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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

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GEOLOGIC HISTORY OF THE PORTLAND AREA

by

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FOREWORD

If all communities were as favored in natural surroundings as Portland, the average citizen would be more geology-conscious. He would be more constantly aware of the intimate relation between geology and the course of his everyday life.

The Portland area has a most interesting geologic history. The basaltic hills of West Portland, the Boring hills to the southeast, the little cinder cone on the flank of Mt. Tabor, the peculiar turn of the Willamette River near Oregon City, the classic gorge of the Columbia with its precipitous cliffs,- did not materialize over night, just before the advent of man. These and many other unusual landforms in the environs of Portland developed according to a logical pattern throughout millions of years. This pattern was complicated by such episodes as glacial floods, and volcanic explosions by outflow of lava, and long continued erosion.

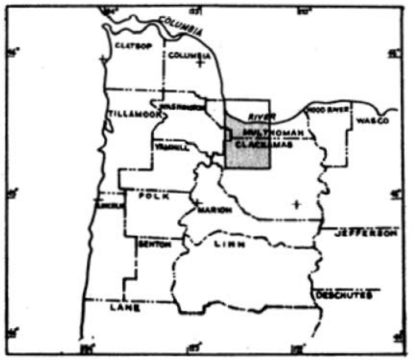
One does not need a technical background in order to understand and form a reasonably clear general picture of the course of events that resulted in the present rock types and topography in the Portland area. With this in mind, this paper has been made as non-technical as possible. It is issued primarily for the layman, for the student,- for the average citizen who looks at the hills, the streams, and the valleys and is greatly interested in learning why, how, and when.

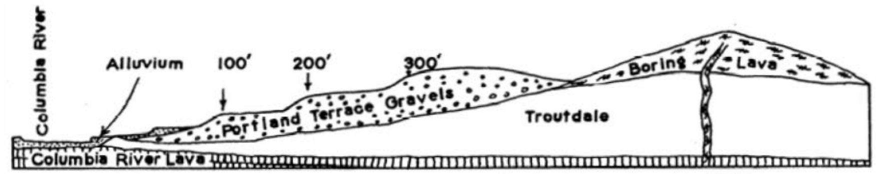
Work on the geology of the Portland area was started in 1939 by Ray C. Treasher, field geologist of the Department. In addition to the present Short Paper, a geologic map of the area has been prepared by Mr. Treasher and is now available. A more comprehensive report on the mapped area in the form of a geologic bulletin will be published by the Department.

No attempt has been made in the present paper to settle various controversial geological points which have for years been a source of disagreement among geologists of the Northwest. Certain of these will be discussed in the bulletin. The intention of this paper has been to present interpretations of the principal events of the geologic history based on results of the detailed study of the area.

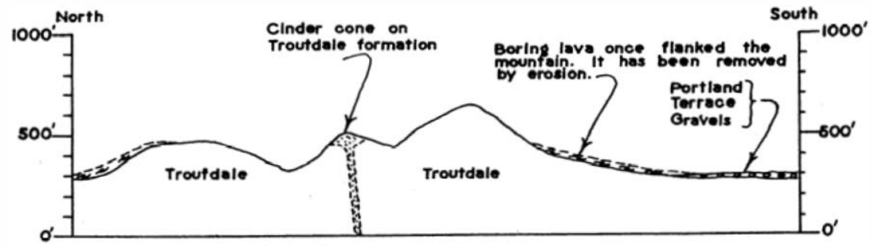
Earl K. Nixon, director

January 30, 1942



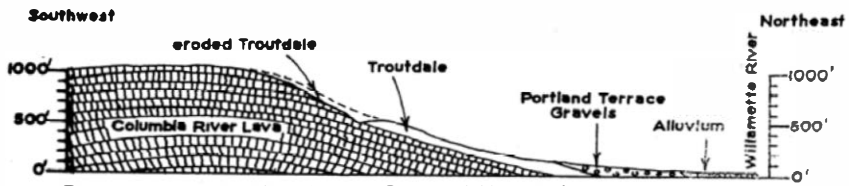


Diagrammatic section Columbia River to Boring Hills
to show terrace relationships



