphanitic gray black rhyolite composed essentially of glass.

Very little information was gained by a microscopic examination of this rock. A few small grains of accessory magnetite and several phenocrysts of orthoclase showing Carlsbad twinning, were the only minerals iden-
tified. Magnetite dust distributed in the glassy ground gives the rock its dark color.

Both of the afore mentioned divisions of this formation are undoubtedly of the same age, as evidenced by the prominent columnar jointing which passes from one division to the other without change.

The striking contrast between these two divisions of the Harney formation is not easy to explain. Presumably the difference in structure of the upper division is original and due to some condition of eruption not active in the case of the glassy flow.

The absence of stratification and the fact that the plate-like fragments of pumice that enter into the composition of the upper part of this formation are standing on edge, are evidences that the tuff fell on land and is not a water laid deposit.

**Thickness.**

The Harney formation is most commonly 30 to 40 feet thick, but locally it may reach 200 feet as in the Camp Creek canyon in sec. 31, T. 17 S., R. 22 E. These variations in thickness are presumably the result of the irregular surface upon which the Harney rhyolites were deposited.

**Stratigraphic relations and age.**

The Harney formation disconformably overlies the
Fig. 11. Outcrop of Harney formation on Camp Creek, showing flat-lying character of rim-rock.

Fig. 12. Contact between black, glassy, perlitic rhyolite and overlying reddish-brown rhyolite.
Mascall(?) beds throughout most of the area. Occasionally it overlaps the Mascall(?) beds and lies directly on the Columbia River lava; at Logan Butte it caps a thick series of John Day tuffs.

Lithologically, the Harney formation closely resembles the Rattlesnake formation of the John Day Basin. Merriam and others have recognized this similarity, suggesting that the rhyolites of the Crooked River region may possibly be the same as the Rattlesnake formation. Both of these formations lie nearly horizontal with dips from 1 to 3 degrees to the south. They both exhibit columnar structures on the exposures and extend with notable uniformity over considerable areas.

Field evidence tends to support the assumption that the Harney rhyolite is in reality the Rattlesnake formation. The fossils collected have been examined by Dr. E. L. Packard, whose determinations are as follows: Pliohippus sp., Alticamelus sp., Teleoceras sp., Rodentia sp., Probiscidea, Rhinoceras sp. genus indet. All of these forms are common in the Rattlesnake formation.

The collections from the Harney formation are, for the most part, fragmentary and difficult to determine.

accurately. None of the specimens gathered are found in place. In view of this unfortunate situation, it is only possible at this time to infer the correlation of the Harney and Rattlesnake formations.

Proper field procedure condemns the correlation of formations on lithology alone but it appears to the writer that under existing conditions in this area, it would be more practical for future workers to consider the Harney formation as the Rattlesnake beds of late Pliocene age until field evidence proves otherwise.

Geologic literature is staggering under the confusion of thousands of local names for otherwise widespread formations.

Quaternary Alluvium. All the unconsolidated or slightly consolidated alluvial material in the region is termed Quaternary alluvium. This includes the deposits in the present stream channels, the flood plain deposits along the larger streams, such as those in the Crooked River valley, and the detritus on the terrace tops.

Because of the shifting character of the stream deposits, the thinness of some, and the small areal extent of many, no attempt was made to differentiate them in mapping. It would be quite impractical to show many of them on a map such as the one included in this report; which is intended primarily to indicate the distribution
of the bedrock formations.

The most extensive and thickest deposits of Quaternary alluvium rest on the Mascall(?) formation, and in places they can scarcely be distinguished from disintegration products of that formation.

The alluvial material ranges from coarse gravels containing large boulders in the stream headwaters to fine silts in parts of the flood plains. Some of it is composed of angular blocks of diverse sizes derived from near-by outcrops, and some is composed of sorted and rounded grains which have in the course of many years been carried far from their source in the swift torrents that fill the stream channels in response to seasonal rainfall. The material is irregularly bedded and variable, a characteristic of recent alluvial deposits. It rarely exceeds 20 feet, and in many places it is only a few feet thick. In parts of the Crooked River valley it is probably over 50 feet thick. There are wells in the valley as much as 50 feet deep and according to the owners, are still in unconsolidated alluvium.

