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THE MINERAL RESOURCES OF OREGON

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The Oregon Bureau of Mines and Geology

See

Capitalize

Oregon

Oregon

First

Scenery



Waterfall in Cascade Range
Photo by Weister

Some Little-Known Scenic Pleasure Places in the Cascade Range in Oregon

By IRA A. WILLIAMS

114 Pages

66 Illustrations

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of the

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CONTAINING

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ANNOUNCEMENT

With this issue we present the first number of Volume 2 of The Mineral Resources of Oregon. This is the first issue since December, 1914, and the first to be completed for publication giving results of field work during the past season. It is a preliminary paper involving the general geology of the Cascade Range and is to be followed by detailed reports upon the various other economic resources of the Range. Reports on other sections of the state will also be published later in the year as a result of field work during the summers of 1915-1916.

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VOLUME 2

NUMBER 1

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THE MINERAL RESOURCES OF OREGON

*A Periodical Devoted to the Development
of all her Minerals*

PUBLISHED MONTHLY AT CORVALLIS BY
THE OREGON BUREAU OF MINES AND GEOLOGY
H. M. PARKS, Director

SOME LITTLE-KNOWN SCENIC PLEASURE PLACES IN THE CASCADE RANGE IN OREGON

By IRA A. WILLIAMS

As a reader of this issue of the Mineral Resources of Oregon, do you know that Oregon possesses in her scenery an only slightly developed asset that can be made equal in economic importance to some of her principal industries? To bring Oregon into her own in this respect is requiring perseverance on the part of her inhabitants, and the expenditure of both money and energy, just as are these required for the opening of her paying mines, the establishment of her prosperous farming communities, the initiation of her large lumbering and fishing enterprises. Oregon today is thoroughly alive to this responsibility, however, and realizes the opportuneness of the present time to enter upon a campaign of active and substantial development of her scenic resources. The following article will interest you.

"SEE OREGON FIRST"

THERE seems to be a natural inclination on the part of many people who live in this western country to consider that the much used slogan "See America First" is not necessarily intended to apply to them; at least not in so forceful a degree as to those who live in lands where mountains and forests and canyons are not ever present features of their surroundings. We in Oregon quite generally realize that there is an abundance of scenic attractions at our very doors which therefore may be enjoyed at our convenience. As a result of this general impression that at home Oregon scenery is plentiful and always easy of access, many of us not only do not take our outings within our own state but deliberately plan vacation trips at greater expense and measurably less

ultimate pleasure and satisfaction, if the truth were known, into neighboring states and other distant regions.

The scenic resources of the state are thus in the minds of many reduced to the commonplace, while, as a matter of poignant fact, the scenery to be found in the mountains of Oregon is equaled in magnificence by few and surpassed by no other equally accessible region on the entire continent. The varied opportunity this state affords for the exercise of the out-of-door spirit, whether on the part of the prospector, of the hunter, the fisherman, the naturalist or the climber of mountains, is unexcelled anywhere.

To substantiate this fact one needs call to mind the familiar names of but a few of Oregon's prime attractions: the great Columbia river gorge with its matchless waterfalls and towering cliffs; Crater lake, unique, colossal, world-famed; superb Mt. Hood; the noted limestone caves of Josephine county. Less famous, because less known, are Oregon's Matterhorn, Mt. Jefferson, the Three Sisters peaks and their glaciers, glacier-scored Diamond Peak, Mt. Thielsen, in appearance the Mount Pelee of the Cascades, Mt. McLoughlin; and Eagle Cap in the Wallowa mountains. Then there are the scores of lesser peaks and craters from which cubic miles of fresh lavas have issued; profound canyons innumerable, plunging cataracts and literally myriads of beautiful lakes and winding rivers.

The Nation's
scenic
watchword

The timeliness of "See America First" as most excellent advice for all wide-awake Americans must be admitted without reserve. For the people of Oregon, however, those who have leisure, men in all busy occupations of life, those whose duty it is to attract travel to the state and to explain its advantages as a place to live; for every live resident of this big state of ours, the national cry should be paraphrased into "*See Oregon First*". "*See Oregon First*" can be made the watchword of every Oregon person. It can be made made so if, when freedom permits, Oregonians will practice as well as pronounce this kind of allegiance to their home state. To bring this about the idea must, in some way, be made to sink deeply into the conscience and heart of every loyal citizen.

Glittering phrases and spectacular expressions when put in print are usually thought of as the ammunition of the habitual booster, and it is well known that their use is not always strictly confined to the presentation of the truth. On the other hand, there is no more fruitful method of advertising a meritorious article than by the adoption of a "trade-mark," a word, a set of words, caricature or design, that by continued use comes to stand for something that intelligent people may depend upon. Such a mark of merit uniformly admits its bearer everywhere, whether it be attached to a household article, farm implement, an organization, to a state or other commonwealth. Its mere use or mention is an introduction to something that is worthy and sub-

stantial. In just this way has the Portland Rose Festival become known the country over. "For you a rose in Portland grows" is accepted as literal truth because this great pageant has year after year justified itself and proved to thousands the right of that city to be heralded as the city of roses.

In the same manner has Oregon, a state filled with so bewildering a variety of scenic attractions, won the right to urge upon its own inhabitants and to emblazon to the world so commonplace, yet trenchant, a bit of advice as "*See Oregon First.*" The applicability of this slogan is based upon a resource of which Oregon possesses a preeminent amount. No one who has ever heeded this advice, whether citizen of Oregon or visitor from other state or land, has conscientiously said that it is in the slightest degree inappropriate. In fact, it is the devoted followers of "*See Oregon First*" that are the most active agents in broadcasting that happy idea to the world. The thought is one that should be kept before the minds of our children in the schools. It should be impressed upon the consciences of business and professional men and by all heralded far and wide as the recreational motto of a great state. In this way those at a distance should be told and invited to share the joys that are ours. 'If to our own *State* we be true it follows as the night the day, we can not be false to anyone.'

Oregon's
scenic
trade-mark

Sordid figures may sound scarcely in place amongst visions of beautiful scenery. But even numbers may be made to contribute a delicate even if practical touch to the problem. There is in Oregon but one national park, that which encloses as the major attraction, Mt. Mazama in which is Crater Lake. Statistics of the past two years for Crater Lake National Park show that in 1914, 7,096 persons were admitted, and in 1915, 11,371 persons, the last an increase of more than 60 per cent over the admission for the preceding year. In 1914, 1,107 automobiles entered the park and in 1915, 2,015, an increase of over 80 per cent. Of the automobiles admitted, a considerable proportion are known to have come from outside of Oregon, many from states beyond the Rockies. We may confidently accept these numbers as indicating the growing appreciation of the scenic value of this one of Oregon's natural features by those who live in Oregon and those who pass through it.

Financial
value of
Oregon
scenery

We may further ponder the figures. In round numbers 11,000 persons entered the Park in 1915. The probable shortest stay of the average visitor is one day. It is apparent that the majority of visitors entered the park in automobiles. If we assume that on the average each person expended the cost of one day's stay while in the park, including personal expenses and supplies, the account may stand something like this: 11,000 persons at a minimum of \$3.00 per day—\$33,000. 2000 automobiles at, say \$2.00 per day—\$4,000, making a

total of at least \$37,000 expended within the park by one-day visitors the past season. This amount is interest at 10 per cent on \$370,000. In 1914, 7,000 persons visited the park. Estimating on a similar basis, a minimum of \$23,500 was spent by visitors in the park that year, which is 10 per cent in value of two-thirds of the former amount. The reasonable assumption is that the increased attendance is an indication of the recognition by the people of the state and country of the worth of this one of Oregon's scenic attractions. Crater Lake is being recognized because it is accessible. Its economic valuation thus raised during last year at least 57 per cent. With the improvements now being made and the general awakening of American people to home attractions, there is every reason to anticipate a continued swelling of the tourist traffic for each of several seasons to come. Each of these years its value will rise in similar proportion. It is easy arithmetic to determine at such a rate just how soon Crater Lake, but one of Oregon's attractions, will be creating an income of millions per year instead of thousands, besides bringing many people to Oregon that might otherwise never come.

The above figures take no account of extras indulged in by nearly every one, photographs, postcards, boat rental at the lake, etc., nor the cost of reaching and leaving the park, items all properly creditable to this particular one of Oregon's scenic spots. Many of these persons have traveled hundreds of miles from their homes both within and without the state for the sole purpose of seeing Crater Lake, the cost of such travel swelling in like amount the value of this feature as an economic resource.

Yet a few further figures for comparison will be instructive. In 1915, 51,820 people visited Yellowstone National Park, an increase of more than 150 per cent over the record for the preceding year. 34,814 people entered Mt. Rainier National Park in our sister state in 1915. There too, the attendance jumped over 140 per cent from that of 1914. As far back as 1913 concessionaires' receipts for the year in Yellowstone park amounted to over one million dollars. The difference in admissions to these two well known pleasure places is due less to their particular scenic features than to the accommodations for reaching and sojourning in them. These parks have been improved and persistently advertised throughout the years in a multitude of ways and thus brought to the attention of the world.

The foregoing data are presented only to emphatically suggest what may be the financial possibilities to Oregon from her scenery. We have no way of even estimating in concrete form the value of her many other scenic spots. We know that thousands of sightseers already yearly travel the Columbia River Highway, as they do also the McKenzie road across the crest of the Cascade range. Hundreds of

persons annually flock to our hot and mineral springs. A much lower number reach the less accessible, though no less magnificent, other pleasure places, of which there are many throughout the principal mountain ranges of Oregon. Were it possible to appraise the value of Oregon's scenic resources and to express that value in dollars and cents, even those meager small portions that are now generally known to the sightseeing public, it is not overstating the case to say that we would obtain a figure that would, without question, compare very favorably with the valuation of some of her other much better developed industries. Some day in the future it may be possible to do this and the gratifying thing about the matter is, there is enough for everybody. The state's resources in scenery are not consumed or rendered sterile by use as are her soils, depleted as are the forests, or become exhausted as do mines. All may enjoy scenery, the same scenery, throughout time. The more use made of it, the greater its value and the more substantial a source of income to the state does it become. *Oregon's scenery, and her pleasure places, constitute just as truly one of her principal undeveloped economic assets as do her mines, her vast timber resources, even her agriculture, the extent of each of which is only beginning to be realized. Capitalize Oregon Scenery.*

SCENIC FEATURES OF OREGON

THE State of Oregon is one of large size and small population. Being a state of giant forests and great mountain ranges it is to be expected that many parts of it would remain practically unknown for many years after settlement began. Today there are sections in each of the principal mountain ranges whose character is known only to the forest ranger and the hunter, the prospector and the occasional mountain climber. Some of these little explored regions possess attractions that, were they located so as to be easily reached, would class them high among the scenic features of the continent. Yearly more is being learned of these places, more publicity is being given to them, and with the rapid development of the various fundamental resources of the state they too will be gradually opened up, their beauties described and rendered available for our enjoyment and pleasure. That they will constitute important sources of added financial income to the state need not again be stated.

During the summer of 1915 the Oregon Bureau of Mines and Geology despatched a party into the Cascade range to make a reconnaissance trip along the crest of the range. Prior to this time some of the main geologic features of the range have been known in a general way, but theretofore no careful inspection of it had been made with a view to determining the source and character of the lavas that have issued along its crest, or their relation to the present peaks and less con-

spicious craters so plentifully scattered throughout its whole extent from north to south across the state. A further and chief purpose in all geologic work is the study of mineral deposits and the discovery or determination of the likelihood of the occurrence of bodies of ores of economic value.

Much prospecting and some mining has been done at various places in the Cascade range but, so far, such work has been carried on more or less haphazard and without the assistance that a thorough knowledge of the geologic conditions there would supply. This knowledge is now being acquired by the Oregon Bureau of Mines and Geology and the results of field work in those particular regions will be published from time to time during the coming years for the use of miners and prospectors.

**Geology
of scenery**

Inasmuch as Oregon scenery is not surpassed in excellence anywhere, and since it cannot fail to become from the economic standpoint one of the state's great resources, considerable attention has been directed toward acquiring an understanding of the combination of conditions which produce features that are called scenic. Obviously scenery depends in all cases most largely, often entirely, upon the working of geologic processes. Forests adorn and grass and flowers decorate the earth features of hill or mountain, rock ridge, glacial meadow or sloping canyon wall. But these are mere veneer, the embroidery, as it were, that give the final beauty touch or setting to forms already built through volcanic agencies, the plowing action of the glaciers, the erosion of powerful rivers. Add to these uncounted lakes, bedeck the peaks with snowfield and glacier, place roaring rivers in each of a bewilderingly intricate meshwork of canyons and the geologic picture is complete. Thus the problem of scenery becomes one first of geology, then and secondly of *economic* geology for the reason that people come long distances and pay freely to enjoy it and through it revenue is yielded to the state.

**Localities
to be
visited**

It is proposed in this paper to call attention to some of the less known localities along the crest of the Cascade range that, though distant, have been found to possess an abundant scenic interest. Two particular localities stand out vividly in the writer's mind as exercising strong appeal to any one who has a love for the primitive in nature, the gigantic and the beautiful. These are Jefferson Park at the north foot of Mt. Jefferson, and the Three Sisters region, the position of which is indicated by the names of the peaks themselves. The two places are shown on the accompanying map which is a portion of an enlarged photograph of the large scale relief map of Oregon. The main wagon roads and principal trails are indicated on this map. Practically all of the area covered by it is within the national domain. This fact is one that assures proper protection and use of whatever valuable resources

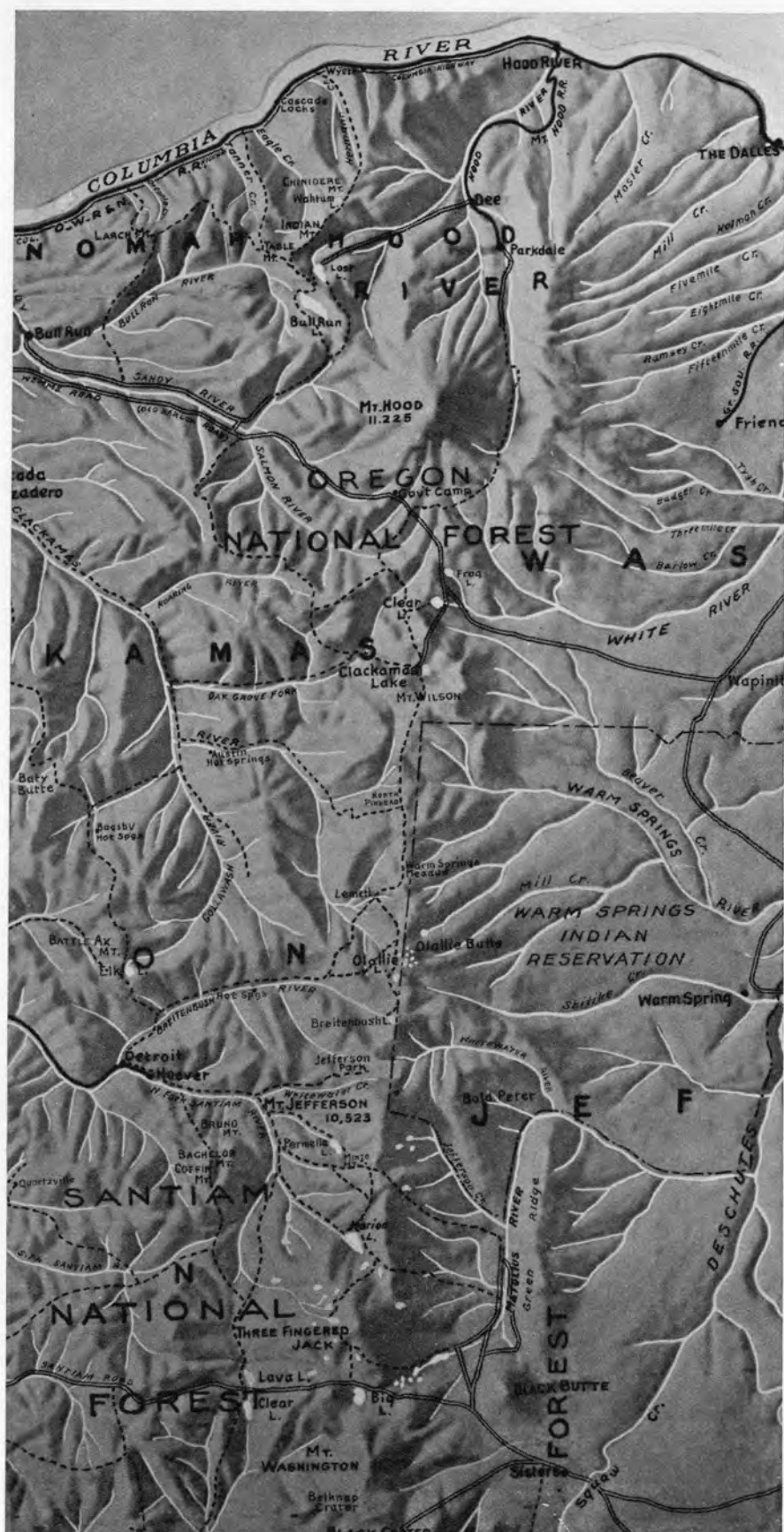
may exist there. Within the area of the map is included a portion of the Oregon National Forest at the north and from north to south parts of the Santiam, Deschutes, Cascade, Umpqua, and Crater National forests. The Warm Springs Indian Reservation lies north of the Deschutes forest and extends to the Cascade divide.

If one were to contemplate a visit to this region of rugged mountains, which, as the map shows, covers only the crest or summit portion of the Cascade range, he would first familiarize himself with whatever roads and trails there might be by which he could reach any particular locality. This information is to be obtained from maps, the most serviceable being those made by the United States Forest Service. Should one be so disposed that an extended trip into various parts of this interesting section could be undertaken, requiring a month or more of time, it would be necessary to ascertain not only the routes by which the different places of interest could be reached, but the plans for the trip must be so laid that replenishment of supplies will be possible at occasional points as needed. The geography of the entire region must from this standpoint be carefully studied and a working acquaintance gained with distances as well as places, also with the character of the trails and of the country to be traversed. Such preliminary knowledge not only contributes to the enjoyment of every mile of the journey, but is quite essential to its success.

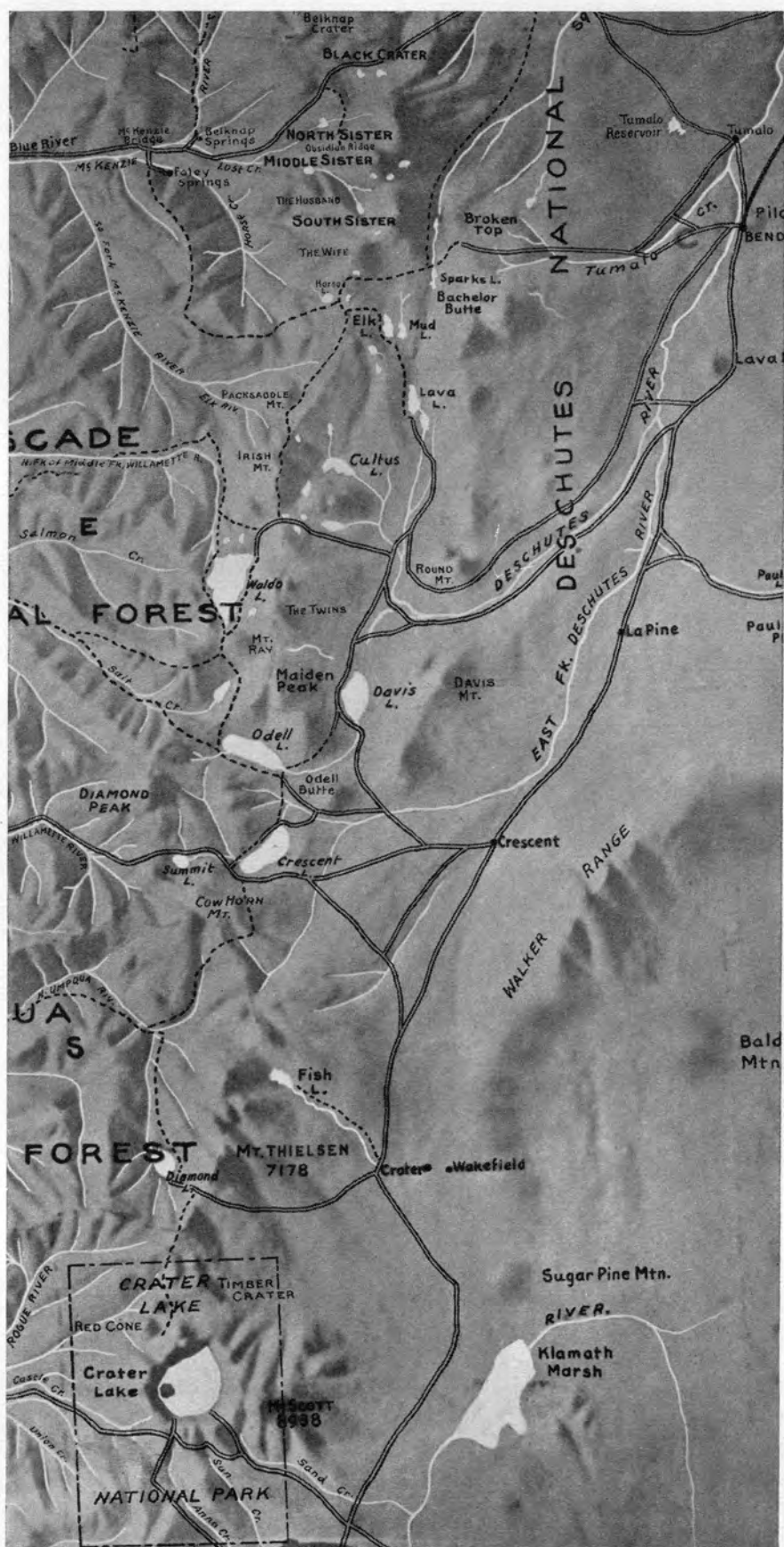
JEFFERSON PARK TRIP

A VISIT to Jefferson Park is to be the object of our first excursion. As already pointed out, Jefferson Park is located at the north foot of Mt. Jefferson, which by the map is seen to be about 50 miles almost due south from Mt. Hood. Mt. Jefferson is barely more than 70 miles essentially due south from the town of Wyeth, a point on the railroad at the Columbia river, the north boundary of Oregon. An east-west line through Mt. Jefferson would pass about two miles north of the city of Albany, 65 miles to the west in the Willamette valley, while the town of Madras, beyond the Deschutes river in central Oregon, would be about an equal distance to the south of it and a little short of 35 miles away. Jefferson Park was formerly known as and still called by some Hanging Valley. Inasmuch as the latter term is commonly used with a somewhat different meaning, and since "park" is most happily applicable to this beauty spot of the Cascades, it is urged that the name Jefferson Park be permanently adopted.

The nearest road from which it is possible to reach the park terminates at present at Clackamas lake ranger station 30 miles up the summit to the north. From the west a wagon road is built up the north Santiam river to beyond Mill City 30 miles west and a little north of the park, and a branch of the Southern Pacific extends to



North portion of the summit of the Cascade range in Oregon, showing principal peaks, rivers, main roads and trails. Scale approximately 14 miles to the inch. This and the following map cover, north and south, 250 miles of the summit of the range.