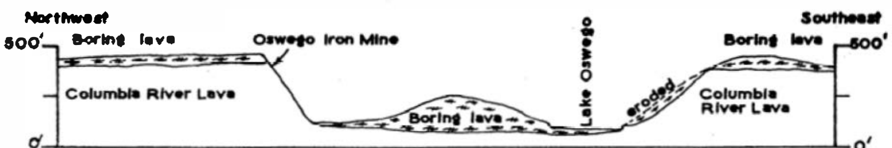
Section through Mt. Tabor showing cinder cone

0' 1000'



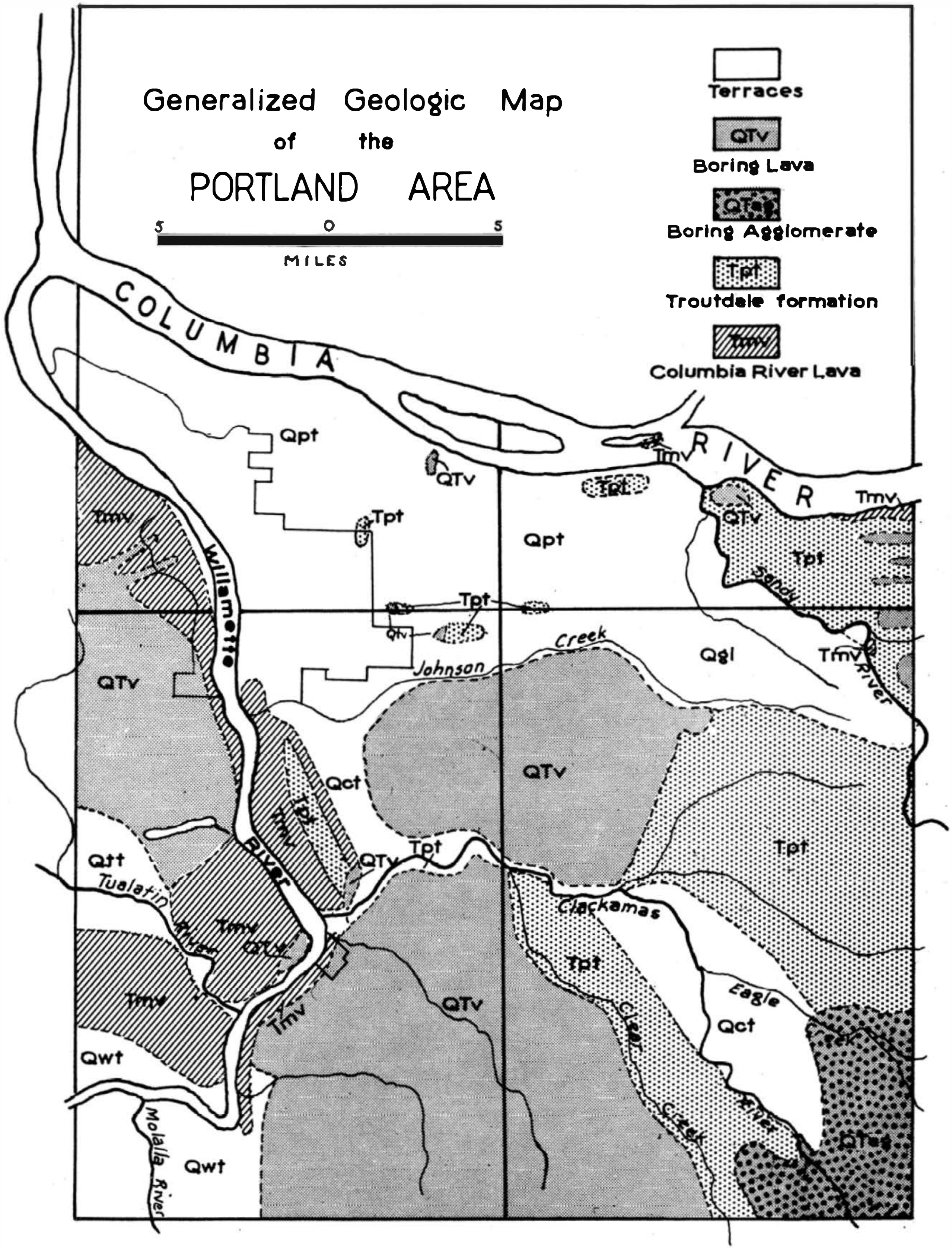
Diagrammatic Section Across Portland Hills & Willamette River.
silt is not shown.