The alluvial deposits just described are all younger than the Harney formation, so they are definitely post-Pliocene in age; some of them are in the process of formation at present. Thus some may be as old as Pleistocene and some are Recent, but all have been de-
posited in the Quaternary period.

**Structure.** In general, the structure of the Maury Mountain region is simple consisting in the main of open major folds and associated secondary folds and faults. It is somewhat difficult in places to trace the structure in detail, because horizon markers are wanting in most of the formations. In many places landslides and erosion have concealed some of the evidence, but enough is known to determine the major features of the structure, and many more details could be learned by longer and more thorough examination than it was possible to make during the present investigation.

**Rabbit Valley syncline:**

The major structural feature of the Maury Mountain area is the Rabbit Valley syncline, the axis of which strikes NE-SW. To the NW rise the Columbia lavas with dips of 4-6 degrees S 45°E to S. 20°E. The SE limb of the syncline has dips of 4-6 degrees N 45°W to N 60°W. At Rabbit Valley, the bottom of the syncline is about 3500 feet below the axis of the anticline that bounds it on the north west and 1000 feet below the anticline that bounds it on the south west. A continuation of this syncline has been noted by Wilkinson in the Dayville quadrangle.

1/ Wilkinson, W. D., Personal communication, 1938.
The syncline decreases in dimensions and becomes less prominent to the southwest.

**Secondary folds and faults.**

The most prominent secondary folds of the Maury Mountain region are two small anticlines to the south of the Rabbit Valley syncline. These two structural units are in reality a continuation of one another, their continuity being broken by the faulting along Beaver Creek some 4 miles southwest of Paulina. The anticline enters the area in sec. 6, T. 17 S., R. 23 E. and trends S 25 W for approximately 13 miles ending outside the area in the Headlands, a Columbia lava promontory 3 miles south of Arrowwood Point. The anticline is asymmetric, its southern flank dipping 6-9°8 40 E. and its northern flank about 4-8°N 50 W. See Plate 4.

The northern portion of this anticline is an extension of the Paulina Ridge anticline of the Dayville quadrangle and is thought by the writer to be a part of a major structural unit common to both the Dayville quadrangle and the Maury Mountain Region.

Faults are common in the Maury Mountain region. One of the largest is a normal fault that strikes N 40 E along the present course of the North Fork of the Crooked River. The vertical displacement becomes smaller to the northeast and eventually reaches zero at a point near the mouth
of Fox Canyon Creek. This fault can be traced southward to the mouth of the North Fork, but its continuation from that point is concealed by unconsolidated rocks and alluvium.

Another normal fault occurs in the eastern part of the area some 4 or 5 miles southwest of Paulina. This fault strikes E-W and is traceable for 3 miles in T. 17 S. R. 22 E. The south block is downthrown 100 to 150 feet. The displacement diminishes to the eastward, the fault disappearing somewhere in the vicinity of the USGS bench mark 2 miles southwest of Paulina.

Several secondary faults of small displacement occur at the Maury Mountain Mine. These are difficult to trace on the surface, but are clearly defined in the tunnels of the mine.

Landslide topography is prominent in many places, occurring for the most part in the eastern and southeastern parts of the area. Landslides are also present at many localities in the western part of the area especially in the weaker members of the John Day and Clarno formations. The most prominent examples of this structural phenomena is a scarp approximately a mile long trending N 40 W across sec. 6 and 7, T 17 S., R. 22 E. At this place a large portion of the rhyolitic Harney rimrock has slumped vertically about 100 feet. This slide and others are due
to the incompetence of the underlying Mascall(?) formation.

The landslides of this area occur adjacent to the creek valleys and are undoubtedly superficial features which do not affect the strata lying below the level of the streams.

Geologic History. The geologic history of this region may be inferred from the geologic facts and hypothesis discussed in the preceding sections. In this region, sufficient fossil evidence is available to warrant the assignment of most of the rock formations at least approximately to their proper places. Many of the events of geologic time in this region are known, and more will be inferred as facts regarding this and neighboring regions accumulate, but parts of the record will always remain a mystery.