Middle portion of the summit of the Cascade range in Oregon, showing principal peaks, rivers and lakes, main roads and trails. Scale approximately 14 miles to the inch.

Detroit and Hoover, the former a direct distance of 18 miles straight west of Jefferson Park. Better than 20 miles directly down the summit to the south the Santiam road passes across the range. At present, however, the park is inaccessible by trail from this direction, as it is also from the southeast, on account of Mt. Jefferson itself to encircle the west base of which necessitates a detour of many miles. Thus the only way that it can now be reached is by trail from the railroad at Detroit, and along the summit from the north, the last several miles of the latter course being along the rocky, treeless divide where occasional signs of an ancient Indian trail are all but obliterated by slides of loose rock and the shifting boundaries of the snowfields.

It may be well to remind the reader at this point, however, that even if the trip is long and some of it made less pleasant by poor trails or none at all, the effort necessary to make it will most certainly be fully repaid to every hardy one who loves the wild and the beautiful in nature, both of which are here to be enjoyed in exhilarating measure.

**Government
camp**

He who proposes to enter Jefferson Park from the north by a trip along the summit of the Cascades will first land at Government Camp at the south base of Mt. Hood by horse or auto stage, after a trip from the west over the Barlow toll road. This road connects western with eastern Oregon and is the first crossing south of the Columbia River Highway. Up the west slope of the range it follows for many miles the canyon of the Sandy river and, approaching the summit, that of the Little Zigzag. After crossing the top of the range, down which it follows nearly to Clear lake, this road passes by easy grades out upon a great basalt plateau into which the Deschutes river has carved its gorge, often thousands of feet in depth. The old Barlow road followed down the canyon of White river. The present road, known as the Oak Grove road, now starts down the slope along the ridge between Clear and Frog lake creeks. Wapinitia, about 2,000 feet in altitude, is the town nearest to the summit on the east side and here connection is made with the main automobile road leading both north and south into all parts of eastern Oregon.

**Side trip
to Mt. Hood**

While at Government Camp a trip up the slope of Mt. Hood is a most instructive and profitable one. A wagon road runs to Camp Blossom some 3 miles distant and about 2500 feet higher than Government Camp whose altitude is 3,880 feet above the sea. Camp Blossom is the point at the timber line where climbers spend the night and from which an early morning start is made for the top of Mt. Hood. In protected places at this elevation snow remains the year round and above the trees an unobstructed view to the east, south, and west may be obtained. Beyond the timber-line the slope of the mountain, except for occasional jutting ledges of hard rock, is a mixture of loose sliding



Mt. Hood from the south side near Camp Blossom. At the right is Steel Cliff. Crater Rock, an outcropping volcanic plug, shows through the snowy expanse high up toward the summit. Snowfield of the Zigzag at the left and of the White river glacier below Steel Cliff at the right.

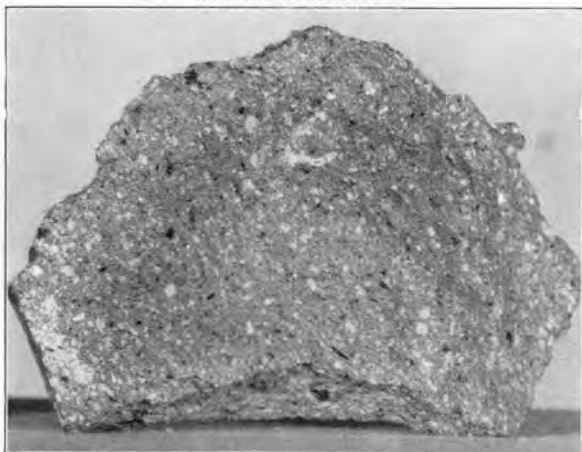
pieces of andesitic lava, volcanic ash and scoria. Into this the streams are deeply carving on all sides sharp V-shaped canons and the glaciers are gouging it out above and constantly moving large quantities of loosened material downwards within the reach of the ever greedy streams. The glaciers themselves furnish by their melting an unending supply of water. One naturally casts longing glances toward the summit where Steel Cliff, Crater Rock, and the snow-tipped northern rim of the old crater itself yet nearly a vertical mile above appear to be urgently beckoning. But our back is turned to the allurements of their call and we gaze southward toward Mt. Jefferson and Jefferson Park which, though 50 miles away, nevertheless exert a spell not possible of resistance.

The rugged
Cascade
range

Down the range toward the south Mt. Jefferson preeminently dominates the view. At our right in a westerly and southwesterly direction there is spread out a great expanse of most rugged mountainous country. Myriads of peaks there are and deeply riven canons. The distinct sky-line, which to the west is perhaps 25 miles away, as does also the intervening space, presents an interrupted though closely packed series of mountain tops and it is no illusion of the atmosphere that the more distant ones are fully as high as those that are nearer by. Many of these, a notable number of them, have flattened tops, and the tops of those that are highest are conspicuously even, as though all were portions of a former more or less flat lying plateau. Indeed, from our view point we may in imagination picture an originally fairly level stretch of country leading from the very base of Mt. Hood, where we now stand, west and southwestward for many miles and nearly to the present Willamette valley front of the Cascade range. Into this region of even surface we see the streams begin their work, cutting constantly headwards and extending their branches, gashing away slowly yet relentlessly throughout the hundreds of thousands of years, carving and undermining and carrying away the materials of this plain.

Sooner or later portions of the old surface would be destroyed, flat-topped divides would be reduced to sharp ridges and these ridges slowly melt and crumble and wear away. In the progress of this process of land carving, or erosion as the geologists call it, this land area would present varying features depending upon the stage in its wearing down at which it is observed. If our present observations and inferences are correct, it would seem that we are now looking upon this vast stretch of Cascade mountainous area at a time when its erosion, though pretty well advanced, is still being actively prosecuted by the many streams that flow from it and too while there yet remain many peaks with flattened tops to indicate the character of the surface of which they are now but widely separated parts. Many of the present

Two-thirds natural size



Magnified thin section



Porphyritic hypersthene andesite. This is the prevailing type of volcanic rock of which most of the higher parts of the Cascade mountains in Oregon are made. All of the principal peaks of the range (former craters) gave out chiefly this variety of lava. In the thin section the large white angular crystals of feldspar and occasional brown ones of hypersthene are seen to be set in a matrix of much smaller crystals, and the latter are in turn caught and held in a glassy residuum from which they were formed. At least two generations of crystals are thus clearly shown: the larger, called phenocrysts, began to grow early, possibly deep within the earth before the rock was erupted as a liquid lava; while the smaller crystals took shape during the brief time allowed them while the molten lava cooled and finally solidified.

Two-thirds natural size



Magnified thin section



Hypersthene andesite. The texture of the andesites varies from rather coarse-grained and porphyritic to fine-grained or dense, and sometimes vitreous or glassy. A "porphyritic" texture is one in which distinct crystals of one or more minerals appear in a background or matrix of finer grain or of actual glass. In this and the preceding view the white specks are mostly angular crystals of plagioclase feldspar, while the much fewer dark spots are a variety of pyroxene called hypersthene. The texture of the rock is further brought out in the accompanying photograph of the thin section, in which elongated crystals with sometimes ragged, sometimes angular outlines are seen to be set in a groundmass of glass. A larger "phenocryst" is seen near the top of the section.

peaks of conspicuous sharpness within the field of view are no doubt but remnants of once flat-topped eminences, could we have seen them in ages gone by, that have been, as it were, worn to a point, or edge, by just such vigorous stream action as we see going on today.

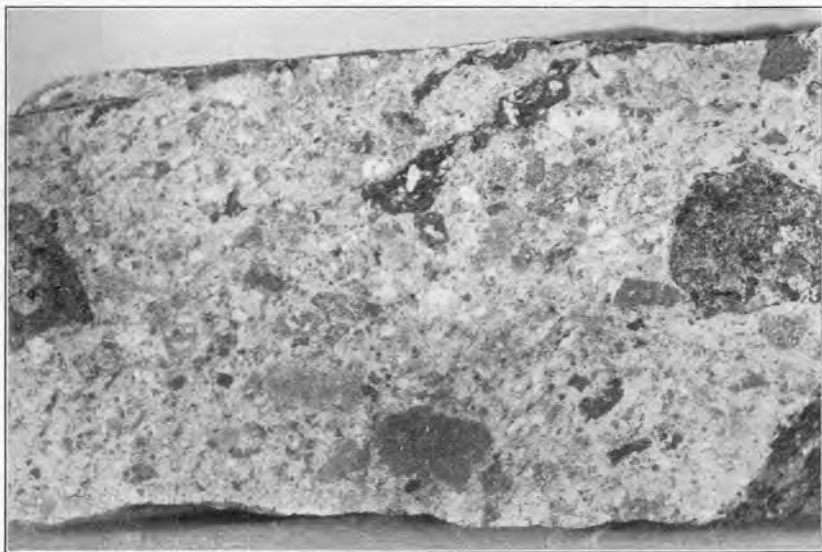
Nor do we need to depend alone for our conclusions upon deductions made from the present distant point of view. When we examine at close range many of the prominent peaks in the part of the Cascade range that stretches west of its summit for sometimes 30 miles or more, and extends from the Columbia river 150 miles south to the Calapooyas, it is found that, as has been inferred from our distant view, the high peaks are often but miniature table lands or sharp rock-bound ridges or giant pinnacles, deeply separated from their neighbors by precipitous canons that are now occupied by the very streams whose incessant industry has modeled them into their present forms. And the rocks of which the different mountains are made resemble each other so closely as to leave little question of their having originally been portions of the same connected or closely related beds.

Rocks of
Cascade
range

As we still ponder the view before us, we try to conceive of the way in which the parent plain may have been brought into existence from which this part of the Cascade range grew, and above the general level of which now rise all of the more recent and many higher peaks so plentifully arrayed along its summit. The rocks comprising this former old plain are almost entirely volcanic. This means that it was built up by the accumulation of materials produced by the eruptions of volcanoes. It is found that the upper parts of this plain, and, therefore, of the isolated portions of it that today stand as flat-topped ridges or peaks, consist of a series of beds of hard rock that flowed out one layer after another as liquid lava and solidified as they came to rest and cooled. These hard top layers are prevalently of a light to dark gray colored dense rock called andesite and they attain a thickness in places of a thousand feet or more. They are sometimes interbedded with less solid layers of rough and often rusty red or brown scoriaceous character, and rest nearly everywhere upon thick beds of tuff, hundreds of feet of which may be seen in the walls of the canyons of every river of any size in the entire region. The tuffs too are of volcanic origin. They are made up generally of coarse and fine angular or rounded pebbles or blocks which have usually been rather strongly cemented together into a firm rock by a filling of fine particles of ash, or of volcanic mud or in many cases of liquid lava, that has caught up these rock fragments and carried them along or has flowed into the open spaces among them and solidified, binding the entire mass together much the same as does the cement in a mixture of ordinary concrete.



Volcanic conglomerate. The bouldery nature of this type of rock is conspicuous. Filling in among the larger, more or less rounded boulders is a mixture of volcanic rock fragments of all dimensions from the size of pebbles to that of the finest ash. The heterogeneity, both in size and character, of the mixture of pieces of which the rock is composed leaves no question that they have been tumbled in together in a most promiscuous manner. When rock materials are deposited by water they are usually separated, or sorted and classified to a greater or less extent, into successive layers of sand, and silt, and gravel, etc.; the particles in each layer possessing a noticeable uniformity of size. In the volcanic conglomerate shown, this sorted arrangement of materials is absent. We are thus brought to the conclusion that water had little to do with its accumulation. Much evidence goes to show that great quantities of this kind of rock in the Cascade mountains of Oregon were formed by the down-hill movement of volcanic rock fragments, and an intermingling of them in some such manner as we see today about the lower slopes of more recent craters that by explosive eruptions have produced much of clinker, cinder and ash. Quantities of fine ash and dust were projected into the air and gently settled over wide stretches of country, the smaller pieces creeping into and occupying the interstices among the larger, until the whole became compacted into a bed of rock. Such we know was the process, and slow and gentle must it oftentimes have been, for in places now we find the trunks of trees, usually in part petrified, still standing upright, as though mercifully smothered by the quiet rise of slowly accumulating sediments about their base.



Volcanic flow-breccia. Natural size. It is apparent that this rock is made by the cementing together of sub-angular to round pieces. Where the pieces are prevailingly round, as are gravel pebbles and boulders, the term "conglomerate" is used. These chunks of rock which, as may be seen, are of all sizes, are all of volcanic varieties. Close study by means of the microscope proves that the cementing substance which has bound them into a solid rock is itself also volcanic lava. We thus seem to have here a case of percolation of a liquid molten lava into the openings among the pieces of an open-textured bed of gravel or talus, the cooling and solidification of the lava tying them firmly together; as it were, a natural concrete. Doubtless in many instances the flowing lava picked up and carried along for miles rock fragments from its path, incorporating them into its mass to become a constituent part of the resulting rock strata, great thicknesses of which we observe today in many places in the Cascade range.

Naturally we inquire as to the source of these volcanic products that have been responsible for so much of the bulk of this great mountain range. As yet we do not know for certain, nor do we know much as to the position with reference to the sea level of the old surface over which these many hundreds, often thousands, of feet of volcanic rocks were spread. Doubtless some came out quietly and in large volume through fissures or breaks in the earlier rock layers that extended to sources of supply below. We are certain by the character of the rocks that large quantities were erupted violently from craters not unlike our Mts. Hood and Jefferson of today. But whether from these same mountains or others the location of which we now know, is a question yet unsolved. True it must be that the lavas came from some source at a higher level than the area over which they spread. Since we now find them occupying positions on the tops of many peaks so high that they could not have reached there from any of the present known sources of lava, and since the rivers have been able to dissect these beds, cutting downward through them two, at times three thousand feet, we are forced to conclude either that these rocks came from vents that were originally at higher altitudes still, or, as seems

more reasonable, that the country which they covered was at that time at a lower level and has since been bodily uplifted, no doubt with extreme slowness, to its present position. It is highly probable that part of the vast body of these rocks that we are now able to study was first deposited in or flowed down the sloping bottom of an area of ocean water, coming to rest in great or shallow depths, then later elevated to become land surface.

It seems to be one of the tragedies of nature the pitiless attack that flowing streams wage against all land surfaces from the time they first emerge above the level of the ocean. We thrill to watch the process, though generations of men are as but moments in its slow and measured enactment. Here in the maze of peak and canyon before us, we see the net result so far of this everwaging battle between the forces that have lifted and those that are tearing down. The forces of elevation operate intermittently while those that wear down and carry away are ever active. It is to the never ceasing work of the main rivers and their tributaries in this part of the Cascade range



Ready for the trail. Three pack and two saddle horses comprise a satisfactory outfit for three persons. If supplies are well chosen, in quantity and character, two weeks' rations for both horses and men and sufficient camp equipment for comfortably and pleasurably "roughing it" can be carried on three animals. This photograph was taken at Warm Springs meadow on the Cascade summit. The tree of conical outline at the right is one of the firs, several varieties of which grow at this altitude.

that we may attribute the chief conspicuous features. That this is not true for most of the summit portion of the range we may guess by a glance in that direction and shall have demonstrated to us as we pass southward along its crest toward Jefferson Park.

THE CASCADE SUMMIT

GOVERNMENT Camp is the last point from which supplies can be obtained, though outfitting for the trip must already have been done at some place lower down to the east or west before entering the higher parts of the range. From Government Camp the road may be followed nearly south by Summit House and Frog lake to Clear lake, or the trail may be taken from Summit House down Mud creek and across Salmon river by Jack Pot and Dry meadows and Crater lake, a rough, more roundabout way to the same destination. Clear lake is about 12 miles from Government Camp, a short but ample distance for the first day's pack. It is an irregular shaped lake in part grown up with tules and surrounded by marsh. Though stocked with trout, it is not an ideal camping place in mid-summer as the only convenient water supply seems to be a poor spring near the east end of the lake.

Between Clear and Clackamas lakes, a distance by auto road of about ten miles, the divide is crossed. Clear lake drains eastward to the Deschutes, while Clackamas lake is the source of Clackamas river, one of the chief tributaries of the Willamette. Clackamas lake is the site of a Forest Ranger station and here the wagon road ends. From this place it is a short day's trip by trail to Warm Springs meadow and, if one is not hurried, yet another to Olallie meadow.

Thus far the country has been comparatively even and one rides for hours in the dense forest with scarcely a single glimpse of bare rock or opportunity to satisfy the longing for an unobstructed view of his surroundings. Occasional open places are named meadows since they are covered with grass, and are swampy or frequently surround ponds or lakes of varying size. There are many of these, and they appear to bear a direct genetic relation to the time when all of the higher parts of the range were covered with the perennial snow and ice of the glacial period. The presence of the small glaciers on Mt. Hood has been noted. There is evidence of their former extension for some distance south along the range crest. But it seems likely that while the general mildness of the topography is primarily due to the outpouring of liquid lavas, the lakes, ponds and marshy spots may have largely resulted from the accumulation of earthy materials so as to clog or obstruct drainage ways during the melting of the ice, whether or not the glaciers actually rested upon this part of the range. In any event, it is very apparent that the period of time during which the streams

have had to work, many of which have cut enormously deep canons but a few miles west of the summit, has not been sufficient for them to extend their head branches to the very top of the range. Complete drainage and obliteration is the ultimate fate of all these undrained places. We may therefore look upon this part of the summit as being in the youthful stage of its existence. It is simply too soon for the rivers yet to have accomplished the dissection so spectacularly displayed in the front of the range.

Beyond Clackamas lake we pass within view of Mt. Wilson a rugged ridge of andesitic lava on the top of which the U. S. Forest Service maintains a lookout station during the fire season. Peavine mountain a few miles to the southwest appears to be of similar type, though the rock of which it is composed has almost enough of the iron-bearing minerals in its make-up to be called a basalt.



North Pinhead peak. Before reaching Olallie meadow the trail passes close to North Pinhead, a cinder cone some 800 feet in height. This cone represents the most recent of volcanic activity so far seen on our journey. Its base is of solid lava and at the northwest and south small flows have issued. The shoulder low down at the left in the view is one of these basal flows. In the top is a shallow crater and its rim and steep sloping sides are composed of loosely aggregated scoriaceous boulders, lapilli and volcanic ash. That these are the products of violent volcanic eruption and that the cone has been built up entirely by the materials from its own crater are the obvious conclusions to which one is led. In their fragmental nature they differ from the prevailing rock so far. The rock composing the cone itself is andesitic in character while the flows from its base are of a more basic, generally darker colored rock that differs little from the basalts. About the mountain and particularly on its south slopes the mountain lily blooms most profusely in July.

NOTE.—Since the interest and value of a paper of this nature must depend quite largely upon the photographs accompanying it, the reader in perusing this brochure is kindly asked to follow and read in order, as an essential part of the text, the descriptive matter relating to the views so that no connecting link or sequence of events may be lost sight of.



Looking south from the top of North Pinhead peak. Each day has brought us nearer to Jefferson Park and interest in what is ahead should be greatly stimulated by the view obtainable from the top of North Pinhead. Though still 20 miles distant, Mt. Jefferson dominates the sky-line towards the south. In part obscuring its east flank is the black dome of Olallie butte. To the right we look out across the headwaters of the Clackamas and far into the much broken Santiam country, and are again reminded of the remarkable and more or less even height of the mountains for many miles to the westward.

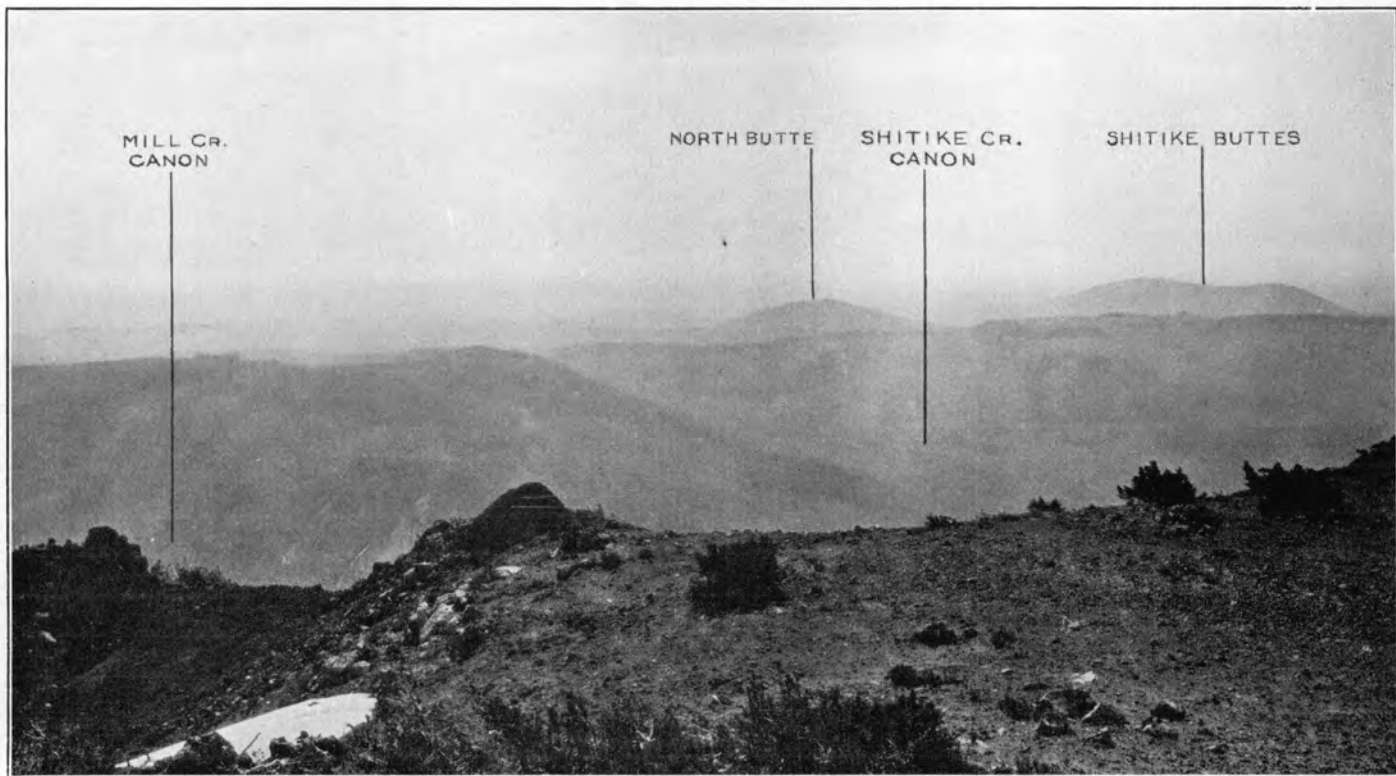


Mt. Hood from North Pinhead peak 30 miles to the south. The character of the country at our rear is in contrast with that ahead. The snow tip of Mt. Adams in the State of Washington may be seen at the right of Hood and well to the left is the symmetric snow-white cone of St. Helens also beyond the Columbia.