0' 1000'



Diagrammatic Section Across Lake Oswego

0' 500'



Generalized Geologic Map
of the
PORTLAND AREA
5 0 5
MILES
Terraces
QTv
Boring Lava
QTag
Boring Agglomerate
Tpt
Troutdale formation
Tmv
Columbia River Lava
COLUMBIA
RIVER
Willamette
River
Johnson
Creek
Sandy
River
Clackamas
Tualatin
River
Eagle
Clear
Creek
River
Molalla River
Qpt
QTv
Tpt
Tmv
Qgl
Qct
Qtt
Qwt

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GEOLOGIC HISTORY OF THE PORTLAND AREA

Introduction

As we look out over the landscape it is difficult to realize that the "everlasting hills" are as ephemeral as the seasons. It seems that Mt. Hood must always have reared its snowy peak to the heavens, that the Willamette River must always have lapped the base of the Portland Hills. It is difficult to realize that at one time there was no Mt. Hood, nor a Willamette River, - that the Portland area was a monotonous volcanic plain on which shifting streams deposited extensive and very thick gravel beds; that volcanoes lit the sky with their lurid flames and buried whole sections beneath molten lava; that streams raged and tore at these new barriers, removed some of them and skirted others to locate new channels; that it was many, many thousand years before man came on the scene and built the City of Portland.

Many people are not satisfied with taking landscapes for granted. They want to know how these landscapes came to be, and what the country was like in past ages. This story of geologic history is written for them in the hope that they may find pleasure in visualizing the transitions that have taken place in the past.

No particular attempt is made here to give all the evidence of these changes. This history is written as if all controversial points and details were settled. Presentation of evidence and technical discussion is reserved for a bulletin to be released at a later date.

A geologic map of the Portland area is available, and may be used to help interpret some of the evidence. A map of this kind ordinarily shows the material that exists at the land surface. However, silt and soil of comparatively recent origin covers most of the surface and if plotted as such the map would be of little use in deciphering the geologic history. Therefore, the rocks are depicted as if this heavy cover were stripped away.

Acknowledgements

Assistance in the preparation of the geologic map and the report has been received from various sources and is gratefully acknowledged. Without this help, the work would have been much more difficult, and in some cases, impossible. The bibliography acknowledges the source of a large part of the assistance. Particular mention is made of John Eliot Allen, F. W. Libbey, and E. K. Nixon, of the staff of the State Department of Geology and Mineral Industries; A. M. Piper, geologist, Ground-water division, U. S. Geological Survey; Lloyd Ruff, geologist, Corps of Engineers; W. D. Wilkinson and

Herbert Harper, Oregon State College; Lloyd Staples and Robert Brook, University of Oregon; Ralph W. Chaney and Beverly Wilder, University of California; to the Geological Society of the Oregon Country for their interest and assistance in unraveling evidence and in particular to A. D. Vance and Bruce Schminky. Other acknowledgements are given in footnotes.

GEOLOGIC HISTORY

It is difficult to estimate geologic time in terms of years, as it goes back much farther than man-made historical records. It is necessary to find some measure other than years for indicating time. For example, the geologist found that rocks were formed in an unbroken sequence up to a certain point. Then there would be a gap in the record, - either the rocks that were deposited were removed by erosion or no rock material had been deposited. At least five profound breaks in the record have been identified and recognized as being almost world wide in extent. These breaks form the basis of the major divisions (Eras) of geologic time,- the Archeozoic, Proterozoic, Paleozoic, Mesozoic, and Cenozoic. Then it was observed that the major divisions had minor breaks or unconformities in the record, which permitted the naming of geologic periods. Still more minor unconformities within the periods gave rise to the epochs.