The geologic record of the Maury Mountain region begins in the Eocene time. The land was elevated above sea level and received pyroclastic showers of ash, tuff, breccias, and fine clastic material which makes up the Clarno formation. These showers were intermittent and at times were replaced by flows of basalt and rhyolite. Very little evidence regarding the events of early Tertiary time has been found and the lack of fossils makes it impossible to date accurately such facts as are known.
Probably, in a broad way, the appearance of the topography was similar to that of today. There were numerous differences in topographic detail, but some of the major features of the topography were probably already in existence and the climatic conditions were probably sub-humid.

A cessation of volcanic activity at the end of the Eocene time brought to a close the deposition of the Clarno formation. A period of erosion followed in which this formation was sculptured into prominent hills and valleys. How long this erosional period existed is not definitely known but it was sufficiently long enough to develop a topography of early maturity.

In the Oligocene, or perhaps earlier, there was a renewal of igneous activity. Heavy showers of ash and tuffaceous material were deposited upon this mature topography. These showers were intermittent and at times very light. Rhyolitic lava flows supplanted the pyroclastic outbursts towards the end of the Oligocene period. Part of these tuffaceous showers settled in water and part on land. It is obvious that during extremely heavy showers of volcanic ejectamenta the land would be incapable of supporting life. However, at times of volcanic quiscence the land supported a flora similar to the redwood forested hills of northwest California and south—
western Oregon. This humid climate existed only during the early part of the Oligocene period. Evidence of increasing aridity is common in the upper portions of the John Day beds. Merriam and Sinclair have stated that the plains and forest types of mammals occur together in the Upper John Day beds. The plains were becoming wider, aridity was increasing, and the absence of fossil plants indicated that the forested areas were becoming more and more restricted. It is probable that the period of erosion intervening between the accumulation of the John Day pyroclastics and the eruption, in the Miocene time, of the Columbia River lava was of short duration, since in many places the Columbia lavas overlie the John Day beds with an apparent conformity.

The Miocene record is one of a long series of eruptions, presumably of the fissure type. The pre-Columbia lava drainage was entirely destroyed. These fluid lavas eventually covered all of the Maury Mountain region, and the topography was one of ridges of accumulated lava on the flanks of the fissures, with intervening valleys. These valleys were filled with lakes formed from the disruption of the post-Miocene drainage and the accumulation of yearly precipitation. Very little is

known of the life that existed in and around these lakes, since the fossil record is incomplete. A number of diatoms have been found in the sediments that filled these basins. These lake accumulations which constitute the Mascall(?) formation were deposited in late Miocene and early Pliocene time.

The next episode in the geologic history of this region followed a short period of erosion of the Mascall(?) beds. The degradation of these lake beds was interrupted by the penultimate stage of vulcanism in this area. Rhyolitic lava, ash and pumice, probably from vents near Arrowwood mountain were deposited upon the land. These volcanic extrusives reached a thickness of more than 200 feet near their presumed source but thinned away uniformly in all directions. They are called the Harney formation, lithologically of Pliocene age. These eruptions did not greatly disturb the established drainage pattern, as the flows were small in thickness and apparently covered only a small area in the southeastern part of the region.

Upon the land surface produced by the Harney, Mascall(?), and Columbia River lava, the streams performed their work of degradation. They were interrupted locally by structural movements such as the fault along the north side of Beaver Creek.
The history of the area since Pliocene time has been dominately one of erosion, save for the local eruptions of andesite during late Pliocene or early Pliostocene. These accumulations of highly viscous lava were from broad, flat local cones such as Arrowwood Point on the eastern end of the Maury Mountains. Several other cones of similar nature occur on the eastern boundary and in the extreme northeastern corner of the area. There is no way of definitively dating the age of these lavas. Lithologically they are post Harney in age. Judging from the soil mantle and the excellent forest growth, they must be late Pliocene or early Pliostocene in age.