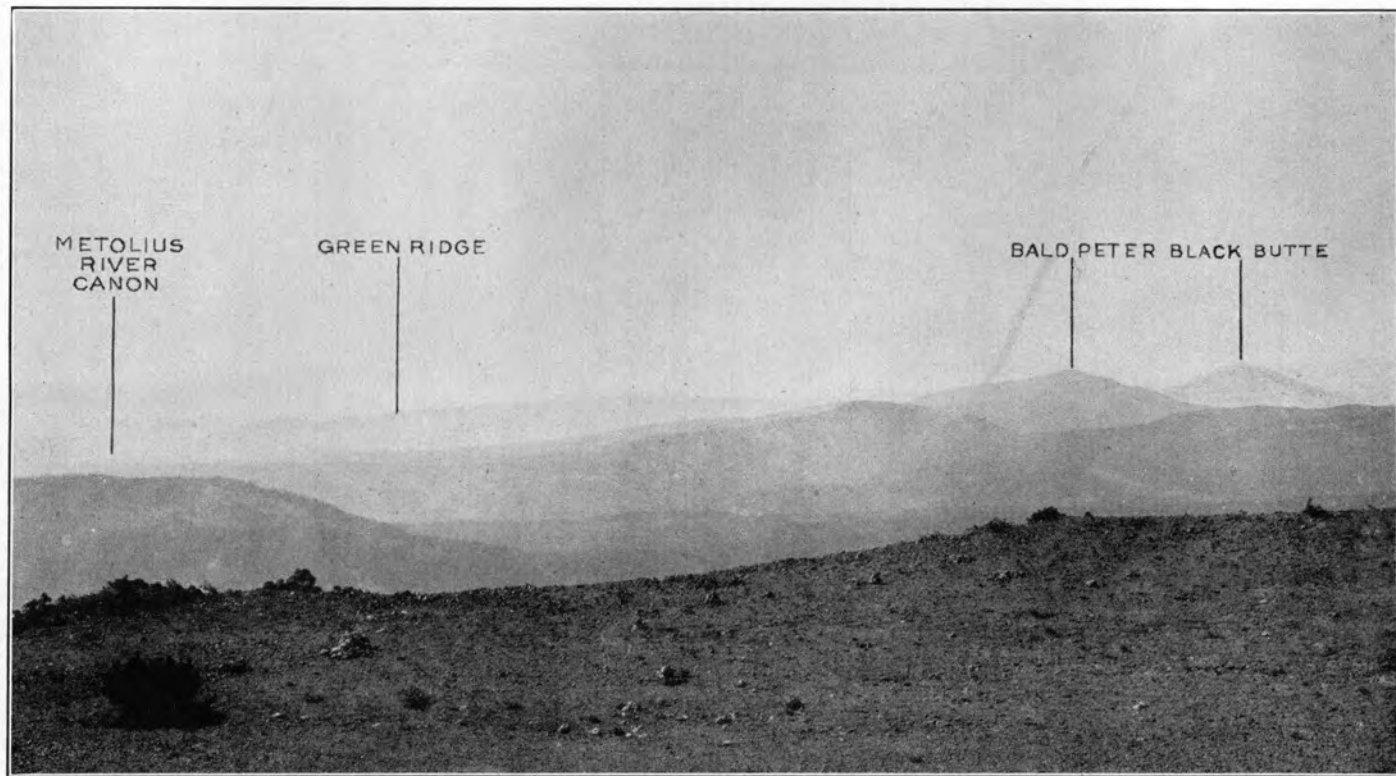


Olallie butte from the southwest across an arm of Monon lake. It is sometimes a disconcerting illusion that the nearer one approaches to a prominent mountain or peak the less imposing it becomes. Its dwindling is in this instance, nevertheless, quite unreal and a climb to the top of Olallie butte from Olallie meadow is a vigorous effort well repaid and a real treat not to be foregone. The summit is about three miles from the ranger station at the meadow and can be reached on horseback over a newly built trail. The butte has an altitude of about 7500 feet and rises 2500 feet above Olallie meadow. The cone is seen to be founded upon a base of lighter colored rock which on examination proves to be andesite. Upon this platform, which may possibly represent the earlier outpourings of lava from the same deep vent, Olallie butte rests, a vast pile of cinder, scoriaceous boulders, broken rock and volcanic ash. These contrast with the solid base only in physical appearance for the microscope proves them to belong to the same general class.

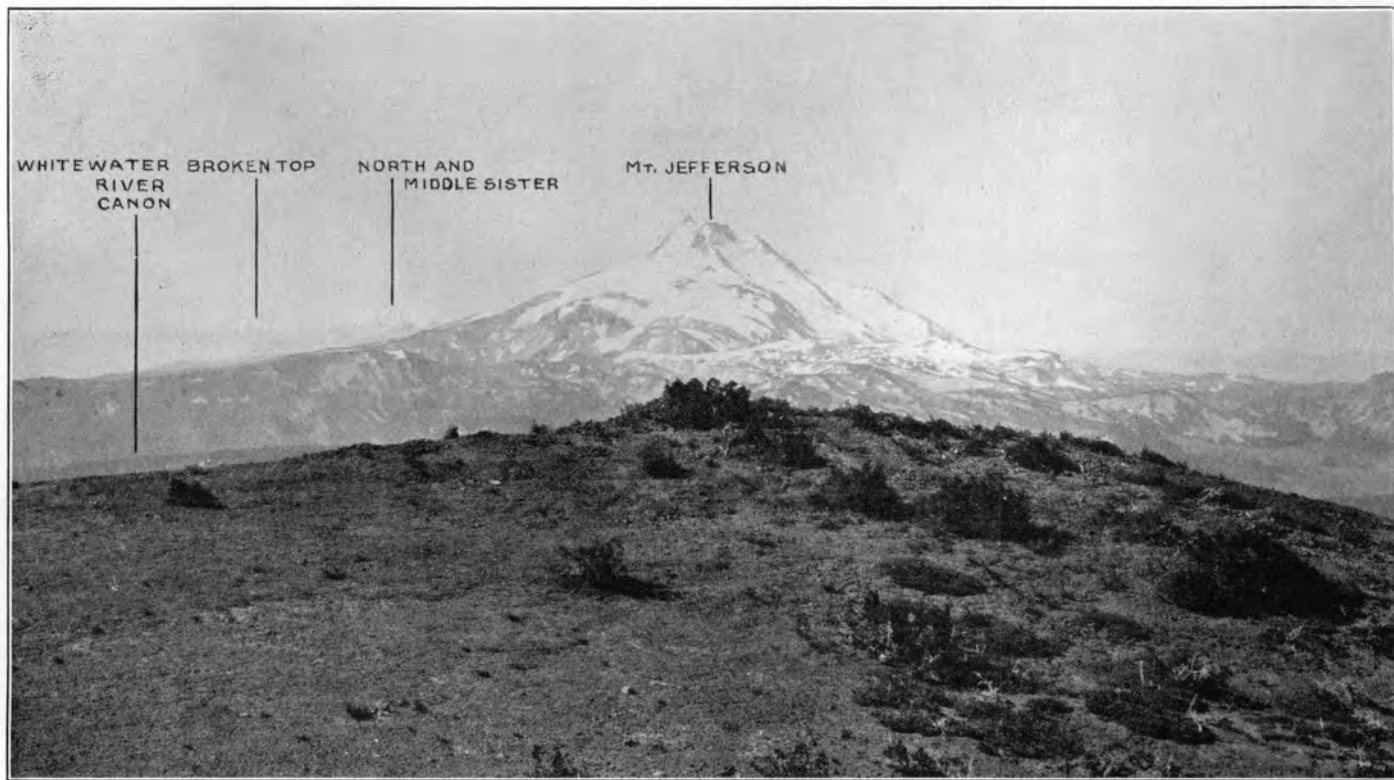
The following five photographs taken from the top of Olallie butte, when matched together, constitute a panorama of 200 degrees. The first view is toward the east, the second to the southeast, the third to the south, the fourth toward the southwest, and the fifth view of the series practically due west.



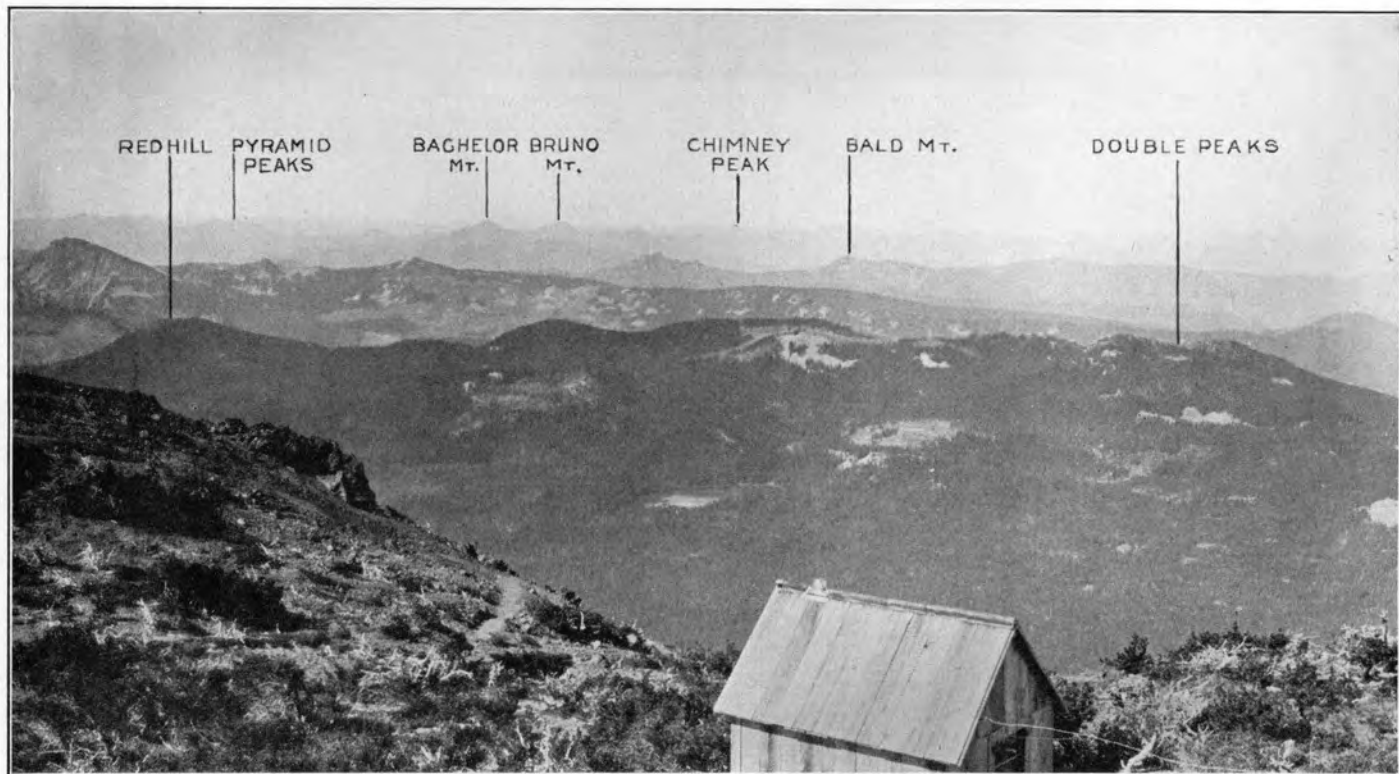
The top of Olallie butte affords a wonderfully commanding view in all directions. Here is located one of the Oregon "fire-finders" by which the Forest Service determines the location of forest fires. Toward the east one may look across the Indian reservation far beyond the Deschutes river into Eastern Oregon.



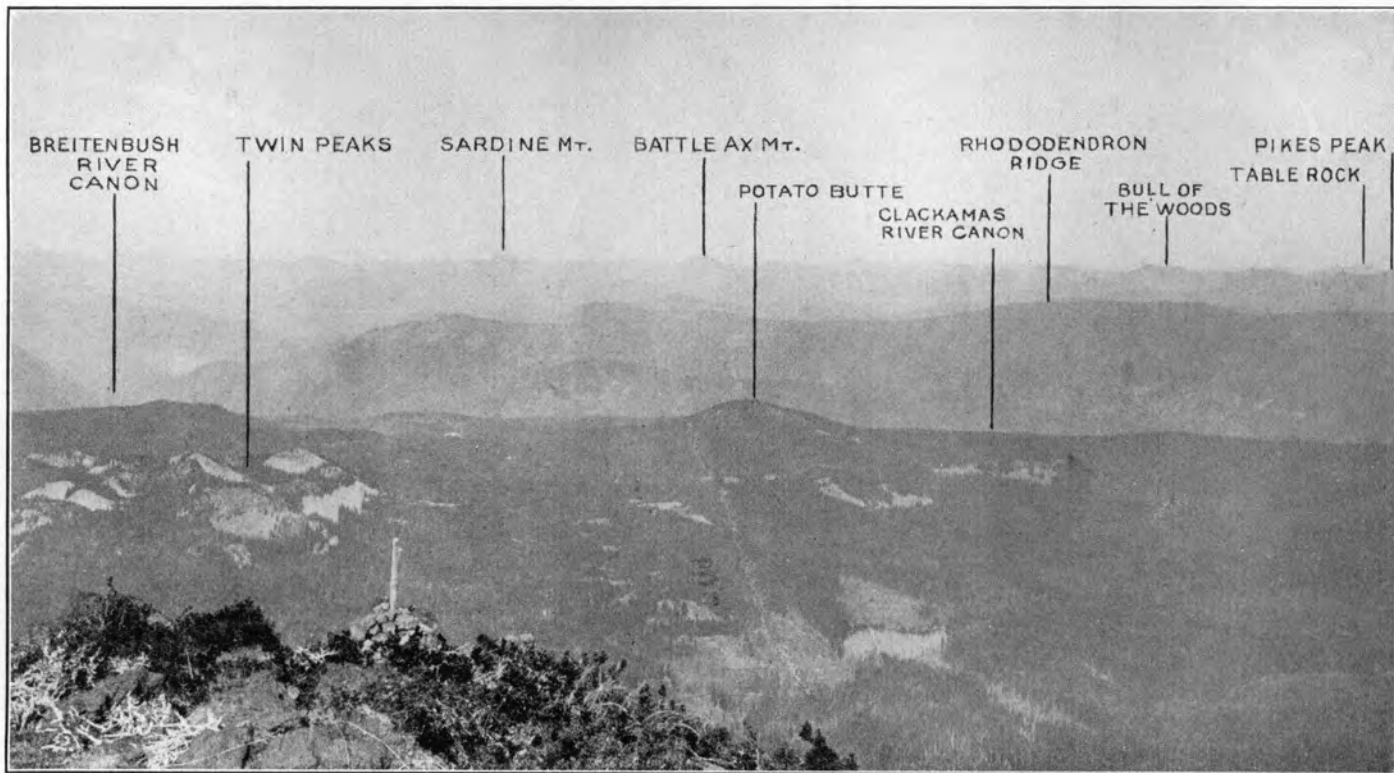
To the southeast, Green Ridge is prominent, parallel to which the Metolius river flows. At the left is the gap in this ridge where the Metolius turns towards the Deschutes and nearer is the deeply cut canon of Shitike creek.



Directly south Mt. Jefferson looms, flanked at the left by Black butte and Bald Peter, and less distinctly in the distance are the outlines of Black crater, Broken Top, and of the Sisters peaks.



Towards the southwest the notched, spreading slopes of Jefferson grade away into the labyrinth of peaks among which Bachelor mountain, Bruno mountain and Chimney peak stand out conspicuously.



Due west is Battle Ax mountain and to the north of west Pikes peak and Table rock, the latter barely short of 30 miles away. Again as the gaze sweeps over this broad westward expanse one cannot but remark the notable uniformity of height of the major peaks, some of them sharply limned against the western sky.



Crags at the east side and near the top of Olallie butte. Its side slopes are often as steep as 30 degrees from the horizontal, in places more. In the top is a small depression and around its rim the softer parts of which have been in part eaten away, jagged crags project that appear to be the outcropping of dikes of harder rock that, while molten, forced its way outward through the more loose materials of the main body of the butte. Mt. Jefferson in the distance.



Lakes about the south base of Olallie butte. Toward Jefferson again our attention is irresistibly drawn. In the foreground at the south foot of the butte on which we stand the evenly-forested, hummocky surface for several miles is literally spotted with glistening water patches of all sizes. Lakes Olallie and Monon with their picturesquely digitated borders are nearby, while Horse lake and uncounted others are seen snugly shelved, yet in what appear such precarious positions that we wonder why they do not spill one into another. Many of them have no outlets whatever and the smaller ones dry up under evaporation by the warm summer sun. All of them occupy shallow depressions in the solid lava and as our trail later leads along a tortuous course among them we will learn that they are not swampy as have been most of the lakes heretofore seen. Their shores are clean-cut and usually stony, and there is an unmistakable mien of newness about them and their surroundings.

We are led to soliloquize as to the origin of this great group of small bodies of water about Olallie butte, situated as they are on the very crest of the main divide. They rest upon a rock surface that is geologically new and they themselves are features of a new and unstable topography, as are lakes wherever found. It would require rather careful examination of the lakes and adjacent hills to determine definitely what has caused the numerous pits and broader rock basins which are so impervious as to fill to their limits with the water that runs into them from the melting snows. It is conceivable that the uneven top of a widespread flow of liquid lava might provide many depressions in which the water could accumulate. Although there is an abundance of evidence of recent volcanic activity here, yet this is a condition rarely found and not often to be expected, since the lava in coming to rest is usually more or less broken and cracks and cavities are produced through which water would quickly escape.

Summit
lakes

From even our distant viewpoint, light-colored bare rock shows through in many places as though whatever of loose materials may have covered it have been scraped away. And so our thoughts run to the probability of this region having been ground down and the hummocky unevenness brought about by the work of the ancient glaciers. The general resemblance to parts of the summit ahead to the south, where the results of glacial action are so glaringly distinct as not to be mistaken is very striking, and until we are permitted to inspect at closer range the various details of this region we shall not go wide of the mark in bearing away the impression that its chief attractiveness too is attributable to the same agency. At our distance we recognize its strong likeness to the land of characteristic ice-molding. The easy-curving ridges, dome-shaped knobs and rounded hills, amongst which are dropped here and there in rock-bound hollows gouged possibly from the softer parts by the moving ice, lakes of sky-blue or verdant green, and the moraines, all appear to be there. The veneer of forest is the only need to complete the picture and it too is present to lend its finishing touch to a scene more entrancing than which one rarely beholds. Just beyond Monon lake at the right is Red Hill, a mass of iron-stained sliding rock, either itself a volcanic cone or the ejecta from an erupting vent at no great distance. White against the lower slope of Mt. Jefferson is the line of the snow-covered divide that cuts off our view into Jefferson Park, now distant but one long day's journey.

From Olallie meadow to Breitenbush lake, called also Divide, is a half-day trip. After winding its way about several of the little lakes down upon which we have looked from the top of Olallie butte now rising commandingly at our rear, the trail climbs perhaps a thousand feet by Horse lake to the top of a dividing ridge of andesite, whence we pass from eastern into western Oregon and down to Breitenbush lake.



Cascade divide between the headwaters of Breitenbush and Whitewater rivers.

This lake is the head of the north fork of Breitenbush river, a tributary of the North Santiam, and much resembles those just passed on the other side of the divide. Here however we find indisputable proof of a glacial origin. As before, the topography suggests it, but at the south end of the lake a series of morainal ridges occurs successively one above another along the rocky slope and many bare rock surfaces are planed smooth or characteristically furrowed and striated. The lake itself occupies a depression plowed out by the ice, or at any rate formerly filled by it, and the further traces of its work will doubtless be found to extend to the westward far down this fork of the Breitenbush.

Breitenbush lake is a beautiful spot. At its south end an ice-cold stream enters and here too is open meadow where horse feed is plentiful. Elsewhere the forest comes to the water's edge. Rock cliffs look down from both east and west and to the south the sharp conical outline and rocky slopes of Campbell butte stand out. The rock at its base is andesitic and is sometimes broken and cemented into an agglomerate. Fire-wood is abundant. So likely a place does this appear to be that one is almost tempted to unlimber rod and fishing tackle were it not known that none of the lakes of the region hereabout have yet been stocked. Despite this discouraging fact, a brief halt in such environment will be full of enjoyment; although if the time be early summer one's stay is apt to be quite rigorously contested by the mosquitoes. Their industry in the early evening hours is something marvelous, to combat which active, even arduous measures are necessary. An essential precaution on a trip of any length is a goodly supply of mosquito netting in one's outing equipment.

Breitenbush
lake

Cascade divide between the headwaters of Breitenbush river a tributary of the North Santiam, and Whitewater river an affluent of the Deschutes. There is no laid out trail between Mt. Jefferson and Breitenbush lake. The most favorable course will be found to lead nearly due south for a mile or thereabout up the uneven and glacier-scored slope of the rocky divide bearing somewhat to the right as the summit is approached. The rocks are covered with soil only in patches and a sparse open forest permits the keeping of directions and progress is made with little delay. Bare rock surfaces are planed smooth and it is notable that the numerous glacial markings run north and south, or up and down the slope, instead of parallel to it as would be the case were the ice that produced them moving in a down-stream direction in this part of the Breitenbush basin. The top of the ridge is reached at the head of a sharply V-shaped gorge cut by its stream into a bed of very loose sliding materials composed entirely of broken pieces of volcanic rocks of the andesitic variety. At the rim, which is wind-swept and barren of vegetation, is a low monument built up of flat stones. In the view this monument is directly in line with the horse at the left.



Head of north branch of Whitewater river. Mt. Jefferson.

Head of north branch of Whitewater river. From here one may gaze to heart's content down into the vast amphitheatre that encircles the head of the north branch of Whitewater river. It is one of the main streams that flow from the slopes of Mt. Jefferson toward the Deschutes river. From the snow patches that so plentifully bedeck the sides of the great semi-circular bowl on the northwest rim of which we are now stationed, streams course down, we hear their sullen roar, to join the parent stream which soon plunges headlong into the shadow of its main canyon at whose precipitous character we can only guess. The crumbly, disintegrating rocks that form the walls of this amphitheatric pit can be seen to be interspersed with jutting ledges of harder kind. And the combination is one that is yielding so rapidly to the vigorous attack of the elements that most of the few trees upon the slopes are seen to have gained only a precarious foothold. There is no question that in glacial times this depression was broadened to near its present size by the grinding action of the moving glacier which no doubt filled it to overflowing. Again, we may only conjecture as to how far down-stream the ice extended, but we are reassured of its former existence here by the remains of the crescentic or elongated morainal ridges which we can scarcely mistake at our right—rock detritus built into embankments by the glacier during the intermittent halts in its final melting away.

Our eyes naturally cling to the great rock-studded snow pyramid of Mt. Jefferson. In direct line it is yet fully five miles away. Between us and the mountain still intervenes the prominent rocky ridge whose darkened rim, in our view, almost blends into the bulk of the mountain. It is from the crest of this ridge that the first glimpse will be had of the objective point of our journey, Jefferson Park, which, while it is located squarely upon the very summit of the Cascade range, occupies a great cleft in the crestal ridge, and, as we shall see, snuggles closely within the shadow of the great peak itself.