Columbia River basalt epoch

The geologic history of the Portland area goes back far beyond the memory of man to what is known as the Miocene epoch of the Tertiary period of the Cenozoic Era. The known history begins in the middle or latter part of the Miocene with the extrusion of the Columbia River basalt. The old land mass shuddered with earthquakes and great cracks opened, through which poured rivers of molten rock. This molten rock, or lava, spread over the old land surface and began to fill the depressions much like water fills a reservoir. When one flow stopped - due possibly to the draining of an underground reservoir - peace reigned for a while. Then another series of earthquakes rocked the countryside; old underground channels for molten rock were reopened, and new ones formed; and another flow of liquid lava inundated the area. This process was repeated many times, flow following flow in an interrupted cycle. Occasionally the time between flows was great enough to permit the development of a soil and the growth of a cover of plants and trees, as at the Oswego Iron Mine (Diller 96), where a tree stump was found rooted in a soil interbed and surrounded by Columbia River basalt.

During this epoch of lava flows, the Oregon coast line was east of its present location, probably near St. Helens, Oregon, and it was bordered with tidal flats and fresh water swamps. Some of the lava ran into the ocean, as we find it interbedded with the Astoria formation of Miocene age (Weaver 37), and some ran into the swamps east of the ocean (pillow basalt at Crown Point and Corbett station).

After thousands of years had passed the lava floods ceased; what a different looking country it was! Instead of green hills and valleys, there was a monotonous, flat volcanic plain on which a few blades of grass and a few hardy trees began to grow. Soil was blown in from adjacent areas; the lava itself began to decompose into soil; more seeds drifted in, and the lava plain became covered with plant life. Trickles of water began to carve stream channels. Streams from the interior of Washington and Oregon began to seek a way to the ocean.

In eastern Washington and Oregon these streams carried sand and gravel which were deposited to make the Ellensburg and Dalles formations. An ancestral Columbia River began draining eastern Washington along a route roughly parallel to that which it follows today (Warren 41) except that it cut across the present Yakima Valley through Sunnyside and across the Horseheaven Plateau at Goldendale.

This ancestral stream carried many pebbles of quartzite and other metamorphic rocks which could have originated only in northeastern Washington; the resulting gravel deposits are called the Hood River conglomerate (Buwalda & Moore 30; Warren 41). The Hood River conglomerate was deposited southward and mingled with the upper portion of the Dalles formation that was being laid down by streams draining eastern Oregon. Time on the geologic clock indicates that it is early to late-early Pliocene.

Troutdale epoch

There were no Cascade Mountains then as we know them today. There must have been some higher ground between the Portland area and eastern Washington and Oregon because the Ellensburg and Dalles formations were deposited by streams that were flowing southward and northward rather than cutting straight west to the ocean. Also, there must have been a sag, or low point, in the terrane about where the Columbia River now flows westward to Portland.

Several streams flowed westward across this gently dipping plain to the Pacific Ocean. This westward drainage should not be thought of as one concentrated stream such as the present Columbia River, but as a series of streams covering a wide area. The streams eroded Columbia River basalt enroute and ground it to pebbles and grit 1/. They also carried materials from re-worked Dalles

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1/ The term grit is used to designate material larger than sand and smaller than pebbles. It is subangular in shape. The term is used in preference to granules, as it is more descriptive of the shape of the material.

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formation and Hood River conglomerate. The stream load was deposited in a very extensive piedmont fan of low gradient which began somewhere east of the Portland area and extended westward beyond the area mapped. This is the Troutdale formation, and our geologic time clock points to middle Pliocene.

At first the work of the streams was largely erosive but as they neared the eastern limit of the present Troutdale formation, their velocity was checked and gravel, grit, and coarse sand began to be deposited. The streams continued to flow with sufficiently high velocity so that the deposited materials were worked progressively westward by the migration of numerous river bars. There was some volcanic activity at the time, as evidenced by the crystal lithic tuffs that are found within the formation. The deposits accumulated to a thickness of several hundred feet.

The Troutdale formation consists of lenses of Columbia River lava pebbles averaging 2-3 inches in diameter; of lenses of Columbia River basalt pebbles with up to 30 percent quartzite pebbles (Allen 32) that are typical of Hood River conglomerate; of lenses of lava grit (broken up Columbia River basalt); of occasional lenses of sand that contain abundant grains of quartz and mica; and infrequently of lenses of silt that may carry leaf impressions. Just east of the mapped area, on Gordon Creek, is a very impure coal, indicating local ponding and an accumulation of organic matter with the grit.