Economic Geology—Mineral Resources. The only occurrence of a metallic ore within the area mapped is at the Maury Mountain Cinnabar Mine, located south east of Post on the Crooked River in Sec., 10, T. 17 S., R. 19 E. This mine was discovered in the summer of 1930 by Frank Towner and J. E. Staley, co-discoverer of a number of cinnabar prospects in the Ochoco region. Shortly after the discovery of the property the Maury Mountain Mining Company was formed, capitalized and financed through outside interests. This company installed a 4-hearth, 10 foot diameter Herreshoff retort in 1932. This plant produced only 50 flasks of quicksilver, after which it was sold to the Horse Heaven Mines of Ashwood, Oregon. In
1934 the company ceased operation, due partly to the decline in the price of quicksilver at that time and to the mining methods used which were on much too large a scale for the size and type of property.

Immediately after the failure, Fred C. and Herbert W. Eickemeyer, tunnel contractors for the old company took over the Staley claims and Frank Towner continued to work his claims. At the time of the writers visit to the property, Towner had ceased to work his property, and the only active mining was being carried on by the Eickemeyer brothers.

The ore occurs as a network of veins in a brecciated andesite of Clarno age. The veins can hardly be described as having any definite course; they are commonly small, branching, irregular stringers and impregnations. Locally the stringers tend to follow stronger controlling fissures and send out branches in all directions. They range in thickness from a knife-edge to about half an inch thick. The cinnabar is accompanied by quartz, chalcedony, calcite, and a hydrocarbon locally called "gilsonite."

The larger, older workings have been abandoned temporarily, and activity is confined to a new drift to the north east. This tunnel, begun in May 1938, is approximately 200 feet long and follows the north east-south
Sketch map of the Maury Mountain Mines

Scale 1" = 100 feet
Contour interval 10 feet.
west strike of the ore occurrence. This mineralized zone
dips south east and appears to be independent of the
occurrence at the older workings. Much rich and profit-
able high-grade ore has been removed from this tunnel.

The ore is treated in a rotary retort which has been
devised and constructed by the Eickmeyer brothers. It
has a 24 inch inside diameter, is 6 feet long and is
driven by a four horse-power gasoline engine which also
runs a small jaw crusher. In a 24 hour period the retort
consumes 3/4 of a cord of wood. The plant has a maximum
capacity of 3 tons per 24 hours, each charge of ore
weighing 1000 pounds.

The quicksilver deposits of Maury Mountain offer
promise of production on a small scale. The property
shows no large reserves but future development work may
reveal larger ore bodies. Nevertheless, with careful
development work, minimum overhead in the operating costs,
and efficient condensing apparatus, the property should
continue to show a profit in a moderate way. The mine is
favorably situated for cheap fuel; the close proximity of
the Ream sawmill with its low-cost rejected wood, reduces
fuel costs to a minimum.

**Sand and Gravel.**

Abundant deposits of sand and gravel are present
in the beds of the various rivers and creeks of the area.
This material is readily available along the Crooked River, and could be used to advantage on the roads of the valley.

Building Stone.

The extensive beds of rhyolitic tuff within the Harney formation can be used to advantage as a building stone. Some of the ranch houses of the area are constructed of this material which has proven to be dependable, and efficient.

Volcanic Ash.

Beds of volcanic ash are common in the Harney, Shaw, Columbia and John Day formations. This material has an economic value as a base for polishing and scouring powder, however, due to lack of favorable conditions of transportation, and a nearby market, the deposits are practically worthless at the present time.
EXPLANATION

IGNEOUS ROCKS

- MADRAS FORMATION
- UNNAMED ANDERSON SERIES
- HANKEY FORMATION
- COLOMBIA RIVER LAVA

SEDIMENTARY ROCKS

- ALLUVIUM
- MASCALL FORMATION
- JOHN DAY FORMATION
- CLARNO FORMATION

STRIKE AND DIP OF STRATA
- PROPER FAULT
- HYPOTHETICAL FAULT
- PROBABLE LOCATION OF ANTECLINES
- PROBABLE LOCATION OF SYNCLINES

SCALE 1:250,000

1938

GEOLOGIC SKETCH MAP OF THE MAURY MOUNTAIN REGION, CROOK COUNTY, ORE.
Plate 5

Section along line A-A'

Section along line B-B'

Section along line C-C'

Section along line D-D'
BIBLIOGRAPHY

The publications listed below deal with the geology of this part of Oregon. Only a few of them, however, specifically relate to that part of central Oregon discussed in this report.