Our further course towards Jefferson Park naturally appears to be along the broken and rocky rim on which we stand. This rim forms the divide on the east side of which the waters drain away towards the Deschutes and on the west into the south fork of the north fork of the Breitenbush and on to the Willamette river. The streams on either side, and the glaciers before them, have so vigorously contested the ground that the ridge has become sharpened in places to a jagged edge impossible of travel and deep notches cut from which the melting snows send their waters each way, to meet again where the Willamette pours into the Columbia, after traversing widely separated routes. It thus proves necessary to drop down the steep slope several hundred feet on the Breitenbush side where an hour or so of meandering over hummocky morainal heaps, through meadow-like soddy plots, across glacier-plowed bare rock surfaces and again up over a succession of slippery rockslides, brings us to the edge of the snow.



Crossing the snowfields. In places the snow is soft and mushy at midday, in others, firm and crusted with ice. The grade is steep and cautious judgment is required to steer a safe course. At intervals signs of the old Indian trail are detected where the flattened slabs of platy andesite that show through between snow banks have been settled into place or otherwise arranged to facilitate difficult crossings. A judiciously selected path across some half mile of snow lands us finally, though circuitously, at the coveted vantage place whence from one thousand feet above we may gaze down upon Jefferson Park.

MT. JEFFERSON

According to the most recent measurements Mt. Jefferson has an altitude of 10,523 feet. Its topmost pinnacle which is nearly due south and yet three horizontal miles away, thus towers still 3,000 vertical feet above our present position. Although every feature of the mountain proves it to have been built up by the eruption of volcanic materials, it does not now exhibit the characteristic cone shape of the typical volcano. Instead it is a peak of ragged rocky ridges that radiate from its apex point where they culminate in what appears from our distance to be a cluster of precipitous rock walls and spires. Those who have climbed Mt. Jefferson confirm this observation and further testify to their precipitous nature by the information that not so large a fraction of those who try are able to actually scale the uppermost rock of this vast pile. The depressions between the ridges of firmer rock are seen to be occupied by large snowfields, and as we trace these far down the mountain's side, we see the unmistakable blue of solid ice showing through, where in its movement the ice has been broken across in a series of crevasses or open joints.



Jefferson Park from 1000 feet above it. Mt. Jefferson. Irrespective of the time of day and at once oblivious to the many interesting features of our immediate surroundings, we find ourselves anxious to yield to the call with which is laden the very breeze that floats up to us from this beautiful spot. But we compel a rest of a few moments from the tedious trip across the snow to ponder the great white pyramid in our fore.

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These are small but nevertheless real glaciers. The snows of winter accumulate in such quantity above that a gravitational downward movement must follow. In this movement and as a consequence of continued melting and refreezing, as well as the effect of its enormous weight, the snow is compacted into firm ice. Literally a stream of flowing ice is thus formed that is constantly replenished by the snows above while below it melts away as it meets the warmer conditions of the lower altitudes. Before us and high up in the notch at the right of the center of the mountain can be seen a snow cliff where, apparently because of harder rock or more rapid cutting out below, there is a sudden change in the steepness of its bed and the snow breaks and drops down to become a part of the moving glacier. This head portion of a glacier where the snow accumulates is often semi-circular in shape and is thus called an amphitheater or cirque. As the snow passes to lower levels it is first changed to a granular or half-snow, half-ice condition, and in this intermediate state of consolidation is called *névé*. Even here the depth of the glacial stream is such that below the surface it is in large part solid ice.

We ordinarily think of ice as being a rather hard substance and therefore brittle and unyielding. It is actually found by experiment, however, and when we carefully observe its movement as a glacier slowly creeps its way down the mountain side, that it will bend and spread out and alter its form in many ways without breaking as a truly brittle material would. It in fact *flows* and therefore adjusts itself to irregularities in its bed and to changes in direction of movement without breaking apart, unless these be too abrupt. Where the ice in its downward flow passes over jutting crags or is forced by some obstacle to sharply alter its direction, the strain upon it is frequently so great that it can no longer hold together. It then breaks and open joints or crevasses appear, their long way being across the line of greatest strain and usually crosswise of the ice stream itself. We may thus in many instances as correctly refer to ice-rapids, ice-falls, and to eddies in a glacial stream, as we do to these same features of a stream of running water. So we account for the transverse lines of blue that are plainly discernible in the lower part of this central ice stream on Mt. Jefferson, and particularly numerous and distinct far down towards the end of the larger one at the extreme right, by their being breaks in the solid ice, some of which are only wide open cracks, others being faults in which one side has dropped down and exposed a sheer wall on the opposite and up-hill side of the break.

From our vantage point, better than which could not be chosen for studying the north side of the mountain, we can plainly note the increased amount of dirt and broken rock with which the surface of each of the three glaciers is strewn towards their lower end. The middle

one even finally disappears beneath so heavy a covering of detritus that its lower limit cannot be made out. In the midway portions we detect in places dark streaks of rock materials running up and down parallel to the sides of the glacier. These are the result of the gouging action of the ice against the walls of its channel. At projecting points rocks are undermined and broken loose. These constantly fall or roll down upon the top of the ice and form rows along its sides that are later deposited as lateral or terminal moraines. At the same time the great mass of the moving ice-stream causes it to bear down so heavily upon its bed and against its side walls that it rapidly wears them away. Boulders and pieces of rock of all sizes are frozen fast and become most efficient tools with which the ice grinds away at every surface over which it moves. Both these and the rock powder, sand, etc., produced by its grinding are carried forward, not only beneath but are also gradually incorporated into the body of the glacier. Towards its distal or lower end, therefore, where melting is extremely active and, finally, at its very "toe" or "snout," where as a stream of ice it ends, it is to be expected that vast quantities of rock detritus would accumulate. This we see in the shape of ridges and bouldery heaps that are made up of a promiscuous mixture of all the different kinds of materials the ice has picked up on its way down the mountain slope. The stream or series of streams that always issue from under the snout of a glacier come out supercharged and milk-white or yellowish with the pulverized rock flour they are carrying away. The streams can transport only fine particles, however, and the remainder of the glacier's load is dumped as lateral moraines around the curving borders and as terminal moraine about its very tip.

At the left and a part of the sky-line the distinct outline of a dark low morainal ridge is seen at the lower boundary of the long snowfield. From this snow a glacial tongue swings towards us and far round and down the northeast slope of the mountain. It is pretty thoroughly snow-covered, the blue of the ice showing through only in places. We cannot mistake though the typical character of the lateral moraine that fringes its lower border, or of the great hummocky mounds of grayish black at its extremity; though more distant, the darkened rims that outline the borders of each of our other two ice-streams are likewise too characteristic to be questioned.

We see then that upon the north side of Mt. Jefferson there are three live glaciers. The one farthest to our right, whose snowfield we probably do not see, appears to be the largest of all. Among Oregon peaks glaciers are found on Mts. Hood, Jefferson, each of the Three Sisters and, farthest south in the range, a bare remnant still clings to the east slope of Diamond peak. Most of the glaciers about the best known peaks have been given names. So far as can be learned no names

Names of
glaciers

have ever been attached to any of the glaciers on Mt. Jefferson. The three within our present view are so well-defined and so frequently will, we predict, this region be referred to in the literature of the coming years, it would certainly seem that failure to appropriately christen each of them should in justice visit upon the writer properly-earned censure. It is proposed therefore to give to the center glacier, which from our position can be seen to rest in a mighty niche that it has cut for itself in the mountain side, the name Russell glacier. This naming is made in recognition of the brilliant pioneer geologic work done in Oregon by the late Professor I. C. Russell, who in 1904 described Mt. Jefferson and its glaciers. The glacier at our right which too occupies a similar deep cleft of its own will be called Jefferson Park glacier, inasmuch as the much crevassed blue-green ice of its lower end is in plain view from many parts of Jefferson Park. The glacier at the left whose snowfield rests high upon the mountain's northeast shoulder, may be termed with propriety the Whitewater glacier since its waters drain largely into Whitewater river and thence to the Deschutes river.

**Permanency
of glaciers**

Although we are compelled to regard these glaciers as for the present, and so long as present climatic conditions prevail, permanent features of Mt. Jefferson, we can nevertheless see many indications that they are but diminutive survivors of ice-fields once much more extensive. Attention has already been called to the glacial work along the rocky summit behind us and in the higher portions of the river canyons that lead down both of its slopes. We now stand upon a rib of rock that was more than likely covered with many feet of ice. If this were the case we are at once forced to the further conclusion that the glaciers also once filled to over-flowing the depression before us, at the bottom of which is now laid out for our inspection a most handsome park. Our inferences in this particular will be fully substantiated when we descend to examine more closely this beauty spot. Along the mountain sides to the very tips of the present glaciers are found also some signs of their having slowly receded to their present positions.

Mt. Jefferson appears thus to have been a gathering ground for the snows that in ages past doubtless fell much more copiously than now. Surely the mountain must have been but a great white dome and so deeply snow-covered that scarce a point of rock showed through. From its sides great glaciers moved in all directions; far out to the north and south along the summit, as well as down the range slopes to the east and west did the sheets of moving ice spread, occupying the river canyons and grinding away at every surface over which they passed. We are very certain that the ice from Jefferson actually met and joined with that from other high peaks that were at the same time areas of snow accumulation from which glaciers emanated. An abundance of

evidence is found that the entire Cascade summit from Mt. Jefferson southward for more than one hundred miles was not only entirely ice-covered, but the rocks everywhere along it were so profoundly eroded that we can gain little conception of the amount of rock material thus carried away.

There can arise little question therefore that the position of Jefferson park was formerly filled with glacial ice hundreds of feet in thickness. In fact when we consider the varying character of the rocks of Mt. Jefferson at the foot of which the park lies, we will be at once impressed with the probability that the indentation in the summit which it occupies has been cut out chiefly by the glaciers themselves. The body of the mountain is composed of a great deal of ash and scoria, and loose pieces of broken lava. Beds of harder rock stick out in places as though in the course of eruption this volcano, for such it is, had at times poured out liquid lava, or great dikes of harder rock have resulted by the hot liquid magma within pushing its way outward through the looser textured materials. In any case the combination of hard and soft materials in its make-up has rendered Mt. Jefferson quite susceptible to the action of the tearing down forces. The weather has crumbled the harder ledges wherever exposed and the glaciers have so riven its sides that what we see now seems but the partly dismembered skeleton of what was in all probability once a somewhat higher, much more symmetric and commanding peak than at present. It is rugged and reputedly difficult to climb because of the merciless rending it has suffered from the glaciers, and the tearing down process still proceeds unabated.

After thus making a hurried study of our surroundings, we may again look down upon Jefferson Park. It appears to be flat-floored and among the clusters of trees that are arranged in open order, there is a liberal speckling of lakes of many sizes. The park has a maximum width of one mile from north to south and the level portion is not over two miles in an east and west direction. At the far edge it is abruptly bounded by the steeply rising ramparts of Mt. Jefferson. To the west it breaks away in a succession of shelving meadows down into the impenetrable canyon of Whitewater creek and that of the south fork of the Breitenbush, while its east border is determined by a series of similar picturesque meadows that, too, soon give way to the rocky slopes leading down into the gorge of Whitewater river.

From Government Camp to this point is about a five day trip by pack outfit. In the five days we have come south about 40 miles and with the meanderings of the trail have probably traveled a total of close to sixty miles or thereabouts. This route to Jefferson Park is a most satisfactory one during the midsummer months. Packers (and with pack horses, beyond Clackamas lake, is only way the trip should be

Summary
of trip

attempted) will find an abundance of feed and water at convenient stopping intervals. The scenic features along the way thus far, coupled with the constant high pitch of anticipation of what is ahead, are certainly sufficiently ample and varied to not only ward away monotony but, except to him who borders on the stupid, thoroughly prove an outing of extreme educational as well as health building value. Before examining at closer range the various features that together make Jefferson Park so attractive a place, brief space will be given to a hasty reference to the other routes by which it may be reached.

OTHER TRAILS TO JEFFERSON PARK

IT has been pointed out that Jefferson Park may be reached by trail from the railroad at Detroit. Instead of the railroad ride to Detroit one may enter the Cascades from the Willamette valley at many points, usually by wagon road that later gives way to trails as settlements are left behind and the less accessible sections reached. Along the front of the range are many railroad towns from which start may be made. The town of Estacada in Clackamas county, itself a resort of note, has proved a convenient outfitting point and one easily reached from Portland and all outside localities. Jefferson Park is in direct line something like 50 miles from Estacada but on account of the exceeding roughness of the country the trail between the two places will prove to be at least one-half longer than this distance. Though the part of the Cascade range through which one will pass is one of wildness and extreme interest geologically, unless time is an item of minor consideration this route should probably not be seriously considered. To the person with leisure, and who loves the out of doors, it will be highly gratifying.

Estacada to
Elk lake

At Estacada a very coarse gravel may be seen resting upon the uneven surface of columnar basalt in the gorge of the Clackamas river. The altitude of the town is 464 feet above the sea. From this the road to the south climbs quickly to the top of a rather even-topped bench between 1000 and 1100 feet in elevation. This bench is soil-covered and the site of prosperous farms. It slopes gently towards the Willamette valley and in places angular and rounded boulders and gravel pebbles appear. At the north fork of Clear creek two miles southeast of Dodge the elevation is over 1200 feet and here our first glimpse of the rock strata is obtained. At this place and at the crossing over Clear creek a little farther on, are heavy ledges of a hard bouldery volcanic tuff, a vast bed of broken blocks of lava cemented together into solid rock. In the next 10 miles we rise rapidly to an altitude of 4000 feet at the Timothy Patch, and to 4500 on top of the divide near Cold Springs ranger station. At Baty butte six miles beyond this station we have climbed to 5000 feet. At all altitudes up to 2000 feet and,

just below Baty butte, as high as 4000 we still note the presence of the rough volcanic conglomerate. In the canyons which here are both deep and precipitous it stands out far below the trail as bare cliffs and as crumbling pillars and pinnacles. The tops of most of the ridges thus far however, some not higher than 1500 feet, have a covering of lava, usually thin, at the most not over a few hundred feet in thickness.

From Baty butte to Elk lake the trail first drops over 2000 feet into the canon of the Hot Springs fork of the Collawash river to Bagsby hot springs and then climbs with the grade of this stream and by the Silver King mine to nearly 5000 feet at its head. This is the top of the divide that separates the Santiam drainage at the south from that of the Clackamas river. The hot water at the Bagsby springs bubbles out from several openings in a coarse volcanic conglomerate apparently similar to what we have seen at many points along the trail. The rounded pebbles and boulders of which it is made are firmly cemented together by what may have been fluid volcanic mud, or even of molten lava, that has picked them up or percolated into the openings among them so as to form a dense rock. The so-called Silver King mine though



Battle Ax peak from the southeast. Dunlap lake in front at the left. The rounded slopes are glacier molded. From the head of Hot Springs fork the trail continues southward first on one side then on the other of a sharp divide, across burns and over patches of glistening or loose sliding rock, to the base of Battle Ax mountain. Battle Ax is itself a part of this divide, because of its height so prominent and its horizontal sky-line so conspicuous as to be seen and recognized from almost every slightly point in the whole northern part of the Oregon Cascades (see panorama from top of Olallie butte). It is built of a series of volcanic beds with a platy augite andesite at the top. This variety of rock alternates with red and black scoriaceous or cellular lavas down for about 750 feet. Below this a great mass of lighter colored, less basic hypersthene andesite showing many distinct white or shiny crystals of feldspar forms the base and the ridges leading to the north and eastward from it.

1400 feet higher in elevation is similarly a nearly vertical gash in this coarse bouldery conglomerate that has been filled with quartz and some of the metal-bearing sulphide minerals. There are indications that considerable prospecting of this vein has been done.

The aneroid if carried to the top of Battle Ax, and it is a delightful climb not by any means to be let slip in the huckleberry season, will indicate its altitude to be a little over 5700 feet. Mt. Beachie one mile to the west of south appears to be a part of this same crumbling ridge at both the east and the west slopes of which the streams are so vigorously gnawing away that between these two mountains at the head of Elk Lake creek, the dividing wall has in places been reduced to a sharpened edge and parts of it nearly if not quite toppled over.

GLACIATION IN THE CASCADE RANGE

A LONG the northeast base of Battle Ax where the trail passes is a series of little lakes and swampy places and elongated embankments of earth and rocks, all perched high up on an irregular shelf of solid rock at the lower edge of which the land drops nearly precipitously for a thousand feet or more to the headwaters of several small creeks that flow eastward into the Collawash river. We do not need to search long to discover the origin of these features. Bare rock surfaces are seen here and there that are polished smooth or bear the unmistakable parallel facets or grooves that are produced only by the ponderous movement of great masses of glacial ice armed with sand and pebbles so that it can grind down the hardest of rocks. We are thus forced to conclude that in times not long past parts of this portion of the Cascade range, as we have seen is true of the summit, were also covered by ice during the glacial period. Far out on the ridge to the north of Elk lake the evidence of glacial molding is recognized, and on the divide to the south and east of it the bare rocks are still in sight as though just scraped clean and deeply scored by the ice. Here, too, about the head of the west fork of Humbug creek, are a number of small lakes that occupy shallow pits that have been scooped out of the hard rock by the movement of the glaciers. Dunlap lake is one of these. Elk lake itself, a pretty little body of water immediately at the southern foot of Battle Ax, is probably also of glacial origin though situated over 1700 feet lower than the summit of that peak.

We have been examining here but one of a great many places in this front and more rugged part of the range where evidence of the former work of glaciers may be found, yet where not even the remnant of one exists at the present time. Though we are more than 20 miles west of the summit of the range, the highest peaks are many of them fully as elevated and some more so than are parts of the summit itself. It is not surprising therefore to discover that from some of these peaks

glaciers have flowed down from the heavy snows that must have accumulated upon them and have left their imprint upon the mountain sides, just as they did from the main peaks along the crest of the range. While here we see in the presence of the lakes, the moraines and the ice markings only the footprints, as it were, of the active agent that produced them, about the highest peaks along the summit, as Mt. Hood, Jefferson, and the Sisters, we actually find besides these marks the dwindled remains of the ice-streams themselves, insecurely clinging high up on their slopes, it is true, nevertheless a further convincing key to conditions once existing there. We have few data as yet to tell us much about the distance to which the streams of glacial ice moved down the slopes and into the river canyons from the various elevations in whose snowfields they originated.

Elk lake and summit peaks from the top of Battle Ax mountain. From Battle Ax the view to the east is one of sharp ridges and deep canyons. Olallie butte is due east and at the left in the picture. Mt. Jefferson stands commandingly at the right. While at one's very feet is Elk lake, all within its scope reflected from the water's surface as from a mirror. At the right we look lengthwise of the canon of the south fork of the Breitenbush river and across Whitewater creek and see the notch at the north foot of Jefferson where both take their rise in Jefferson Park. Just beyond the first dark forest ridge in the center of the view is the canon of Humbug creek, a tributary of the Breitenbush, and a little to the left the low gap marking the location of that of the north fork of the parent stream. Near the extreme left can be seen, far toward the summit and in line with Olallie butte, the position of one of the main head branches of the Clackamas river whose waters pass far to the north-westward to finally reach the Willamette near Oregon City. The Breitenbush discharges into the North Santiam and it in turn joins the parent stream between Albany and Salem. On the slopes of the hills beyond Elk lake, a number of mining claims have been located and prospecting is being actively carried on. The metal-bearing minerals appear to occur in cracks in an andesitic rock that has been broken somewhat by movement and in part altered and silicified.

Although in direct line still fully 20 miles from Mt. Jefferson, the position of Jefferson Park can be so distinctly made out that one is inclined to feel that the goal is nearly won. The course over which one must go, however, of necessity so greatly departs from "the shortest distance between two points" that instead of 20 the distance yet to travel will prove nearer 35 miles.

It will be recalled that the principal trails have so far followed for much of the way along the tops of the ridges that separate the river canyons, many of which are in places 2000 feet and more in depth. From this point on, however, our trail will follow for a goodly part of the way in the bottom of the canyons, while in places



Elk lake and Summit peaks from the top of Battle Ax peak.

for miles the forest cuts off our view and we see even little of the rocks over which we travel.

From the ranger station at Elk lake we go over a low pass and descend between three and four miles to the Breitenbush where our trail joins the main trail from Detroit to the Breitenbush hot springs that are six miles farther up this river. These springs are well known and, although to be reached only on foot or by horse, have become the basis of a popular resort that is frequented by hundreds each year. We could turn here if we chose and, going up the Breitenbush to its head pass over into and across the Clackamas river canyon to join the main summit trail at Lemeti some six miles north of Olallie butte. But all will probably be found more satisfactory if, instead, we turn downstream six miles to Detroit, and then take a most excellently laid out trail up the North Santiam river for 11 miles to where Whitewater creek comes in.

Elk lake
to Detroit

Along the Santiam we are on what is called the Marion lake trail and its good repair can be attributed to its being a much traveled highway to that attractive body of water lying near the summit to the southwest of Mt. Jefferson.

Since leaving Detroit the distance has been ticked off for us by a series of neat though conspicuous mile signs. One cannot but appreciate the spirit of helpfulness that has prompted the putting up of these signs, although had their inexorable accuracy not been tested time and again we might be constrained in case of haste to question their correctness. Nor do we marvel less at the cogency than variety of the advice that is persistently offered to us on the signs that warn against forest fires. Whatever impression they may make as to our moral or legal obligations they do at least remind us that we are traveling within the government domain, this the Santiam National Forest.

Detroit to
Jefferson
Park

It may be with some misgivings therefore that, on leaving this main trail at Whitewater creek, we find our progress often much impeded if not at times actually blocked by, for the most part, a very stony trail and one from which logs have not been removed. It is a tortuous trail largely because of the detouring necessary to dodge these obstacles and to surmount sudden changes in elevation. Even the familiar signs fail and the journey through the forest for eight miles first up the Whitewater and then a tributary, Cheat creek, to Whitewater ranger station though of decidedly jostling interest proves an energy-consuming one to both man and beast. Along Whitewater creek glimpses may be caught of outcropping conglomeratic beds, and bouldery masses in the bed of this murky stream attest the presence of the same general type of fragmental volcanic rock that we have heretofore seen at these lower altitudes in so many places.