All these materials are moderately well indurated (cemented) so that many exposures stand as vertical cliffs; they are more resistant to erosion than the younger (Boring) lavas and the still younger terrace deposits. Many of the basalt pebbles are "rotted" so that they fall to pieces under a light hammer blow. The lava grit may be altered to clay. The degree of induration, the rotted lava pebbles, and the characteristic lava-grit lenses are the principal diagnostic features.

Two fossil leaf localities were found and specimens were collected for intensive study by Dr. Ralph W. Chaney, paleobotanist, University of California. These are the Buck Creek locality originally reported by Williams (16), and the Camp Collins locality which was located during this investigation. (See geologic map). Dr. Chaney's final interpretation is not yet available but he indicates (personal communication) a middle Pliocene age for these leaves. This paleobotanical evidence correlates well with the stratigraphic relationships.

Deformation

Sometime after the deposition of the Troutdale formation the area was disturbed, or deformed. This deformation imparted a basin-like form to the Portland area, with a 10 degree - 20 degree rise to the ancestral Portland Hills on the west and a gentle 1 degree - 5 degree rise eastward beyond the area mapped.

That the Troutdale formation was deformed with the Columbia River basalt is indicated by an outcrop of Troutdale conglomerate near Council Crest. The structural features are so imperfectly exposed that conclusive statements in favor of folding or faulting cannot be made at this time.

The course of the Willamette River northwest of Milwaukee, and the escarpment-like nature of the Portland Hills is suggestive of faulting. Diller (15) proposed northwest-southeast trending faults along the southwest side of Kellogg Creek, at Oregon City, and at New Era. The presence of faults was inferred from topographic evidence rather than any actual rock displacement, since the heavy gravel and silt cover makes it almost impossible to find positive proof of these faults.

Plotted east-west profiles across the mapped area indicate that most of the relationships can be satisfied by folding. (A more complete discussion will be given in the technical bulletin). Lacking proof of faulting, the alternative of folding is preferred at this time. This movement was part of the great late Pliocene deformation in the Pacific Northwest.

After this deformation of the area, portions of the Troutdale formation were removed by erosion, especially on the steeper slopes of the Portland Hills. Streams eroded channels in the Columbia River lava, as at West Burnside Street, Canyon Road, and the east end of Bertha Boulevard. The Columbia River had approximately its present route through the Portland area and to the northwest. The Sandy and Clackamas Rivers were roughly where they now are. The route of the Willamette River at that time is not clearly defined from evidence found within the area but there is a suggestion that it may have come through a part of the lower Tualatin Valley and through Oswego Lake. The area east of the Willamette River developed a mature topography on the Troutdale surface with a relief of about 400 feet.

Boring lava epoch

Late in the Pliocene or early in the Pleistocene a new stage of volcanic activity started. Volcanoes dotted the countryside so that the Portland area smoked and steamed like a "Valley of Ten Thousand Smokes". As nearly as can be determined, this activity began in the region east of the Portland area. New volcanoes kept springing up to the westward until they were being built up on the very banks of the Willamette River.

At first, the eastern volcanoes were explosive and threw out quantities of hot volcanic ash that acted like a fluid when it fell to earth. It picked up quantities of pebbles, cobbles, and boulders, and rolled them inside the mass. It picked up wood and leaves. It finally came to rest after pouring over hillsides and partially filling canyons. At times the volcanoes would pour out lavas instead of ash for we find lava interbedded with the ash.

Today, this material is found as a structureless mass (Sheets 32) with a tuffaceous matrix containing cobbles and fragments of lava and pieces of wood that are so unaltered that they may be burned. This rock is classed as an agglomerate and is here designated as the Boring Agglomerate.

The volcanoes then seemed to have lost their explosive character and settled down to a more sedate production of molten lava. The lava was highly charged with gases so that as it cooled the individual crystals had a better chance to grow unhampered by their neighbors. The resultant rock was "inflated", not particularly with bubble holes but with air spaces between the mesh work of crystals as if the material had partially crystallized and the remaining melt drained away. These lavas have been called the "Cascan formation of Hodge"(40).