From the ranger station where the aneroid indicates an altitude

above the sea of around 4750 feet, rapid rise is made in climbing to the summit of the rocky east and west divide that separates the waters of the Whitewater from those that go to the north into Breitenbush river. The green forest is left behind. We pass across open burns where the bare andesite is frequently seen, and meanderingly zigzag up the mountain side among stern tottering or fallen specters of once forest giants, with only rare signs of a trail to follow. Here, about the head of Cheat creek, is again observed abundant evidence of the work of glaciers. The rounded character of the rock forms some of which, far down towards the ranger station just left behind, exhibit the typical parallel scorings that only moving ice produces, and the U-shape of the stream gorges are unmistakable. The position and form of this ridge which we now follow nearly to Jefferson Park is such as to indicate with great probability that the elevation of Mt. Jefferson was a source of the glaciers that came for many miles down its western slopes. It has been whetted in places to so narrow an apex that one must cross and recross and then find only a precarious footing against its steep and slippery sides or on sliding rocks that are anything but secure. Since the time of the glaciers the streams have by their ceaseless cutting accentuated the abruptness of this ridge, so that at some points we have the sensation of passing along almost overhanging cliffs from which we gingerly peer down for a thousand feet or more into the depths of the canyon where we can occasionally see the debris whitened waters of Whitewater creek, less often hear their booming roar. This too is an old Indian trail and is so little frequented that no work whatever has been put upon its improvement. It is therefore not a trail that one, unless somewhat experienced in mountain travel, passes over with equanimity perfectly undisturbed. A reasonable amount of caution, however, and the exercise of ordinary judgment reduces the element of danger to such a degree that any one possessing these qualities in just normal quantity need not hesitate to pass over it. Relocation and rebuilding are, nevertheless, much to be hoped for, and something too, to be confidently anticipated as the fame of Jefferson Park furthers an already growing demand for a safe means of reaching it.

Park-like meadow at the west side of Jefferson Park. Within a mile of the west edge of the park the trail drops down off the ridge to the south or Whitewater creek side, but we continue to rise over successive rock-supported benches on which are located a series of most beautiful grassy meadows. They are deep-sodded, tree-dotted, covered with grass and a sprinkling of bright flowers and through each meander the branches of sparkling mountain streams that separate and unite, in anastomose fashion, amongst the quiet pools that mark their former courses. No one will question the appropriateness of the feeling that we are already passing through a portion of "the park," for no term could



Park-like meadow at the west side of Jefferson Park.

be more fitting. We are now at the very base of the mountain though not yet quite so entirely within its shadow as we shall be at the end of a further climb of a few hundred feet that will land us upon the summit.

THE TWO ROUTES TO JEFFERSON PARK

WE have now approached Jefferson Park over the two different routes by which it can be conveniently reached, one, following from the north along the comparatively even summit, and the other entering after a passage of greater or less length through the more rugged sections of the Cascade range. The former may be termed the *summit* route, the latter the *Detroit* route. The summit route, as may be seen on the map, is joined at intervals by branching trails, and, in the same way, besides coming to Detroit by rail, can the entrance by the "Detroit route" be used by way of tributary trails from various directions. Detroit to Jefferson Park is between 22 and 25 miles, a good long day's travel for the most hardy. For the average person the only satisfactory plan is to spend one night in camp on the way.

The trip from Estacada, if great haste is not essential, will take five days. The only mode of travel is by pack train and either afoot or in the saddle. Meadows occur at sufficiently frequent intervals to afford feed for horses in plenty and an abundance of good water is obtainable almost everywhere. There are many springs along the trail and innumerable mountain streams whose source is the pure water that seeps or bubbles from the porous rock strata that in turn catch their supply from the melting snows that rest upon them oftentimes until late in the summer season. In this particular is the summit trail somewhat disappointing, for there many of the early season springs disappear and the staleness of the standing water of lake or pond, never more than fit, renders very questionable its use for human consumption during the late summer months. One sees, however, on the two routes two different types of mountain topography. That of the summit, a new and immature one, the other a more pronounced and featureful land surface of middle age, if we may use the expression, where the natural agents seem more busily at work and we see in what way they have been and now are responsible for its shaping.

IN JEFFERSON PARK

THE descent into the park from its north rim is made down glaciated rock slopes, over morainal heaps, and across stretches of earth-filled slide rock. Occasional but scanty marks of an old trail are seen. In a distance of perhaps a mile the drop is about 1000 feet.

An appreciation of the beauties of this place, which those few persons who have visited it affirm is not to be equaled anywhere else in Oregon, could not be gained by reading volumes that might be written

about it. It is one of those rarer gems that nature sets down here and there, that, like other jewels of price, must first be sought out by diligent, oftentimes protracted and tiresome effort. But unlike those jewels it needs not the hand of the lapidary to saw and polish, for nature has already done that part. And she holds out to the steadfast of her children the finished article, to touch which man would mar, not perfect. To reproduce the charm that only the environment itself can lend is an impossible thing. The thrill in its fullness comes only to him who is able to go and see. The camera fixes the bare cold outlines of rock and tree and lake and mountain. It furnishes the visual foundation on which depends the pleasure of a visit to a place like this. If the pictures, therefore, can be instilled by means of the right sort of a written word of explanation or casual suggestion, with ever so little of the spirit that pervades the very atmosphere of the places they represent, their presentation will be fulfilling the main purpose that photographs can serve. Their purpose in this brief story is in part but not so much to remind those who have already enjoyed a visit to Jefferson Park of what they have seen there, as it is to suggest to the many others who may or may never be able to go, something of the attractions and the delights that await them.

In Jefferson Park looking toward the divide at the north side whence entrance is made by way of the summit route. Though we are still on the summit of the Cascade range, we are nevertheless close to one thousand feet below the rim where the snow patches show. The lake in the foreground is but one of many similar bodies of water in the park and is so neatly balanced that one must search its borders to determine whether it will outlet toward the Deschutes or the Willamette. The rounded and moderate slopes beyond the lake have been glacier-molded and are strewn with pebbles and boulders left by the ice that the sod and forest growth have not yet covered up. In the immediate front is a rock-scattered surface from which many knobs of solid rock project that have plainly been worn down by the ice. So recent has this been that only on protected places among the rocks has soil enough been formed for plants to gain a foothold. The trees whose footing too is as yet rather precarious are not of large size and are principally Alpine firs whose natural habitat is only in the higher altitudes. Members of the Bureau of Mines and Geology party appear at the right.

At the immediate foot of Oregon's Matterhorn. The rocks of which the mountain is made are seen to be largely of loose, crumbly character. They produce unstable slopes that are rapidly cut into by streams and speedily eaten away by the glaciers. It is the physical character of the rocks and the intermixing of hard and soft that have made ascent so tedious a task. Unless the course is chosen with great care the climb is extremely difficult from this side. At the extreme left against the sky is a part of Whitewater glacier. At the right and starting high up



In Jefferson Park, looking toward the divide at the north, whence entrance is made by way of the summit route.



At the immediate foot of Oregon's Matterhorn, Mt. Jefferson.



Lake near the west boundary of Jefferson Park.

in a deep cleft near Mt. Jefferson's summit is the Russell glacier. Toward its head, is a vertical wall or ice cliff produced by its passage over some obstacle or a sudden change in the steepness of its bed that has caused not only a transverse crack or crevasse but "faulting" or a dropping down on the lower side of the crack. This kind of crevasse has been given the name *bergschrund* by glaciologists. Formerly a branch of this glacier came down the depression leading toward us in which but banks of snow now lie. Across it are now thrown two barriers, one a tree-sprinkled ridge low down and the other, the thin dark band at the edge of the present glacier, what appears to be part of its lateral moraine. Without making a careful examination it cannot be said but that the first of these also is of morainal character, and if so, put there while in its retreat the lower edge of the tongue of ice temporarily halted in that position. Glaciers recede when melting of the ice is more rapid than the downward movement. Movement is determined by the amount of snowfall from which the glacier is supplied. It is found therefore that glaciers fluctuate, as do rivers of water, advancing after periods of heavy precipitation and receding when drought comes on. Russell glacier makes a turn to the right, that is, to the northwest, above the well-defined moraine near the top of the photograph at the extreme right, so that its terminus is not in view from this location. The foreground is literally a mat of flowers through which white boulders peep. Against the grass green the delicate pink of the red heather vies for dominance with the tender white of the less conspicuous moss heather. A liberal spattering of Indian paint brush crimson lends a pleasing touch of quality to the assemblage.

Lake near the west boundary of Jefferson Park. There is no dearth of camping places. Indeed, they fairly run riot so that one feels almost disconcerted at not being able to take advantage of more than one at a time. A sward delightfully clean and comfortable, enough of loose rocks handy for campfire and settees, lovely flowers to please the eye, ample fuel. Best of all, each may have an individual pool, or as many as may be desired and no need of competition, with borders that for convenience are sod-upholstered and fringed with heather. In them every outline of tree and cloud is mirrored. Their bottoms are stoneless and an unfailing solace to tired feet. At the left and neatly framed between stately noble fir and less pretentious mountain hemlock we look against cliffs that form a lower shoulder of Mt. Jefferson down which what we are to call Jefferson Park glacier creeps. Though it has obviously cut a path for itself it nevertheless is badly broken where the final plunge is made over the steeply declivous rock front to soon waste away, and melting, contribute its substance to the swollen waters of Whitewater creek. The ice shows blue and the crevassed and pinnacled surface makes this glacier an object of outstanding interest from many points in the park. A few hundred feet of climb carries one to its lower end where various features common to glaciers of this type may be studied at close range.

The prominent knob is an outstanding portion of the north wall of the park. At a distance the rock appears black and

about its base the talus slopes are of gray and yellow colors. Without further corroborative evidence one might infer from its general appearance that this isolated peak, though entirely surrounded by the ice that gnawed away at its sides and base, may not have been entirely covered over by the glaciers. In any event the fact of its having so withstood the attack of all the natural conditions that tend to tear it down that it still defiantly lifts its castellated crags to commanding height is eloquent if mute testimony to its relatively resistant character.

There are countless lakes within the park. Some are a half mile across and others but pools in size. Some have outlets, others no outlet that can be seen. The surplus waters from some drain away to the eastward through Whitewater river. From others the excess goes down into the Breitenbush and (unfortunately so named) Whitewater creek, to find its way to the Willamette. The lakes invariably occupy pits or shallow basins that have been scoured out of the usually firm andesite by glacial action. Often the clean, fluted or polished rock surface may be seen about their shores. Again the shore lines are precipitous and erratically indented so as to form embayments and their complements, rocky capes and peninsulas if not islands, as if the hollow the water fills was made by the bodily plucking out of great angular blocks of rock at a place. None have as yet been stocked with fish.



Rock surface molded by glacier movement. At many points glaciated surfaces are found. Some are planed smooth, showing merely parallel scratches, others fluted or grooved, while yet again furrows or channels are seen whose depth and width must be measured in feet instead of inches. The direction of these markings is an index to how the glacier moved that produced them. The rock shown is in place and just at the brink of the cliff at the east edge of Jefferson Park where the slope begins to drop by a succession of precipitous benches into the canyon of the Whitewater.



The prominent knob is an outstanding portion of the north wall of the park.



A mere bank of flowers. Numerous are the secluded nooks where against a shadowed background of clustered fir and dignified hemlock, gardens of flowers are framed. Richly bespeckled with the gray-white of the andesite boulders that show through, and mirrored in the water of the sod-bound lake in the fore, such gorgeous spots as this it is futile to attempt to describe. Indian paint brushes profusely dominate in front and the white, pink and red of the heather are in clumps behind. Through the trees is the outline of a part of the divide to the north of Jefferson Park.



Where whole meadows of flowers bloom. In various parts of the park are flat areas that during the summer are daily irrigated by water from the melting snows of the mountain side. Streams of all sizes trickle down and from noon to late in the day when melting is most active, the water spreads, in places as an irregularly advancing sheet, in others a series of interlacing rills, across level open patches whose ashy soil greedily drinks it in. Mornings one may walk with little heed where at a later hour the way is barred by sticky mud or swollen creek. In the view the meandering course of the soil-charged rivulet may be traced for many rods across the open glade. Colonies of wild lupine adorn its banks among which the bladed leaf and navy blue of the shooting star appear in lesser numbers. Ever present, too, are the Indian paint brushes whose vaunting display of carmine hue imparts not alone dignity but harmony to the scene.



Glacial meadow near the east side of Jefferson Park.

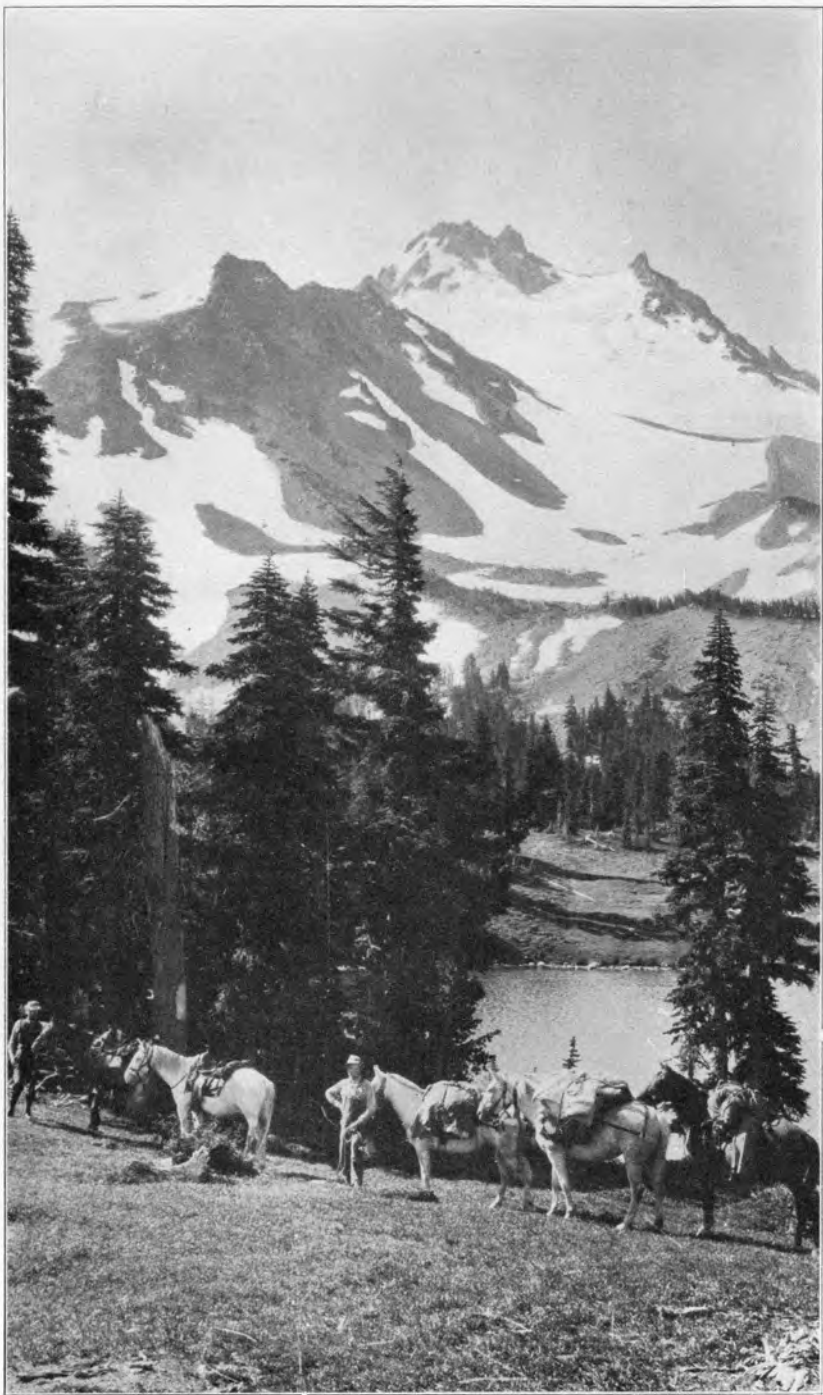
Glacial meadow near the east side of Jefferson Park. At either end of the park, to the east and west, one may go down over a series of benches or rock shelves, one below the other, before reaching the main sharp canyons of the rivers that drain it. Each bench is separated from the one above by a rise and that below by a drop of varying height, sometimes almost vertical and always of exceeding rockiness. Upon these shelves which are flat, are sometimes one or more small lakes, but more often a group of sparkling clear pools or ponds, through or around and among which one or more gracefully meandering streams weave their way. The open space is invariably carpeted with a springy sod that supports grasses and here many of the more brilliant hued of mountain flowers find a congenial home. This type of meadow is one of the most pleasing of the many attractive features provided for the visitor to Jefferson Park, gratifying not alone to the eye of man but to the palate of beast as well. It is the result in some instances of the work of a glacier in the decadent stages of its occupancy of a region. While the edge of the ice remains stationary for a time a rim of earthy rock material is dumped across its channel. We thus sometimes find morainal heaps or ridges at the down-stream borders of the open meadows. During a period of rapid melting when the edge of the ice moves back rapidly, much less of material is deposited at any one point and what is left behind is spread more evenly. In this manner comparatively level stretches may result on which vegetation can gain a start by the filling in, first with water and then fine sediments, of the area across which the ice has receded rapidly and behind or above these recessional moraines that then act in a way as barriers across the drainage channel. Such may some of the prettiest of these mountain meadows be seen to be. The rock cliffs by which they are hemmed in above and below are the result of the plucking action of moving glacial ice that pulls away great rock blocks, fast to which the ice has frozen. The forest fringe at the farther border of the meadow is a typical growth of alpine fir.

A glade wherein wild lupine prevails. Here also are the paint brushes to grace the foreground, and blending with the lupine blue the sensitive yellow of the less pretentious *Townsendia*, an aster-like bloom of modest mien. Though not conspicuous, here is the still more demure saxifrage whose yellow or white-tipped spikes and tufted basal leaves bespeak its presence almost everywhere. Wild caraway too is frequently seen where moisture is more plentiful, lifting its umbellate head above its less spindly neighbors. In this photograph the rounded outlines of a topography that has been quite largely shaped by the grinding action of glaciers is rather clearly brought out. There is an evenness of curvature that water erosion alone does not produce.

A general view of Jefferson Park entire reminds us again that it occupies a deep cleft cut across the apex of the Cascade summit at the north foot of Mt. Jefferson. That it has heretofore been deeply filled with the ice of a giant glacier every evidence goes to prove. We catch signs enough of its work to show that the ice



A glade wherein wild lupine prevails.



Mt. Jefferson from near the west side of Jefferson Park. At present there is in Jefferson Park only such accommodations as nature has provided. These are not to be excelled, so far as nature's provisions go. But the visitor to this wonder region must bring along such of sustenance and the comforts of civilization as he may require. Moreover, the road is a long one and in places of exceeding roughness, which only goes to say that the amount of luggage taken must be reduced to a minimum, whether the journey is made by horse or on foot. Even now the rigors of getting there are as nothing against the gratifying delights of ever so brief a sojourn. Russell glacier as seen from the Park.

must have flowed outward both to the east and to the west and for an unknown distance down each of the river canyons that lead from the park. We further have strong grounds for believing that this two-part glacier of which only dwindled remnants now remain clinging high up on the sides of Jefferson, was responsible for excavating to bedrock and carrying away the vast quantities of mainly loose volcanic materials that formerly extended to the northward as they still do in all other directions as a series of radiating ramparts about Mt. Jefferson. How far into the solid rock the cutting action of the ice proceeded after the removal of the fragmental materials we know only that it must have been considerable. All of the many little lakes occupy basins scooped out by the glacier and the ever present grooves and scratches are its indelible footprints.

Some day, and with an increasing knowledge of its attractions there is reason to feel that the day may be hastened, there will be good trails from all directions into Jefferson Park. Slight improvement of the present Whitewater trail will make it entirely safe and satisfactory from the west side. From the east side, a careful reconnaissance should show a feasible way either down Whitewater river and across the Warm Springs Indian Reservation or, swinging to the southeastward, over the divide to connect near Bald Peter with the Jefferson creek trail and thence out along the Metolius river.

At the north side of Jefferson Park a judicious marking of the present all but obliterated old Indian trail from Breitenbush lake is something very greatly to be desired. Some day this trail too will be accurately laid out and made usable during the summer season.

It will be recalled that there is now a good automobile road along the Cascade summit southward to Clackamas meadow. For its construction the government Forest Service is to be highly commended. Its terminus is, in a straight line, yet about 27 miles away from the park. The extension of this road rapidly southward in the years to come is to be urgently hoped for. So far as the character of the country is concerned, from the scenic as well as engineering possibilities, it is not idle dreaming to believe that not so many years will elapse before automobiles will carry their passengers, without portage, to the center of Jefferson Park and among its beautiful lakes. The attractions of the place need only to be widely and persistently heralded to aid very materially in bringing this about. And then, possibly before that time, as a logical and orderly sequence citizens of Oregon are going to ask that Mt. Jefferson and its scenic environs of which Jefferson Park is but one, be set apart as a national pleasure place. The name Jefferson Park appears thus the more fitting in that but a single word will then need adding to a term with which every one will be familiar and Jefferson Park, expanding with the scope of its area, will become Jefferson National Park.

THE THREE SISTERS REGION

The Three Sisters region is a section of the summit portion of the Cascade range that is second to no other in scenic interest. It is so designated because of its domination by the Three Sisters peaks and they are so named ostensibly on account of their close association and fairly uniform height rather than upon marked resemblance. This group of peaks stands a little to the north of the middle point of the Cascade summit. It is located essentially half way between the Columbia river and the south boundary of Crater Lake National Park, the latter being still somewhat over 50 miles from the California line.

Three Sisters and other summit peaks from near Bend, Oregon.

The first three snow peaks at the right in the photograph are the Sisters. Next to the south member of this group is Broken Top. It is really some four miles nearer to our present position than is South Sister at whose left it appears to stand as a formidable guardian rampart and which, indeed, it is. Slightly nearer at the left of Broken Top and apparently forming a lower shoulder of that mountain is the flattened white dome of Ball butte. Yet to the left and low against the horizon line the top of what is probably Soda hill peeps from behind the intervening forest. At the extreme left the symmetric snow-covered cone with wide spreading base is Bachelor butte, 9045 feet in altitude and, on account of its massiveness and even symmetry, one of the most imposing of the less known peaks of the Cascade range in Oregon. At the right of Bachelor butte and not quite so distant is Tumalo mountain.

The foreground is illustrative of the typical sagebrush land of central Oregon. Among the brush is a scattering of juniper, the dead and bleached remains of a few of which appear in the view. At the right beyond the team is the upper portion of Pilot butte. This butte stands at the east edge of the city of Bend and is a great heap of volcanic cinder, ash and scoriaceous rock with the depression of the crater still showing its top. Pilot butte has the appearance of having stood here and being surrounded as an island by a billowy sea of seething molten lava when the widespread flows of basalt came that now underlie many hundreds of square miles in this part of Oregon.

The Three Sisters region may be reached from both eastern and western Oregon by way of the McKenzie road. This road is so called because it follows for many miles up the McKenzie river, recognized to be the largest of the headwaters of the Willamette which it joins a short distance below Eugene, the county seat of Lane county. From Eugene regular auto stages run for more than 60 miles up the river to McKenzie bridge and to Belknap springs, over a road that in large part is in most excellent condition for automobile travel during the summer months. The Southern Pacific railroad station in Eugene has an ele-

The
McKenzie
road



Three Sisters and other summit peaks from near Bend, Oregon. The Sisters peaks stand a little apart from conspicuous summit peaks to the north, spine-like Mt. Washington 15 miles distant being separated from them by many square miles of impregnable lava flows of geologically recent date. From the southwest on the other hand the Sisters are but the culmination of a succession of snow-clad summit heights that, as one views them in early summer from the country to the east, stand deployed as would be the outlook sentinels of a distant great battle front.

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McKenzie road in the canyon of Lost creek.

vation of 426 feet above sea level. The climb in the first 60 miles to McKenzie bridge is somewhere near one thousand feet.

From McKenzie bridge to the summit is about 20 miles and the auto road continues on down the east slope of the range for another 20

miles to Sisters in the Deschutes valley, whence branch roads radiate towards all of the settled parts of eastern Oregon. In the 20 miles from McKenzie bridge to the summit one rises about 4000 feet or an average of 200 feet to the mile. Sisters has an elevation of 3175 feet, a drop of a little over 2000 feet from the summit height.

The Sisters peaks are reached by a trail that starts from the McKenzie road in what is known as Lake valley between six and seven miles west of the summit.

Volcanic
rocks in
McKenzie
river canyon

On leaving Eugene the traveler first passes through a prosperous farming district in the lower McKenzie valley. At Eugene, at Springfield, and for some distance up the McKenzie we see hills of basalt, and this rock occurs also very frequently in the river channel. Before many miles are traversed the valley walls close in, farms become scarce because of lack of room, and the rock slopes get steeper and the mountainous ridges at either side increase in height and ruggedness. Small quarries have been opened at several points to provide road-making material where the character of the rocks may be nicely seen. At many places we see the pebbly and bouldery volcanic tuffs, often called conglomerates. Where the volcanic pebbles have somewhat sharp corners and edges as though but freshly broken and tumbled in together the rock is termed an agglomerate or volcanic breccia. Such rocks are frequently as hard as the lavas themselves so firmly are the fragments cemented together. As we progress farther and farther up the river more of the fragmental rocks are seen, less of the dark-colored columnar basalts, and at intervals masses of rocks of coarser grain, lighter color and crystalline appearance. Such a body of crystalline rock is noticed for a mile or so along the road above Gate creek some eight miles west of Blue river. It is attractive in appearance and at first sight might be thought a granite suitable for building or monumental purposes. Careful study with the microscope however, proves it to be of the character of a granodiorite such as in other places in Oregon has been pushed or squeezed or intruded, while in the highly heated condition, up beneath or through the heavy beds of other rocks that overlay them. These overlying rocks have since been removed during the process of the wearing out of the river canon so that the intrusion is now exposed at the surface. It is with bodies of rock of this class that many rich ore deposits are associated. At many points along the route are neatly envired summer cottages and some whose occupancy is obviously not restricted to the summer season. At Blue river a road goes north to the mining district of that name, and somewhat farther up are the flume and power house that supplied that mining camp.

How rocks
are studied

From this point on we begin to see some of the dark gray andesitic rocks such as compose much of the superstructure of the Cascade range. These very often have a porphyritic texture, that is, a texture in which

distinct crystals of one or more minerals can be readily seen but the matrix or groundmass in which they are set is of finer grain or so dense often that with the naked eye one cannot determine what its mineral composition is. In order to study a rock of this kind with any degree of satisfaction it is necessary to make a thin section for examination under the microscope. Thin rock sections are made by sawing, then grinding and finally polishing both sides of a small piece on an emery plate, to such a degree of thinness that light will readily pass through practically every one of even the darkest colored of the minerals it contains. All of the harder rocks are now studied in this manner and sections can with care be ground down to a slice as thin as .002 to .0008 of an inch. No other means has proved so serviceable as this for determining the physical character and mineral composition of igneous rocks.

The andesites form the capping and, as we go farther up, much of the mass of all of the river divides from here to the summit. At McKenzie bridge where the road crosses to the south side of McKenzie river an interesting side trip may be taken to the Foley hot springs, some four and one-half miles southeast up the canon of Horse creek. At this place strong flows of scalding hot mineral water issue from crevices in what appears to be a dense flow-breccia. A well known resort has been founded upon the bathing and healing properties of these waters.

Above McKenzie bridge where there is a flat gravel terrace of some width, the canon still narrows somewhat and our road is within the Cascade National Forest and through heavy stands of Douglas fir and hemlock for which the Oregon Cascades is noted. Between five and six miles above the bridge the road comes to Lost creek and here a branch road crossing this creek continues up the McKenzie for a mile or so to Belknap springs. At this place, which is a resort of wide reputation, the hot gas-charged water bubbles from openings in a coarse volcanic conglomerate that is exposed in the banks of the river for many miles.

About one-half mile below the junction with the Belknap springs road the main road rises rather abruptly over a series of bouldery hills that remind one very forcibly of the characteristic heaps of morainal rock detritus that accumulate about the lower end of a glacier. The embankments seen here may be the terminal moraine of a glacier that formerly extended from the summit this far down Lost creek canon, but to settle this point definitely one should look the region over more thoroughly than can be done by merely passing along the road.

As we pass on up Lost creek we soon begin to see unmistakable signs of the more recent lava flows that have coursed down the wide depression that this creek occupies. We are thus led to question whether the bouldery hills that at first sight appear to be morainal may be after all only the broken up peripheral portion of a tongue of once

New lavas
along
McKenzie
road

viscous lava whose surface is now obscured by soil accumulation and the forest cover.

On crossing the stream at Lost creek ranch we pass for a little distance over a bare black surface of contorted and ropy lava, and from this point forward the trip is largely up and over the edges of successively newer and newer basaltic flows that have come down from eruptive vents higher up. It will be conspicuously noted that the rocks in these recent flows are darker in color, sometimes have white or glassy crystals, show more iron stain, and the pieces into which they are broken have in general a jagged roughness and irregular shape. At our left to the north of Lost creek the high mountainous ridge at the foot of which we are traveling rises a thousand and, as we proceed, possibly two thousand feet or more. Its top has a uniform rise towards the summit and the rock layers are so disposed as to suggest that they too are a succession of lava flows that have spread one after another out upon a fairly uniform sloping surface. They, as contrasted with the newer flows over which our road takes us, are andesitic and of greater age. Very obviously the wide canon of Lost creek that has since served as the



North and Middle Sister from McKenzie road. Beyond Belknap springs the grade becomes steeper and we surmount rim after rim of lava flow, an occasional acclivity testing not only motive power but at the same time the ingenuity and skill of the driver. Although rare glimpses of the Sisters may be had from some points along the way, they have seemed so far to bid us "keep our distance" as though wary of human approach. Shortly after crossing Lost creek, however, some 70 miles from Eugene, a straight stretch of open road affords a first good view of two of the group, North and Middle Sister. A veneer of early autumn snow has partly relieved the sharpness of their outlines, but they rise, notwithstanding, in towering proportions, as if gazing far down into our canon to ascertain who comes there.

channel down which these later more basic lavas came, was hollowed out or cut down through the many layers of earlier andesite whose outcropping edges we can now observe. In places we may pause almost within the shadow of beetling cliffs where great tumbling masses or jutting promontories seem as though to block the way. Again we occasionally see in juxtaposition the two kinds of rock strongly contrasted where we pass successively over a patch of one then of the other, or where as is frequent, on our right we have at the same instant the rough and scraggly heap of new basaltic lava and at the left the cubical blocks or platy talus of the old.

Middle and South Sister from McKenzie road. South Sister, although 300 feet higher than the other two is seen much less often from our route of travel. If one is watchful a fleeting glimmer of her sunlit head may be caught far to the south from near Alder spring, shortly after Lost creek is left behind and a start made up White branch a tributary of it. Alder spring is close to the road and at the base of Deer butte. It is an objective point of supply that all passers-by should not fail to patronize, for the grade is steep and water is usually scarce for some distance ahead. Immediately beyond Alder spring the McKenzie road swings round a bare mound of apparently glaciated rock and we soon come to the rough and broken edge of the newest lava yet seen, an extensive sinuous lobe that has flowed for several miles down the channel of White branch. Here the road gains several quick rises by a series of zigzag curves along the lava front, and again at intervals through the forest screen may be glimpsed the graceful profile of South Sister. Modestly standing somewhat apart from her associates, mere sight of her is a privilege that must be sought if it would be enjoyed. In the view the position of the crater in her top is plainly seen. The road here passes through a belt of heavy timber, mixed fir and western white pine, the latter standing out most distinctly in the foreground of the picture.

Three Sisters peaks from Lake valley six miles to the northwest. The level of a most enticing stretch of grassy park is reached at an elevation of about 4600 feet. At its western border a ridge of glaciated gray andesite shows. Here at the left, ahead and through the trees, one is greeted by the flattened dome of Belknap crater and, in striking contrast, the needle-like spine of Mt. Washington. Across this park which, although a part of Lake valley, we shall designate "west park," a spurt in "high" may be indulged in for a half mile or so. Rising again over a partially soil-covered, glacier-scored and polished rock surface we come to "middle park" at an altitude of about 4750 feet.

Here again for a couple of miles may heated engines gain relief and straining muscles move less wearily. These parks are attractive places. They are openly forested with fir and hemlock, and a plenty of open grassy glens where in the early season sparkling streams trickle and flowers bloom, allure one to linger. It is from middle park that the trail starts southward to the Three Sisters. The point at which it leaves the McKenzie road may



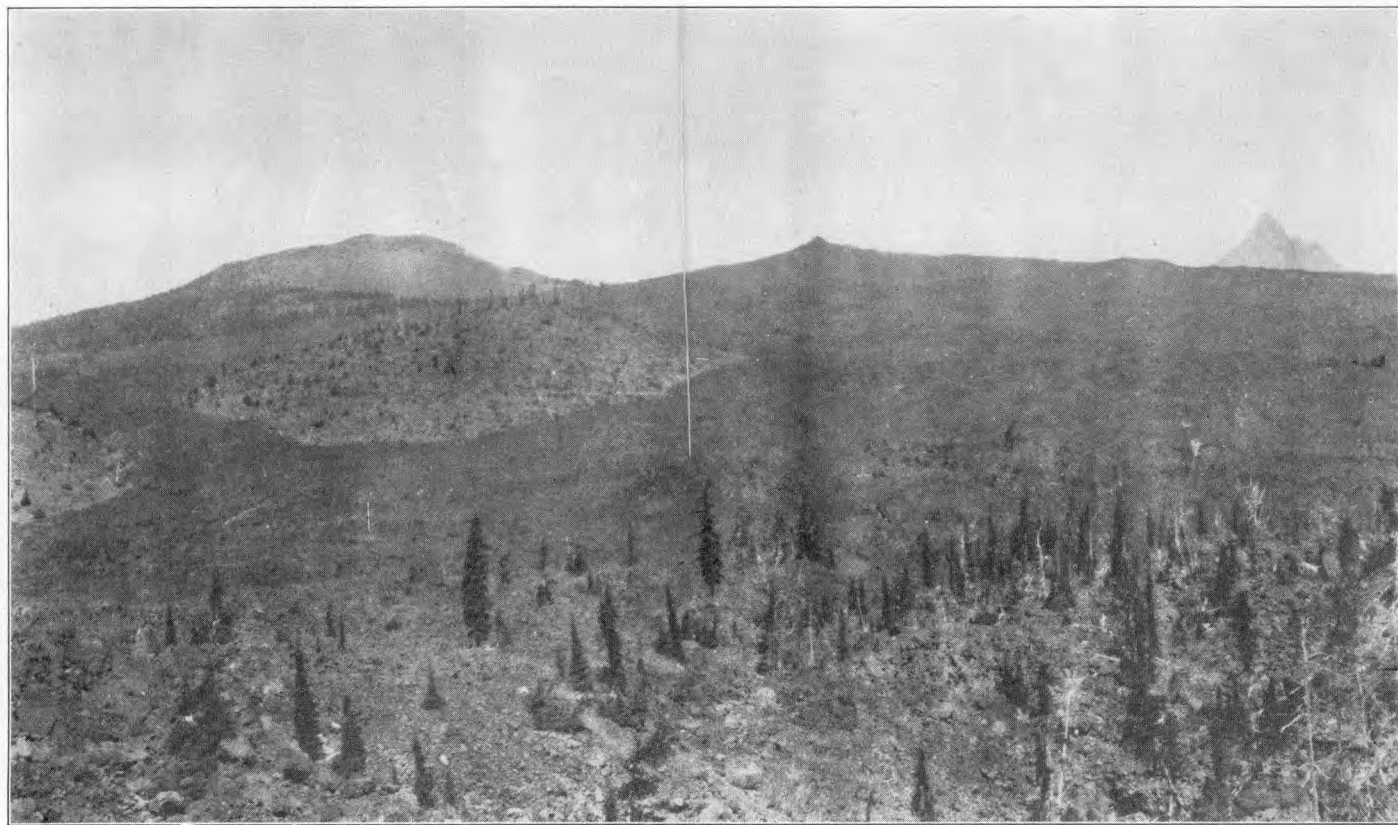
Middle and South Sister from Mc Kenzie road.



Three Sisters peaks from Lake Valley six miles to the northwest.

be easily overlooked by the less watchful passerby. Since 1910 when the place was so styled by the members of the Mazama mountain climbing club, it has been known as Frog camp. From selected positions many good views of the range may be had, both of the Sisters to the south and of the lava beds to the north and the craters that produced them. The journey from here must of necessity be made on foot or by saddle. Before cultivating a closer acquaintance with the snow-clad Sisters, however, and in order to fully get our bearings, it will be well worth while to first make an excursion eastward some five or six miles further to the summit.

Barren lava fields on Cascade summit, McKenzie road. After rising again over irregular masses of the same andesitic rock we soon come at somewhat higher level to a third or, as we may call it, "east park." From all of the higher points of our road we may look to the northern horizon out upon a jagged sea of barren lava. We skirt its border for a few miles, the smooth and glacier-rounded, ash- and cinder-scattered domes of gray andesite over which the road goes, contrasting markedly with the ragged reddish brown and black scoriaceous tumbled blocks that form the front of the new flow. Its surface is rough beyond conception, largely a jumbled mass of great cakes of ropy, twisted or granulated lava that, as they solidified, were torn apart and tossed about upon the yet moving liquid hot stream beneath. Soon we see that the summit ahead is entirely lava-covered, flows having come



Barren lava fields on Cascade summit, McKenzie road.

in from volcanic vents both north of the road and from the south far up the slope of North Sister. The road climbs to the top of this vast lava pile and continues for two or three miles across it. In places sand "islands" stick through, around which the new lavas have flowed. The islands are usually, but not always, elevated parts of the earlier andesitic lavas and are found to have been scored by the glaciers before they were strewn with the volcanic dust, ash and lapilli that now in part obscure them.

All along the edges of the new lava we can see where the former andesite, now sand veneered, passes directly under it. Here we have, then, before our very eyes, several open pages of record of what has taken place on this portion of the top of the Cascades. Here are three kinds of lava, all of which have come from open vents or volcanic craters. The oldest, an andesite, specifically hypersthene andesite, that has been deeply ground down by moving ice during the glacial period. Upon it is a layer of usually yellowish sand, in some places thin and in others of great thickness, particles from the size of dust to that of peas and larger, that were violently blown into the air by eruptive forces and that settled over the surrounding country. These explosive eruptions took place after the coming of the andesite and quite obviously since the melting away of the ice of glacial times in this locality. Finally, upon it all spread out from a series of openings into the earth's interior the heavy sheets of black basaltic lava that we behold today. They are almost barren of vegetation and in appearance so fresh and unweathered that we can with little stretch of the imagination yet see it come. First the dull red glow of the molten rock as it burst from the side of Belknap crater, then the advance down the slopes of shifting streams of hot viscous lava, great widening billows, elongating lobes, over which would rise and tumble blackening masses as parts of the cooling surface congealed to stony hardness. Though of geologic recent date, no one stood by to watch the process here, but in other parts of the world it may be seen going on at the present time. In the view Belknap crater stands at the left and at the right the pinnacle of Mt. Washington three miles farther away. The top part of Belknap is composed of volcanic sand and cinder and we conceive at once of its having very probably been the source of much of this class of material that was widely scattered over the country before it became in part inundated by the voluminous streams of liquid lava that broke out about its base.

Belknap crater displays the typical outlines of a volcanic cone whose earlier eruptions were of an explosive character so as to build up a relatively high steep-sided heap made largely of smaller rock fragments, but whose final and decadent effort was the exudation of molten lavas from cracks in its sides and base. From the foot of the ash cone, therefore, the slope of the lava top is a comparatively flattened one. In

**Belknap
Crater**

Two-thirds natural size



Magnified thin section

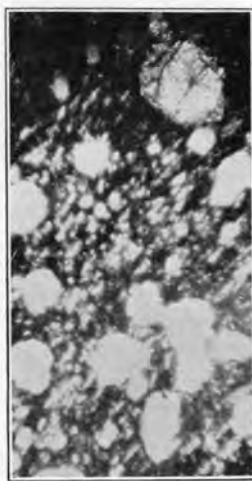


Cellular basalt. The cells, or vesicles as they are called, vary a great deal in size but are always rounded or oval in outline. They are caused by the presence of gaseous matter within the molten lava that would naturally rise toward the surface as movement took place. In this particular specimen the parallel elongation of the oval form of the cells is noticeable. This is a common feature and is due to the flowage of the magma after it had cooled to a stiffly viscous or pasty consistency. The long way of the ovals indicates the direction of flow. The thin section shows that there are also many minute cavities in the rock too small to be discerned by the naked eye. The white spots are cross sections of globular or oval gas-cells formed in the same manner as were the larger openings. The body of the rock is seen to be glassy and in it is a network of crystallites, or incipient angular crystals.

Two-thirds natural size



Magnified thin section



Glassy basalt. This is the prevailing type of lava that has issued from the newer craters on the summit of the Cascade range. The McKenzie road crosses extensive flows of this class of lava where it passes over the summit of the Cascades. The body of the rock is dark-colored, dense, usually glassy. In it are glistening white crystals of feldspar. Under the microscope the groundmass of this rock, which in the hand specimen looks only like a dull black glass, is seen to be shot full of needle crystals. The black background against which the glistening crystals show so well, is real glass, and they represent but the beginnings of the process of crystallization into separate minerals which, had conditions been favorable, would have produced a thoroughly crystalline rock instead of one in part crystalline and part glass. Quick cooling hinders or prevents the growth of crystals. We reason therefore that glassy rocks have chilled and hardened quickly, fine-grained igneous rocks less so, while those made up of coarse crystal mineral particles that can often be recognized with the unaided eye have cooled with great slowness and in undisturbed positions. Lava flows usually cool and harden rapidly; molten rock at depths cools slowly.

the center of the view the mammillated tip against the horizon is the plug that marks the final stoppage of the vent whence much of the lava over which we travel has come. One possessing the temerity to negotiate, much of the way on "all fours," two miles of right down tumultuous going would learn that this plug is a mass of brick-red vesicular lava surrounded on all sides by outpourings of the dense dark kind. The low moderate slopes of a cone built alone by the outflow of very fluid lavas are quite characteristic and in contrast with the steep-sidedness of the cinder or ash cone.

Looking southward along the summit of the Cascade range from McKenzie road. The photograph is taken from the side of one of the sand covered "islands." In the foreground is shown the irregular border and uneven surface of the recent lava flows. Other "islands" are seen in the middle distance and low down against the base of North Sister the dim outlines of subsidiary or adnate cones or craters from which these lavas have come. At the right is Middle Sister, much of her bulk obscured by the Collier glacier along whose snowy expanse we are looking lengthwise. The serrated top of North Sister is notable, and against the rocky northeast slope are the outlines of a diminutive glacier. At the extreme left McKenzie road appears, where it makes a winding way across a stretch of windswept sand and onto crumbly lava. It is an observation of exceeding interest that the scattering growth of alpine fir displays little choice of host, seemingly as much at home upon the fresh and soilless lava as the ash strewn slopes of an earlier generation.

The summit elevation is shown on the U. S. Forest Service map to be 5200 feet above the sea. Near the highest point is a government telephone for use in case of forest fires, and for the public service of course if aught goes wrong with brake or propelling mechanism. At the east the town of Sisters is 20 miles away and at better than 2000 feet less elevation.

Town of
Sisters to
Cascade
Summit

It is located near the Cascade edge of the great central Oregon basalt plateau. From Sisters to the summit is a trip first through the open forest where soil and coarse rounded gravel seem to have so filled in the hollows of the former ragged surface that only here and there do the higher points now show through as mounds or ridges or scraggly bunches of dark basaltic rock. The gravels are composed of a mixture of both andesitic and basaltic lava pebbles and boulders. When the story of this region is at some later day written in more detail it will probably be found that this great outwash plain was in part buried with the gravels that were brought down by strong streams of water from the higher parts of the Cascades during the melting of the glacial ice that, in this latitude, mantled the summit as a great overlapping frigid roof. At that time none of the new and recent lavas that we have just seen existed there.



Looking south along the summit of the Cascade range from McKenzie road.

We are thus not surprised to find, as the grade rapidly stiffens and progress is made towards and about the north base of Black crater, that the gravels before long disappear beneath the edge of later flows that have likewise passed down to the eastward from the summit craters. We follow the south border of such a flow for several miles, in places as within the shadows of a sharp-walled moat, to Windy Point, rising from an altitude of 3175 feet at the town of Sisters to 4860 feet. Windy Point is the crossing of a sharp ridge of andesitic lava that in position has all the appearances of having issued from the north side of Black crater, a prominent cinder cone rising immediately at our left to a height of 7250 feet. From this point in the road the wide expanse and rough character of the lava fields of Belknap crater may be seen to excellent advantage. Volcanic sand covers the surface outside of the lava on this as on the other side of the divide, and with the exception of the outstandingly conspicuous glacial scorings we are here confronted with the same sequence of events that engaged the attention at the other side. Though we observe the results of the glaciers having been here, our knowledge of their extent down the east slopes of the Cascade range is not at all complete.

The Three Sisters from the east. Low down against the left base of North Sister are the shrunken remains of a glacier about the lower border of which is the dark crescentic morainal embankment. The several small glaciers now existing on the east slopes of the three mountains appear to be only what is left of the ice of a great cirque from which a glacier of extraordinary size formerly flowed eastward for several miles. The records of its existence are to be found in the rock materials that it scattered over an area of considerable extent far beyond the present forest line, though its exact limits at the time are not now known. We can not fail to note the more rugged appearance of North Sister. South and Middle Sisters exhibit a comparatively smooth cone-shaped outline while the profile of North Sister is a notched one, its cliffs are jagged and steep and its general appearance pyramidal not conical. Her sides have been deeply dug out and her former outlines so largely obliterated that we have little conception of how lofty a mountain North Sister originally was. It takes only another glance at the other members of this group to tell us at once that North Sister is but the ribbed skeleton of its former self and that it is therefore quite greater in age than the other two peaks. South Sister has suffered least of the three, Middle Sister somewhat more, and North Sister a very great deal from the tearing down activities of weather, water and ice, whose attack is a relentless one everywhere.