As these lavas were being laid down, volcanoes in the Portland area began to sputter and fume as if they were jealous of all the activity east of them. Similar lavas rolled out of cones; they capped many old Troutdale hills, flowed over old surfaces into stream valleys, blocked drainage, and gave a new landscape to the Portland area. The lava was viscous and no one flow moved very far. The final accumulation represents a series of flows that spread from a number of vents over a period of many years. They are named the Boring lavas from their occurrence on the Boring Hills (once volcanoes) southeast of Portland.1/

On the Portland Hills the Boring lavas capped the summit and covered much of the southwest slope. At three places they flowed northeastward down old stream channels, now occupied by West Burnside Street, Canyon Road, and the east end of Bertha Boulevard. Most of the Boring lava has been re-excavated from these channels.

Boring lava dams

At Oregon City, Boring lava dammed the Willamette River to an elevation of 400 feet. Whether this dam forced the Willamette to detour through the present lower Tualatin channel and Oswego Lake, or caused it to cut across to the Tualatin farther southwestward is not known at this time.

The Chamberlain Hill flow originally extended westward across the present Sandy River channel, covering the site of the proposed aluminum plant on the Sundial Ranch. In the Boring Hills the very straight northeast flank between

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1/ The Boring lavas are identical with those exposed on Highland Butte just south of the Oregon City quadrangle (W.D. Wilkinson, personal communication, 1941). The Highland Butte exposure is perhaps better than the Boring Hills, but there are a number of "Highlands" pre-empted, so the name decided upon was Boring Hills, to avoid confusion.

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Anderson and Schiller suggests that this flow extended northeastward. Boring lava dammed the Clackamas River at Carver long enough to produce the terraces southeast of there. Clear Creek skirts the northeast boundary of Boring lavas, causing the creek to parallel the Clackamas River. It is probable that prior to the Boring epoch, Clear Creek flowed more nearly westward.

Another lava flow dammed the Clackamas at Park Place, northeast of Oregon City. Boring lavas in the present stream channel indicate the existence of a channel prior to Boring lava extrusion. This dam forced the Clackamas River to take a channel parallel to Kellogg Creek, until its bed had been aggraded with gravel to the crest of the volcanic dam. Then the river spilled over the lava dam and re-excavated its former channel to enter the Willamette as before.

Boring lava also dammed the old Oswego Lake channel. The lower portion of the cliff below the golf course is Columbia River basalt (J. E. Allen, personal communication) and indicates that a pre-Boring river channel through here was occupied by the old Tualatin River. Boring lava from the north and south dammed the lower end at Oswego, formed the present lake, and forced the Tualatin River to seek the course it now occupies. In the area to the west there is some evidence that this old channel through the present Lake Oswego may have carried the Willamette River for some time.

Hills of the Troutdale formation east and southeast of Portland were capped or flanked with Boring lavas in a manner which protected them from subsequent erosion. These are Grant Butte near Gresham, Hill 585 south of Foster Road and the hill just north of it, Kelly Butte, and Mt. Tabor. Williams (16) originally reported Kelly Butte as being made of lava that was capped with Troutdale formation. Subsequent removal of lava from the quarry at the west end shows that the lava merely flanked the Butte.

Mt. Tabor cone

Mt. Tabor is composed primarily of Troutdale formation although a small cinder cone on its north flank has been interpreted as a volcano. A W.P.A. project was started to open the volcano so the features could be seen easily. In connection with this project, a drilling program proved that the cinders lie on Troutdale formation except possibly in the very center of the cinder mass where no drill holes were sunk to depth.

Apparently, the very small cinder cone had a small connection with an underlying magma. It was not a source of lava flows 1/. Reports indicate remnants of

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1/ Maps and drill records of the WPA work were made available by Kenneth Hamblen, mining engineer, who was technical supervisor of the project. Mr. Hamblen also gave the benefit of his personal experience with the work.

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a lava flow at the Division Street reservoir (Ben Morrow, city engineer, personal communication 1939), a blocky chunk of lava at Hawthorne and 55th (Bruce Schminky, personal communication, 1939), and a narrow strip of lava between Belmont and Burnside Streets (Darton 09). Residential improvements have obliterated these occurrences but the similarity to other areas indicates that they represent remnants of a flanking flow.