Within the past few years a wagon road has been extended from Bend, which is on the railroad, and from the town of Tumalo both in Crook county, up Tumalo creek to the south side of Broken Top mountain. From Bend to the terminus of this road is about 20 miles. The state engineering department has here diverted Little Crater creek into the

Road to
Broken
Top



The Three Sisters from the east. From this direction at all times of the year the Sisters peaks are a most fascinating feature of the landscape. The country about them is less broken and they rise above the fringing forest of yellow pine sheer and clean-cut against the western sky. South Sister at the left no longer poses with her reputed air of humility but from this side assumes a position, while apart from the two nominally sisterly companions, now appears one of commanding watchfulness and even filial concern for their welfare. South Sister can be seen from here to be a composite mountain, the outlines of a subordinate cone showing as a low hump against the east slope. This lesser cone marks a side opening from which lavas issued probably during the later stages of eruption. On the slopes of Middle Sister the position of the two small glaciers may be seen. One passes down to the left, the other apparently hugging close against the lower breaks of North Sister. Their snowfields are united above but their lower portions are separated by a rocky crag and the dark curving band of lateral moraine plainly to be seen from our viewpoint.

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head of the south fork of the Tumalo to provide an increased supply of water for irrigation on the lands of the Tumalo project.

From Broken Top, which is the mere wreck of an ancient volcano, a trail goes southwest down Crater creek to Sparks lake thence west and south in the direction of Horse lake. From this trail it is not difficult to make one's way to the west side of South Sister and if care and judgment be exercised, on northward across the head of Lost creek canon to connect with the Frog camp trail at the north foot of Obsidian ridge. While this is of course a somewhat roundabout route, it takes one through a section of varied mountainous country, that for the beauty of its forests and its lakes, the variety of volcanic and glacial phenomena it displays is most intensely interesting and satisfying.

North Sister from the west. From "Frog Camp" in middle park the trail goes in a general but zigzag southerly direction for about three miles to the new lava flow a part of which we have already seen some miles back on the McKenzie road. The edge of this flow rises abruptly for 75 to 100 feet as a great broken stony wall which both horse and man must be given full freedom of limb to successfully negotiate. The trail meanders for a mile or so across its roughened top and drops down at the south side to White Branch, so called from its running murky to milk white with ground-up rock debris from the foot of Collier glacier.

The country to the west side of the Sisters group is seen to be but scatteringly forested, interspersed with meadows, lakes and much of bare rock surface. The U. S. Forest Service permits sheep grazing in this section and the trail from the McKenzie road, we are told, has been traveled and maintained chiefly by the sheep owners. The construction of a branch wagon road from McKenzie road to the west side of the Sisters peaks is a future accomplishment to which we may look forward. The first obstacle to such a road is the White Branch lava flow to cross which will necessitate an expensive piece of construction. Though not over half to three quarters of a mile in width, its sides are steep and surface of exceeding roughness. Beyond White Branch to the south Obsidian ridge rises as, at sight, a forbidding barrier. Its circumvention can doubtless be best accomplished by following for some distance up the mountain along the north base of the ridge to near timber line, with the probability of finding an easier grade and even a gap through which a feasible passage might be made. The head of Lost creek canon will probably be found to be the only further serious hindrance to an easy route along the west side of the Three Sisters. Careful reconnaissance will likely show that a course must be sought either considerably above timber line where there would be much of loose unstable slope to be crossed, or one that would zigzag down the steep north canon wall to Lost creek and similarly search a somewhat easier way up its south side.

Close view of portion of Obsidian ridge. From White Branch the trail may be seen to climb Obsidian ridge, as already suggested on an earlier page, south of which very few further signs of a trail are to be found. Obsidian ridge is a series of prominent

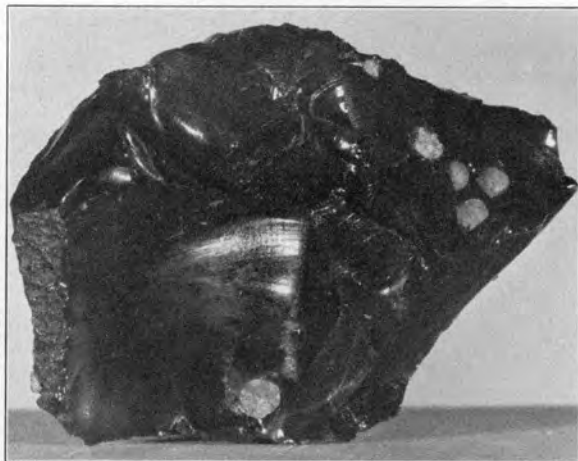
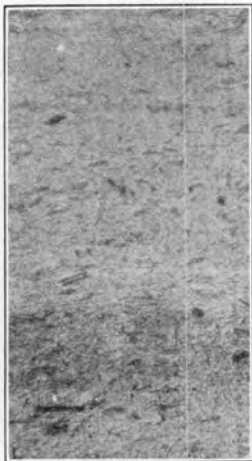
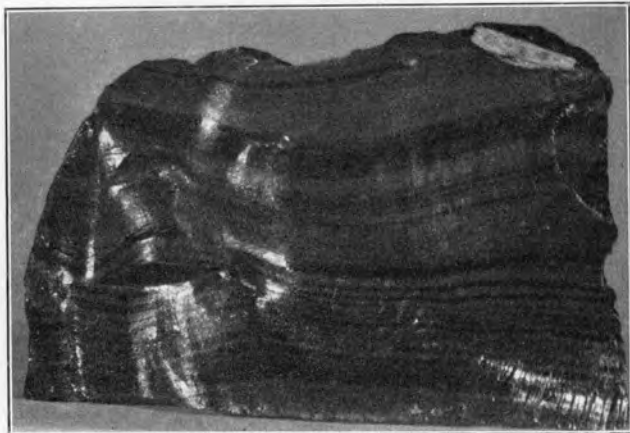
Character of
Three Sisters
country



North Sister from the west.



Close view of portion of Obsidian ridge.
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Volcanic glass from Obsidian ridge. Commonly called obsidian. Two-thirds natural size. The typical natural glass is black in color. When broken it displays a conchoidal or shell-shaped fracture and has sharp or splintery edges, much as does ordinary manufactured glass. The pebble-like globular inclusions are termed "spherulites." They occur in obsidian in size from microscopic to much larger than those shown, and are found to be made of minute needle crystals that radiate from the center point of the sphere. The radial structure is nicely shown in the spherulite near the bottom of the piece. The parallel wavy markings in the specimen at the left are flow-bands, and in the accompanying thin section may be seen the lines of flow and numerous crystallites all oriented in the same way, as would be floating logs in a moving stream. The volcanic glass of Obsidian ridge is the most highly siliceous of the lavas yet found upon the Cascade summit and is properly termed a rhyolite.



Banded obsidian from Obsidian ridge. Natural size. The dark bands are black, brown and red volcanic glass. Between them are layers, in part vesicular matter, but mostly of the globular bodies known as spherulites. The rock is frequently literally charged with them and their arrangement in fairly definite bands has no doubt resulted from the presence of flowage strains, or the friction planes or possibly zones of fracture, that developed during the final stages of its movement and cooling.

elongated cliffs made largely of black glassy lava that can be followed far up towards the west base of Middle Sister. In many places it has been smoothed down by the glaciers. In all probability this ridge represents the outpourings from a vent near the base of that mountain when it was an active volcano.

To satisfactorily enjoy a stay about the Three Sisters, supplies should be packed in and a camp established at some convenient place. Good camping spots are very plenty. Close to timber line on the side of Obsidian ridge one may find an abundance of grass, fuel, shelter and beautiful surroundings. Farther south opposite South Sister are aplenty of tree shadowed glades, mirror lakes, rills from the melting snows, all camp facilities to satisfy the most exacting.



Volcanic glass breccia. Natural size. In many places on Obsidian ridge the glassy obsidian may be seen to have been broken into angular pieces, then cemented together again. The cementing material appears sometimes to be only the finely granulated or pumiceous glass itself, but there seem to be also, nearly always, a layer or blanket of spherulitic bodies surrounding and in immediate contact with each of the chunks of glass of which the rock is composed. When broken apart the surfaces of the blocks are seen to be copiously marked with little pits that were occupied by the spherulites. Obviously the shattering of the glass took place at a time after it was cooled to complete hardness, otherwise the pieces would not possess such angularly sharp outlines. The enveloping layers of spherulites that now largely fill the interspaces and in part bind the pieces together have developed since brecciation occurred and similarly, therefore, after the rock had attained a condition of brittle hardness. Possibly the friction of movement and, to a probably greater extent, the presence of moisture may have had an influence in favoring the process of incipient crystallization that has produced these spherulitic masses to so marked an extent.

Summit of South Sister looking across the Lost creek glacier. One of the joys of spending several days in the Three Sisters region is the climbs of the peaks that may be made. Such close acquaintance with South Sister is well worth while. The U. S. Coast Survey gives its altitude as 10,351 feet. The climb is one requiring persistent effort rather than daring for with care the summit is attainable by safe routes from almost all directions. On the way up the northwest side one may conveniently travel nearly the full length of the Lost creek glacier, the best developed of any about this peak. No name has heretofore been attached to this glacier but its well-defined character and position are such that it seems wise not to longer defer giving it a name. The term Lost creek glacier is therefore proposed as a fitting title inasmuch as



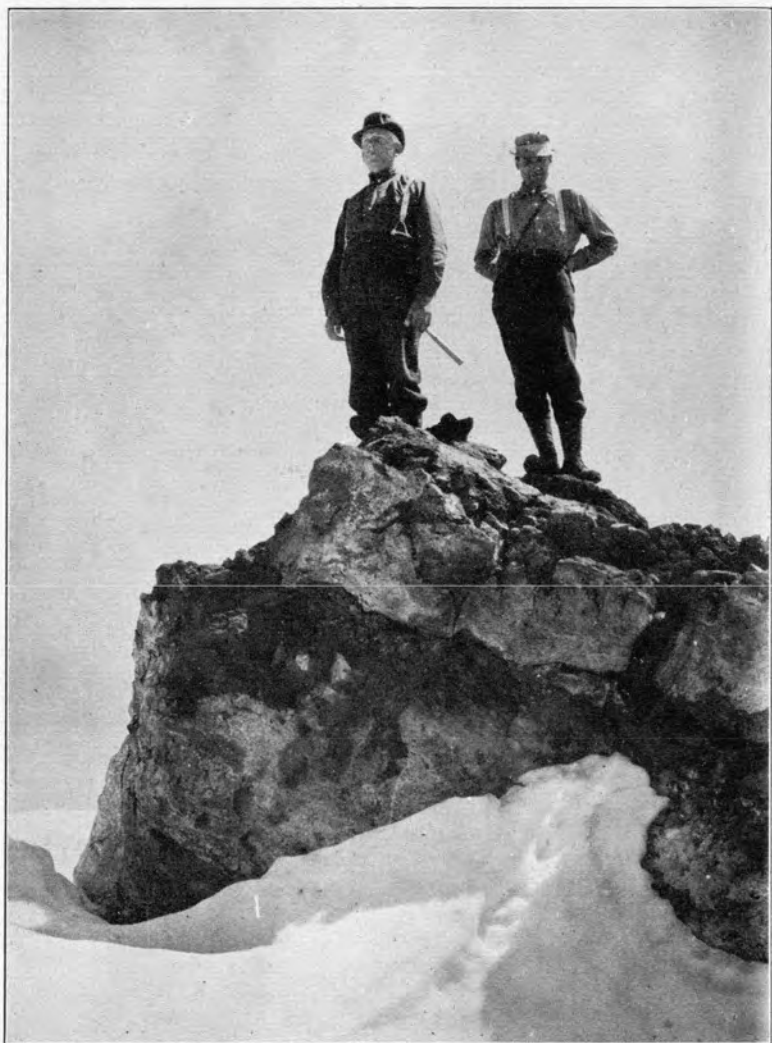
Middle and South Sister from the west. In the panorama the characteristic volcano outlines of the two mountains are clearly brought out. The long even and not steep slopes that lead up to the base of the cone-like tops are notable. To all appearances both mountains have been built up by a succession of eruptions during which liquid lavas alternated with cinder, ash and scoria. The latter are the product of violent and explosive action, the lavas flow out more quietly. They are tossed or projected into the air to cool as they fall upon oftentimes quite a range of country; the lavas on the other hand well up and spill over the crater's rim to pass down outside as a spreading sheet or moving tongue of liquid rock. Or, as often has the fused and seething lava burst through crevices or melted its way out at many points about the sides and base of the mountain proper. The flowing molten lavas tend to produce flattened long slopes out about the main crater. The boundaries of these flows are always irregular, some being miles and others only rods in length. The intermittent eruption of quantities of ash,

cinder, and the like, would fill in between and cover up the irregular surface and scalloped borders of the flows. As they are today, these mountains have suffered much from the attack of the agents that tear them down. Their picture as they first were can be restored only if the imagination can visualize the active manner in which the ice of the glaciers and the waters from their melting have worked to cut into, wear down, carry away and redistribute all of these materials since volcanic activity ceased.

High up on Middle Sister at the left is Renfrew glacier. Against the slope of South Sister two glaciers are seen to cling, the snowfield of the one at the right connecting above with that in the hollow of the crater in the mountain's top. The distance between the summits of these two peaks is slightly over three miles. From Middle to North Sister is a little less than two miles.



Summit of South Sister, looking across Lost Creek glacier. Note the two persons in the foreground.



The topmost point of South Sister, 10,351 feet in altitude, according to the U. S. Coast Survey.

those of its waters that do not sink from sight, ultimately drain away by way of Lost creek into the McKenzie river and to the Willamette. At the head of this glacier may be observed the cruel and relentless manner in which it is digging a vast pit for itself into the very vitals of the mountain. In the photograph just below the filmy cloud scarf is a bed of hard rock beneath which the ice is pulling away the looser rock fragments, so that perhaps a hundred feet or more of ironstained scoriaceous and ashy materials are exposed. A part of the structure of the top part of South Sister is here laid bare, as it is also at the head of a small glacier that rests

against her southwest slope. The process by which a glacier digs into the rocks as its very head or top portion so as to produce and maintain a steep cliff there is known as "plucking" and is an interesting one. The ice of the glacier is by gravity always moving down the mountain, away from the upper rim of its basin. As it freezes onto the rocks of this rim they are literally pulled or "plucked" from their places by the downward motion. As the head cliff heightens, loosened materials fall upon the top of the ice and ride slowly away, rather than accumulate in talus slopes as is the case in ordinary crumbling and breaking down of rocks. More water and then ice fill in the gap, freeze tight, and the rock-pulling process goes on—always tending to cut deeper and actually headward toward the center of the mountain, and to maintain a steep, oftentimes vertical or overhanging, cliff in the hardest of rocks. The cross cracks in the ice, or crevasses, are nicely shown in the foreground of the picture.

The topmost point of South Sister. The summit of this peak consists of a circular crater about one-fourth mile in diameter whose rim is continuous except where joined at the northwest and at the southeast by the snowfields of the glaciers in these two directions. The rim is for the most part blocks of broken lava or ledges and crusts of brown, red and black cellular character. The rock is hypersthene andesite, hypersthene being the chief characteristic iron and magnesium bearing mineral it contains. The word andesite came to be applied to this type of rock on account of its occurrence in the Andes mountains of South America. The andesites are ordinarily light to dark gray or almost black in color, sometimes pinkish. They commonly have a porphyritic texture, that is, one in which the crystals or grains of one or more minerals stand out so as to be seen distinctly in a body or groundmass of finer texture. It sometimes, though less often, occurs too in the form of pumice or a black obsidian or volcanic glass. In the photograph two sloping layers are noticed separated by a band of scoriaceous matter. The inside of the crater which is filled with snow, is at the right in the direction these rock beds dip. At the left is a perpendicular crag, the outside of the rim almost overhanging a steep snowfield on the east side of the mountain. This crag appears to be the result of the same kind of undercutting or plucking action of heavy masses of snow and ice as already described.

Broken Top and South Sister from the south slope of Middle Sister. Broken Top appears to be the jagged remains of a portion of an old crater. Upon it snow remains the year round and there is possibly the much shriveled remnant of a former more pretentious glacier. High up on South Sister the sharp crags of a much frayed shell of a crater appear where formerly lavas issued. Within this old crater a small glacier emanates to join an ice-stream heading high up on the south of east side. A diminutive glacier also flows north towards Middle Sister. This makes a total of at least five glaciers on this peak. All extend down to 7500 feet or below, display crevasses and have lateral and well developed terminal moraines.

From the summit of any one of the Sisters the view in all



Broken Top and South Sister from the south slope of Middle Sister.

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directions is most gratifying. Particularly well from South or from Middle Sister may the array of peaks to the south be singled out. Nearby to the west stands the Husband and safely beyond to the southwest the Wife, both mountains of rugged though not of suspiciously belligerent type. Next in position is Bachelor butte whose darkened profile shows dimly at the left of South Sister in the view, 9045 feet in height and 12 to 14 miles southeast. Thence down the summit come Packsaddle and Irish mountain, each better than 6000 feet, and at about 35 miles the Twins, 7250 feet in altitude. Still beyond and some 40 miles away is Maiden peak, 7750 feet, a crag-studded cinder cone of far from demure mien or delicate proportions. Countless lesser unnamed peaks and craters are within the range of vision to the south and east. It is worthy of note that of the family group only the brother seems absent, but it is not hazardous presumption to believe that even he may yet be present in disguise. The Twins or Bachelor butte may either or both encompass him; in case the latter be the truth the shame of the situation being that so discouraging a space intervenes between him and the maiden member of the group that we can scarce conceive a wooing nod or coyful glance to pass across between them. On clear days Mt. Thiel en is in view and not so rarely Mt. Shasta far beyond the state line in California.

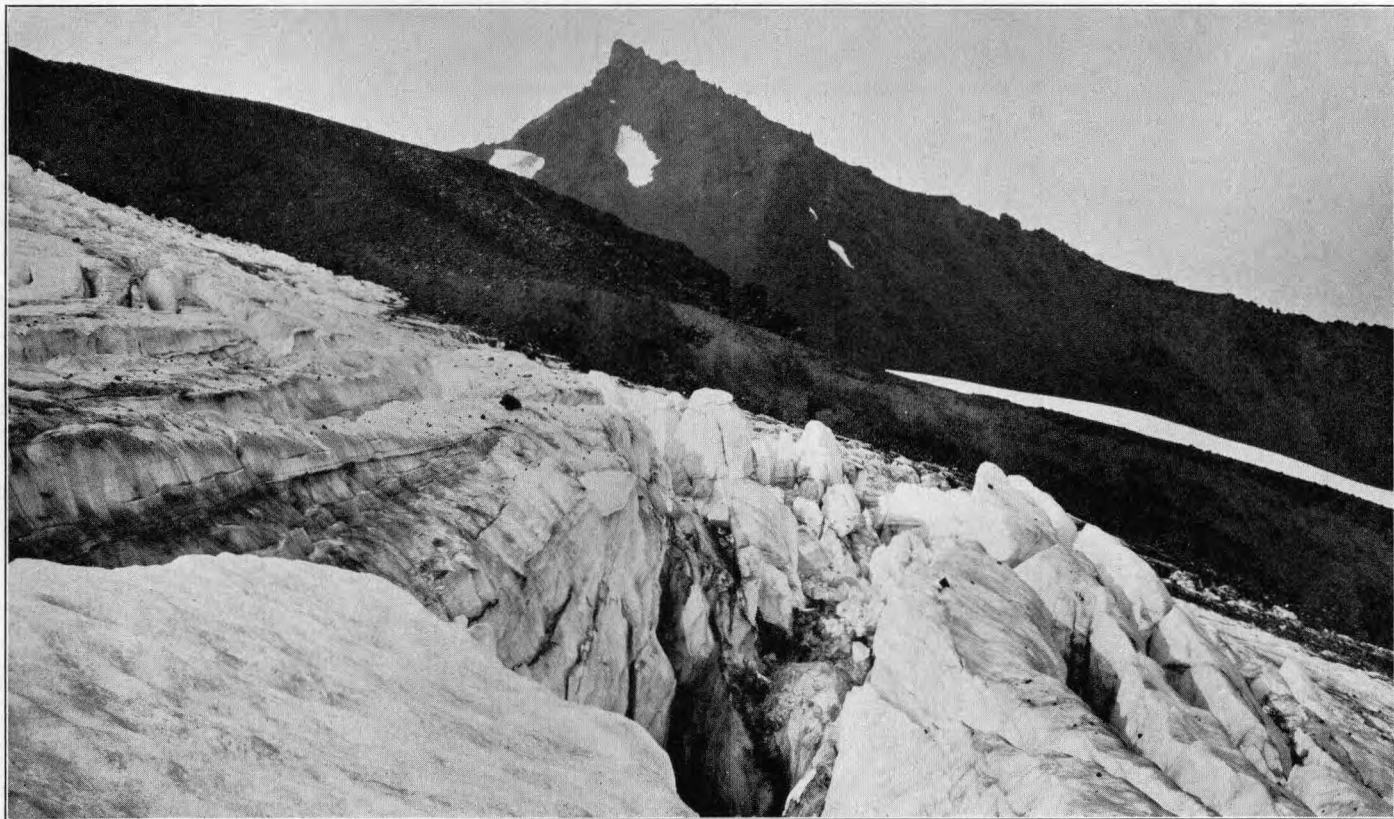
Middle and North Sister from the top of South Sister. At the right of North Sister in the view is the rounded dome of Black crater, at the north foot of which the McKenzie road passes east of the summit. Again is the contrast between North Sister and Middle strongly in evidence. The former rises by ribs of ragged rock to an equally ragged set of pinnacles at the top. To all appearances much more fitting would it seem to call this north member of the triumvirate an "elder brother" or even parent, for his hoary head is relatively "bowed with age" and his shaggy framework shows through as, we can imagine, but a mere shadow of his former self.

Middle Sister still preserves the cone shape of the volcano she formerly was, though less perfectly than does South Sister on which we stand. From this side the apex of Middle Sister exhibits a cusp-like crescent outline as though the eastern edge of the rim had been gnawed away. Two small glaciers hang at the east side of Middle Sister, their neves confluent above. The nearer one has been named the Diller glacier and the more distant whose whitened top obscures the base of North Sister, Hayden glacier. Two small lakes may be seen in the foreground. These rest in glacial hollows and are supplied by the summer melting of the perennial snows that ever cling about the peak. Middle Sister is not difficult of ascent from the west and southwest sides and has an altitude according to the U. S. Coast Survey of 10,039 feet above the sea.

A portion of Diller glacier. North Sister. At the far edge of the ice rocks are being gouged loose and carried along upon its surface. Here is quite vividly demonstrated the fact that, as in the case of water streams, the center portions of the ice-stream flow faster than the sides. Movement is very much retarded by friction with the walls and bottom of the channel while the middle



Middle and North Sister from the top of South Sister. Middle Sister is 10,039, North Sister 10,067 feet in height.



A portion of Diller glacier. North Sister.