Rocky Butte

Rocky Butte is a remnant lava flow and may represent part of an old volcanic vent. Throughout the mass of gray lava that forms this butte are cracks that are lined with red scoria, suggestive of an old vent. They must be inter-connected, as air currents pass through them "strong enough to blow off a man's hat" as one man put it. Pebbles characteristic of Troutdale formation have been rolled into the gray and red lava, where they may be found today in road cuts. Similar pebbles were found at Kelly Butte.

Erosion has wreaked havoc with some of the Boring lava flows. The lava has blocky jointing and running water has been able to separate blocks and remove portions of the lava more readily than it has the less consolidated Troutdale formation. All that remains of the Chamberlain Hill flow west of the Sandy River are scattered "boulder nests" on the edges of terraces. The destruction of this flow and others contributed greatly to the material in the Portland Terraces.

Glacial epoch

Just prior to glacial times, the Portland area had much the same topography as today. The valley of the Columbia River was wide and the extremely thick silt and vegetative cover, present over much of the area today, was lacking.

With the advent of the glacial epoch there was increased stream run-off caused either by increased precipitation, melting of ice and snow fields, or both. The Sandy and Bull Run Rivers ran bank full, and occasionally spilled over the banks, as above Dodge Park. The flood waters removed large parts of the Boring lava flows, as west of Chamberlain Hill.

The load of the streams was increased owing to more active erosion. Suspended material was carried northward and deposited as a piedmont fan in the Columbia River Valley. This process of erosion and sedimentation continued until the Columbia River valley became choked with debris.

Terrace epoch

Some place downstream from the Portland area the Columbia River was dammed. Whether by an ice jam as proposed by Allison (32a, 32b), by a change in the course of the stream as proposed by Treasher (38), or simply because the stream was choked by its own debris is not known at this time, nor is the answer to be found within the area mapped. Clearly, however, the stream grade was raised and the valley became filled with gravels to an elevation at least 350 feet above present sea level. As the obstruction was removed, the river re-excavated its former channel, pausing again at the 200-foot and 100-foot elevations. Three terraces and the present flood plain were formed as shown on the large scale geologic map and cross sections.

While these deposits and terraces were being formed in the Columbia valley, similar deposits and terraces were being formed in the lower Clackamas, Tualatin, and Willamette valleys. Clackamas valley deposits consisted largely of re-worked Troutdale. These re-worked deposits are so similar to original Troutdale that they are distinguished with difficulty.

The Boring lava dam across the old Clackamas River channel at Park Place forced the Clackamas to a newer channel between the Boring Hills (Mt. Scott) and Oak Grove. The river began depositing material eroded from upstream as valley fill. The valley filled with debris, forcing the river to higher levels until it was able to cut across the old lava dam easier than continue northwestward. It finally did so and abandoned the Kellogg Creek channel in favor of its former and present route.

The Clackamas River did not carry as much sediment as the Sandy and Bull Run Rivers, so sediments deposited by it did not accumulate to such great depths. Later, when the Columbia River was dammed, material eroded from the Portland terraces was carried southwestward and distributed over portions of the Clackamas River deposits.

Most of the evidence for the history of the Tualatin and Willamette River drainage lies outside the mapped area. The elevation of the river terraces appears to be controlled by the lowering of the gradient of the Columbia River after damming and the terrace material appears to have originated within the drainage area of each stream.

It should be stressed that the deposits of the Portland (Sandy and Bull Run), Clackamas, Tualatin, and Willamette terraces differ from each other in the character of the material that forms the particles of sand and gravel. They accumulated at about the same time but each originated from its own drainage basin. The Portland terraces were deposited by the Sandy and Bull Run Rivers and not by the Columbia River. Little or no evidence could be found to support the Bretz hypothesis (Bretz 25, 28) of a "Spokane Flood" and a "Portland Delta", or that flood waters poured southward into the Tualatin and Willamette terrace areas (Allison 32b).

The heavy silt cover of the Portland area accumulated after the formation of the terraces. The silt covers practically the entire area to depths ranging from a few inches to as much as a hundred feet. The origin undoubtedly is complex; in part it is residual from underlying rock, in part it is fluvial (water deposited), and in part it is eolian (wind deposited). Some of it has characteristics of loess; it is textureless and stands with vertical banks but it is not as typically loess as that in the Palouse region (Treasher 26). Some of the silt is finely laminated, suggesting water deposition, at least in local ponds or pools.

Origin of the non-residual silt cannot be given at present, and the problem should receive further study. Some of the silt may have originated as glacial rock flour from Mt. Hood, and some may have originated from the Columbia Basin in eastern Washington.

Glacial erratics

Large boulders and blocks of rock lie on many of the Willamette Valley terraces. These blocks are "foreigners"; they consist of granite, schist, quartzite, and could not have been derived from the Willamette drainage basin. The best explanation is that they were rafted by icebergs from some far distant point, and that somehow the ice-rafts got into the Willamette Valley. As the icebergs stranded and melted, the foreign boulders were dropped. The accumulation of these erratics is described by Allison (35, 39).

The above picture is dependent on several factors: (1) that a deep pond or lake formed in the Portland area and Willamette Valley; (2) that ice rafts accumulated in this pond; (3) that eventually the ice rafts crowded through the Oregon City gateway into the Willamette Valley.

Considering these factors in turn; (1) evidence of a lake in the Portland area that was deep enough to float these ice bergs and to permit the dropping of erratics at 400 ft. elevation was not found. Such a lake should have existed long enough to have developed a definite strand line or terrace at an elevation higher than 400 feet. (2) If ice rafts had accumulated in the Portland area and milled around awaiting their turn to drift southward, it seems reasonable to expect that <u>quantities</u> of the ice-rafted erratics should be found <u>on top</u> of the terraces, particularly just north of the Oregon City gateway.

Only two erratics 1/ were found on the land surface within the area mapped.

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1/ Erratics are considered here as foreign material for which no explanation for their emplacement can be given, other than that they were ice-rafted. Cobbles and small boulders could be water deposited, and therefore, are ruled out as definite erratics. Foreign boulders <u>within</u> the terrace deposits are not considered here as this particular problem deals with erratics <u>on the surface</u> of the terrace deposits.

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One is a 4-foot block of biotite granite mass on a Willamette terrace at elevation 100 feet, at the east quarter corner of Sec. 24, T. 3 S., R. 1 W. The other erratic is represented by broken granite fragments at an elevation 200 feet, east of Clackamas in the SW$\frac{1}{4}$ Sec. 3, T. 2 S., R. 2 E. Diller (96) reports a large erratic near the old Prosser iron mine at Oswego. A careful search was made for erratics on the surface to correlate with those found on the surface of Willamette Valley terraces, and the two mentioned were all that were found. This does not mean that there are no others, but it definitely does indicate that they are not plentiful.

There is no doubt of the existence of erratics in the Willamette Valley but it does seem that some more plausible means of getting them there must be found. The solution of this problem lies outside the area mapped and is not the concern of this geologic history.

Mayger weathering

Certain surficial materials are so thoroughly weathered and altered that they are now clay, yet they may retain most of the textural features of the original material. Pebbles still retain their original shape and mineralogic texture, but are so thoroughly altered that they can be cut with a pen knife. Conglomerate, lava, and lava rubble, have undergone this type of weathering. The material is most completely weathered at the surface; the degree of alteration decreases with depth until permanent ground water level is reached; at greater depth the material is quite fresh and unaltered.

This so-called Mayger type of weathered material is found at elevations ranging from 500 to 1,200 feet and always conforms to the present topography. It is not persistent enough to be classed as a formation, as suggested by Allen (32). Similarly weathered material is found from the vicinity of Centralia, Washington to the McKenzie River in Oregon. A more detailed discussion will be found in the bulletin to be later released by this Department.

This type of weathering in the vicinity of Mayger, Oregon had been described by Treasher (Wilson and Treasher 38:19-23) where a conglomerate has been altered to a high-grade refractory clay. This deposit is considered typical, and the type of weathering is herein designated as Mayger weathering, which is believed to have been produced by a definite climatic cycle sometime after the extrusion of the Boring lava and before the construction of the stream terraces. Its tentative age, therefore, could be very late Pliocene to early Pleistocene. W. D. Wilkinson (personal communication 1941) reached similar conclusions independently, from a geologic study in the St. Helens area.

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