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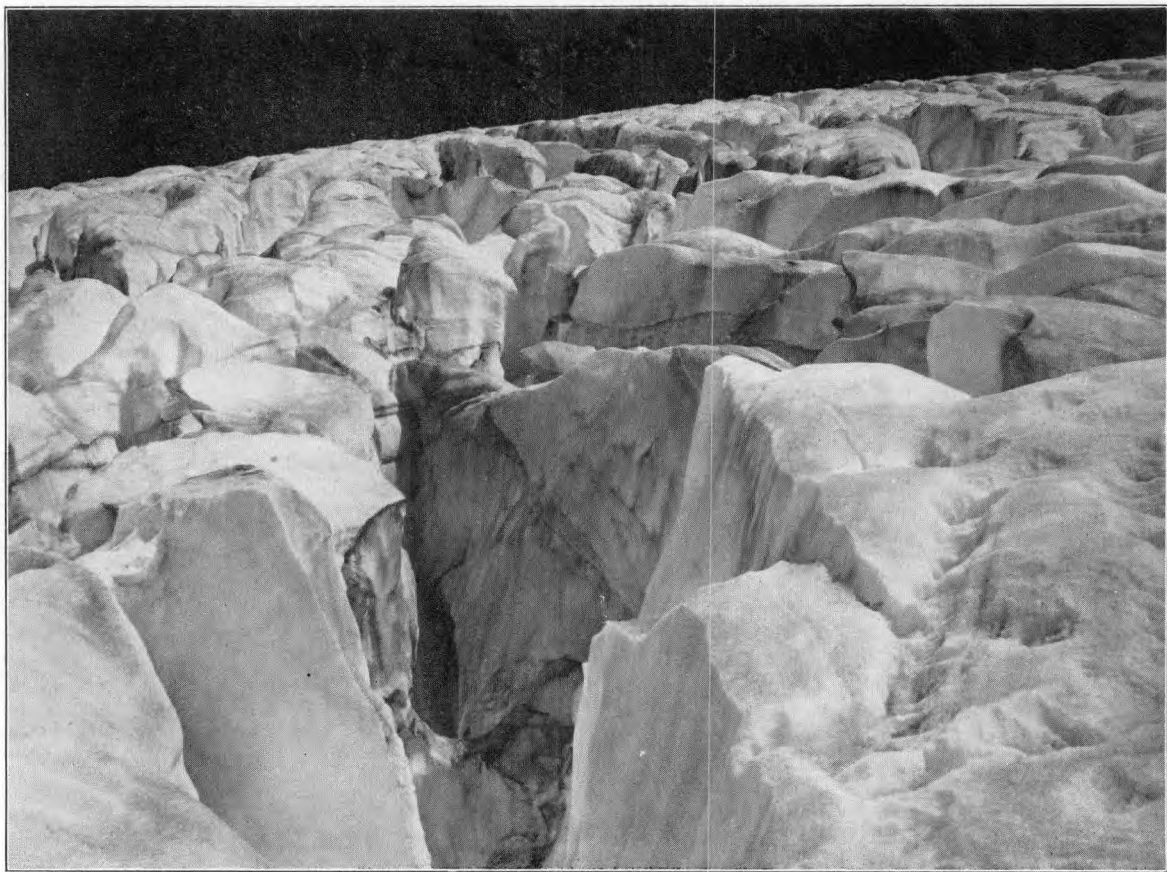
North Sister from the south across Hayden glacier.

Photo by G. M. Weister

portions forge ahead. In a stream of water there are no visible markings by which we can study this phenomenon while it is taking place. In a glacier, on the other hand, curving lines or planes of weakness, or actual break, are very commonly developed by such differential motion that can be distinctly seen and that frequently open up as parallel crescentic crevasses where the ice passes over irregularities that test its strength beyond the yielding point. At the center and to the left in the view corrugations may be seen, each trough the site of a wide open crevasse. Their curvature is very evident and is produced by flowage down the slope, in the photograph, from left to right. Horizontal banding in the ice is also apparent.

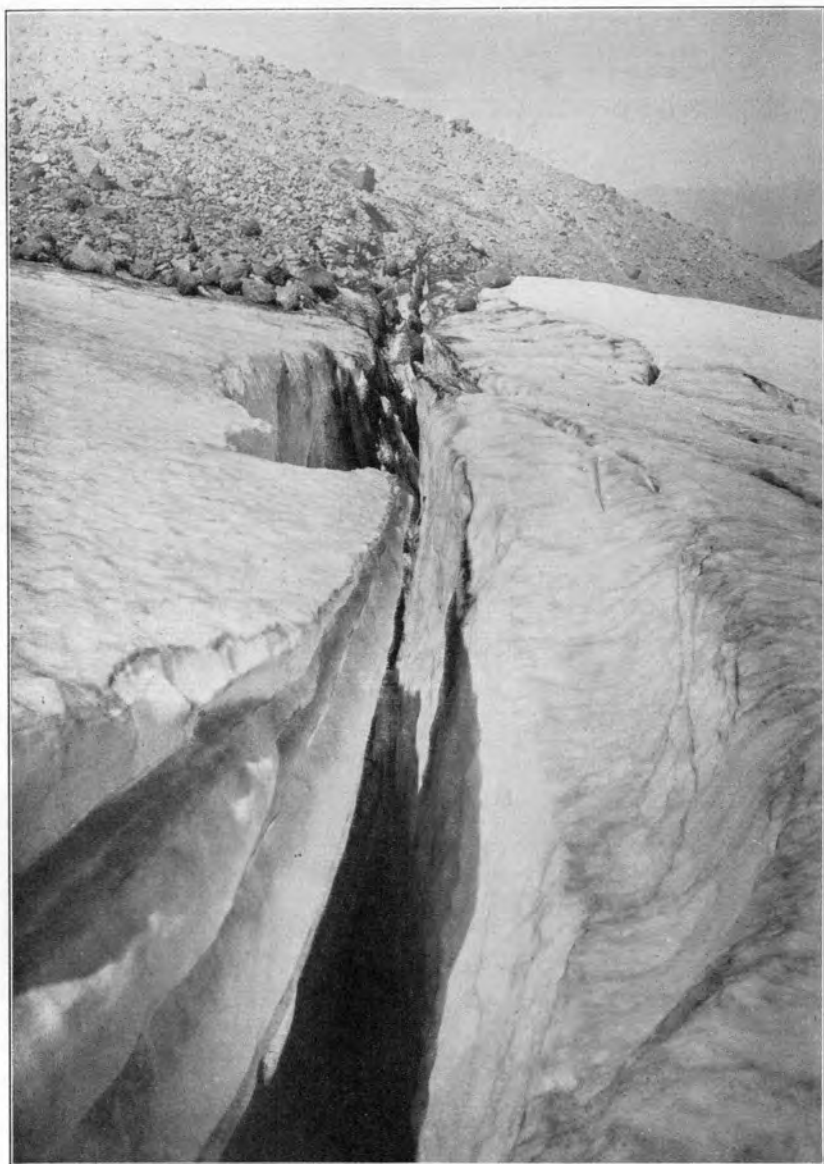
North Sister from the south across Hayden glacier. The character of the surface of the ice is shown in this view. It is marked by longitudinal corrugations and cracks that form across the direction of flow, where the bed is very irregular. As a rule the top of the glacier is roughened somewhat by the presence of heaps of broken rock, boulders, slabs or still larger masses that have fallen upon it. The carrying capacity of a glacier is unlimited. Blocks that are tons in weight are transported as readily as are silt and sand. Large thick pieces protect the ice beneath from melting as rapidly as where the sun's rays strike direct, and are therefore often seen perched upon mounds or even pillars of ice that rise above the general surface. At the left in the picture are many dirt covered mounds. While large pieces insulate against the sun's heat, small stones or thin slabs on the other hand speedily melt their way into the snow and ice. Everywhere the glacier is strewn with more or less of broken rock and where the pieces are small its surface is pitted with holes of varying size and depth at the bottom of each being a gravel stone, pebble or comparatively thin flat rock. This phenomenon is due to the greater amount of heat transmitted by the lesser pieces. During the day they become actually hotter throughout than the temperature of the air, hence convey more heat to the ice on which they rest than would be absorbed directly from the sun's rays. Rocks of all kinds, especially those of dark color, absorb much heat, but if their thickness is such that they do not become warmed through during the time the sun is shining they protect and, as it were, keep cool, the portions of the ice they cover so that it melts more slowly than it otherwise would.

Badly broken glacial ice. Just as long stretches of steep and stony bed produce rapids in water streams, so do the extent of crevassed and broken up stretches of a glacier surface largely depend upon the nature of its channel. Sometimes the ice is shattered in almost every conceivable direction in intersecting series of joints and open cracks that produce a surface impossible of travel. Such cordons of broken ice blocks as shown in the view, after they have been further accentuated by melting and movement are termed seracs. It is a not uncommon notion that the motion of a glacial stream is rapid if not even tumultuous in places. No conception could be farther from the truth. Although the ice may be much sheared, jointed and rent apart, movement can rarely be detected by any means except the most careful of measurements.



Badly broken glacial ice, Collier glacier.

Photo by G. M. Weister



Crevasse or huge open crack in the ice. Crevasses open up where the glacier passes over projections in its channel, as a ridge of hard rock, or where it breaks over sharp rock cliffs. Crevasses are a sore menace to travel upon the glacier for they are often many feet wide and of indeterminable depth. Their walls are sheer blue ice or banded blue and white, the latter being due to included air or the former granularity of the snow, and they usually offer no foot or hand hold whatever to one who is so unfortunate as to approach too near. In the photograph is a moraine embankment from which rocks tumble upon the ice and perchance drop into crevasses to be frozen fast or swept along below.

Photo by G. M. Weister

There is no crashing crunch of crushing ice, no swiftly swirling eddies. All motion is quiet and orderly, so quiet and so slow indeed that unless patience and days are given to the task one may need to come again another season to observe it. Painstaking observations on some of the glaciers of Glacier National Park in Montana have shown movements ranging from one inch per hour down to a scarcely perceptible two hundredths of an inch. The rate of movement varies with the size of the glacier, its steepness and the season. A run of years of heavy snow fall may accentuate movement somewhat, and the glaciers may extend noticeably farther down, but the lesser climatic changes from year to year are apt to be felt but little. Unusually warm summers and in some instances even a series of warm moist days, may likewise cause the ice to creep downward a little more rapidly.

Looking north along the Cascade summit across the foot of Collier glacier. In this view Mt. Hood, 85 miles up the range, shows dimly at the right of Mt. Jefferson a snow-striped pyramid 35 miles away. Next in order stands Three-Fingered Jack and sharpened Mt. Washington, the latter about 15 miles distant. Towards Washington the gaze is across miles of bare lava in which the lighter spots are sand covered "islands" such as we have already seen along the McKenzie road. The photograph is taken from the west foot of North Sister, the disintegrating slope of which is at the right. In the foreground the surface of Collier glacier is seen to be deeply blackened with rocky talus that has fallen upon it. A little beyond and at the right of the main area of white we look lengthwise of a triple-crested morainal ridge. Moraines are built along the melting edges of the glacier by the material which it dumps there. Sometimes, as in this instance, the appearance of a series of closely packed parallel ridges is given by the crease or longitudinal V-shaped notch in the top. This is usually due to fluctuations in the height and width of the glacier surface. The deposition of successive rims of materials marks a diminution in size, which, we judge is the case here. Similar composite embankments fringe the ice border as far as our view extends.

A further most vivid bit of testimony on the course of recent geologic events is to be gained from an inspection of the large black mound in the center of the view. This is a typical cinder crater, its rim being continuous except to the west, our left. This side of it has been broken through and largely removed by a stream of liquid basaltic lava that has flowed down the west slope of the range top and which we have already seen at several points along White Branch. The course of this stream, whose source is the tip of Collier glacier, seems to have been determined and in part changed by this tenuous tongue of lava. We conceive of this great pile of cinder and ash as having been produced by violent volcanic eruption. Following which, as in the case of Belknap and other craters already cited, liquid lavas broke out around its base. Here the materials of the western rim, none too stable at the beginning, have crumbled and slipped into the seething molten stream to be absorbed, or to float upon its surface and be carried away.



Looking north along the Cascade summit across the foot of Collier Glacier.

Photo by G.M. Weister

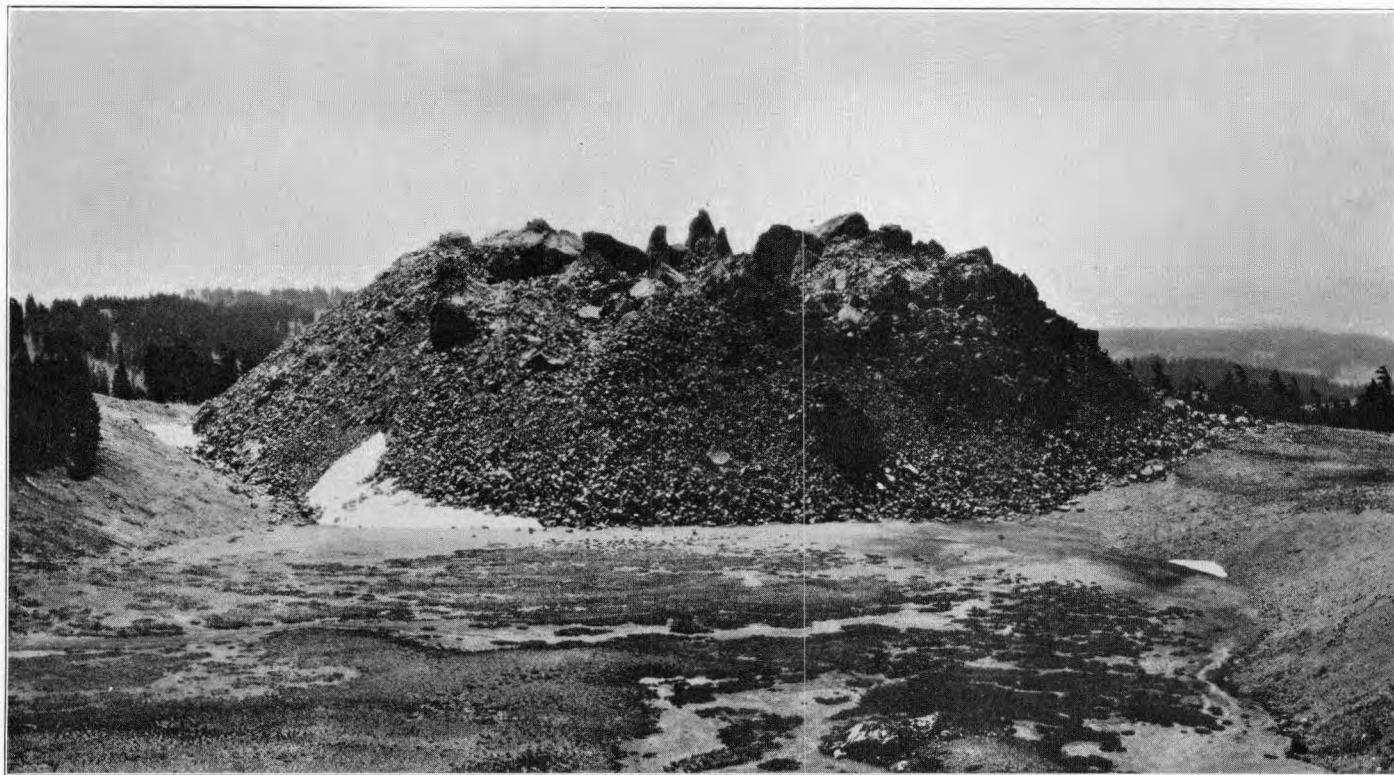
Here too an interesting chapter of the geologic book of records is open for our appreciation. Our cinder crater stands almost directly in line with the lengthwise dimension of the glacier, which turns within the field of view toward the left, into the head of White Branch. It is plainly to be observed that the glacier has been and is now actively gnawing its way into the side of this volcanic pile which rises in its path. We have not as yet unassailable grounds for maintaining that the glacier was here long before the throwing up of this barrier but the surroundings all indicate the correctness of such an inference. Far along the summit to the McKenzie road and beyond we have seen the evidences of scouring glacial action prior to the coming of the recent lavas. The Sisters were no doubt elevated sources whence extensive glacial streams emanated to flow outward down the slopes in all directions. And so here the conclusion is inevitable that the large ice stream of which Collier glacier is the shrunken remnant, formerly sent a branch, if not its main current, onward across the present site of this volcanic cone, and doubtless much beyond, where new rough lava now entirely conceals much of the old glaciated surface. Glaciation and the glacial period thus antedated the erection of our diminutive volcano and of the flows of liquid lava that came from it. Whether the materials actually came up through the ice itself or were erupted at a time when the glacier did not reach so far down the mountain as it now does, is a question over which we may only conjecture. Its position relative to the glacial stream leaves no question as to its having been born since glacial times. And while in all probability it then managed to rapidly increase its stature in the face of opposing glacial conditions, now the tables are turned and the contest is a one-sided one in the other direction. With the fires of volcanism dead little resistance can be offered to the agents that are proceeding to undermine its structure and it is being torn apart and piecemeal borne away.

Looking south lengthwise of Collier glacier, from red lava crag near its extremity. North Sister at the left. Middle Sister at the head of the glacier. The Collier is probably the most extensive glacier in the Oregon Cascades. From cirque to snout it is close to three miles in length. It heads far up against the northwest side of Middle Sister but in all of its lower course is frightfully gouging away at the west base of North Sister peak. Note the two figures on the snow at the lower right. This glacier is in places very much disrupted by crevasses and other flow breaks. Toward its head the ice is seen to be covered by a more or less continuous mantle of snow. At the left is a typically developed lateral moraine. It is composed of rock fragments of all sizes intermixed and so gently placed that the whole is a most unstable heap. One scarcely knows in clambering across it whether to trust less his step to boulders, gravel or slab in size, for either seems as apt as the other and all seem most anxious to settle, roll or slide beneath a minimum of avoidupois upon them.



Looking south, lengthwise of Collier glacier, from near its lower end. The observer is facing almost directly opposite in this view from the position in the preceding photograph.

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A diminutive but full-fledged lava flow at south base of South Sister.

A diminutive but full-fledged lava flow at south base of South Sister. Encircling the south base of South Sister in open order is a series of small craters some of which are cinder cones but the most interesting of which, as we look down upon them, appear like great pimples that have broken out here and there. Of this type at least seven may be counted, each a complete and finished flow in itself. The largest of them lies a little less than three miles to the southwest and the total of its outpourings covers not over one square mile. Each of the others occupies not over a few thousand square feet. Were it not apparent that they had been formed by the oozing out through small vents of viscous lava, they resemble as much as anything rough oval heaps dumped from some outside source. We can see from above, however, the successive curving flow-lines, the marks of twisting eddies, the circular boundaries and the center whence the welling molten lavas rose and spread. The complete little flow shown in the photograph is not over 500 feet in diameter. Its sides are of broken blocks of glassy to pumiceous andesitic lava and rise perhaps 100 to 150 feet to a group of almost inaccessible spines and pinnacles at the center. All of the evidences are present that the pile has been formed by the slow exudation (perhaps more properly forcible extrusion) of a viscous magma, so slowly as the end drew near that the final issue was already sufficiently stiffened by cooling that it pushed upwards as a set of central sharp spires instead of flattening down as would a more liquid medium.

From the top of South Sister many lakes of many sizes and all degrees of irregularity of outline can be seen within a distance of a few miles, all of which on closer acquaintance prove to be of glacial origin. Sparks lake, and Devils lake, Green, Lost, Elk and Mud lakes are a few of these to which names have been given.

Close view of a part of one of the lava spires shown in the preceding photograph. The suggestion of a partial solidification before extrusion took place is further corroborated by close examination. It is found that one or more of the faces of these central lava spires are curved and planed smooth or marked with parallel scratches or grooves resembling in many ways the characteristic glacier scorings we have seen in so many other places. Indeed, in the absence of any part of the entire story that is here so unmistakably held up before us, what we see might pardonably be taken for glacial work. Many of the grooves it is clearly apparent were made, not upon the hardened rock, but upon rock that, while still hot and somewhat soft, was nevertheless sufficiently rigid to retain its form and to take and hold impressions made upon its surface, much as would a cake of soap take and retain the imprints of one's finger nail. The markings are parallel because the spires were formed by being pushed upwards without change of direction, and were made by friction against the already solidified portions through which they were being upheaved by the irresistible but dying forces beneath. In the language of the geologist such planation by the forcible extrusion of partially hardened lava would be designated as a species of "slickensides," this term being applied to the smoothened surface produced where rock masses under heavy pressure rub together.



Close view of a part of one of the lava spires shown in the preceding photograph.

A final open page in the life history of the Sisters region. South Sister stands sharply outlined against the sky when viewed from the border of the new lava flow at her southwest base. At the right is a great uneven wall of broken blocks of glassy lava that rises one hundred feet or more in most places. It is devoid of vegetation with the exception of moss and lichen stains and an occasional scraggly and scantily nourished clinging evergreen shrub. In this respect the group of stately firs at the left and the thickly tufted grass in the foreground are in striking contrast. They grow to the lava's edge and while we question not, still we divine a most gruesome fate for their neighbors that formerly stood where the great heap of broken lava now rests. The smoothed rock platform on which the trees stand has been rasped and rounded by the glaciers long before the coming of this recent flow.

The course of events here is thus made plain. From what can be seen at this place and from our former knowledge of South Sister peak, it is properly concluded that the mountain elevation once served as a source whence glacial ice spread in all directions over wide stretches of surrounding country. Whether the activity of South Sister as a volcano had ceased before that time cannot with certainty be said. Some features of the mountain suggest the likelihood that it was in eruption during if not after the culmination of the glacial period. However that may be, there is before us full evidence that, succeeding occupancy by ice, a sufficient space of time elapsed for the accumulation of a soil and the growth of forest trees, how many generations of them we do not know. Then followed, and the time seems not so long ago, fresh outbreaks of viscous glassy lava, such as shown in the view and as we have seen at a number of places about and to the south of South Sister. Although these lavas are of a less basic character than the flows we have already observed at the north base of North Sister, the date of their outpouring must have been about the same. The difference in the character of the rocks suggests at least that although they were issuing at the same time they did not come from the same subterranean source. When it becomes possible to more carefully study North Sister, whose obviously greater age has been noted, and its relation to the other two Sisters made out, it is not beyond the range of expectation that the rocks of which it is composed may be found to be rather different. This would only go to strengthen the inference that North Sister probably raised high a lofty snow-capped head some time before the other two Sisters came into existence; and again that the reservoir from which its lavas came was not the same as that which furnished the materials for the other two mountains.

Glancing again at the photograph we are impressed with the fact that the glaciated rock surface passes directly beneath the new lava. Around its edges fir and hemlock everywhere approach, but is it imagination that a wary instinct has taught them caution? The clusters are



A final open page in the life history of the Sisters region.

the alpine fir, the more stalwart individuals mountain hemlock. These lavas are the most recent products of volcanic activity in the entire Cascade range in Oregon and as new as any known within the boundaries of the state. How long it has been since they flowed out can not be stated in years. They may be five hundred years old, perhaps nearer a thousand or more. Though they are treeless and so fresh that they still exhibit every line of motion, every swirl of current, yet no signs of heat remain and no indication is there that both they and the fount from which they came have not attained once and for all a condition of permanent coldness and solidity. Their appearance was the closing act of an epoch of volcanism, the same epoch that produced all of the main peaks throughout the Cascade range from Lassen peak in California to the Canadian line.

SUMMARY

This number of the Mineral Resources of Oregon contains some general considerations on the outstanding geologic features of the higher parts of the Cascade range in Oregon, and particularly the surface features or physiography of portions of the summit between Mt. Hood at the north and Crater lake 150 miles down the crest of the range. The particular purpose of this paper is to call attention to the economic importance of Oregon's scenery by emphasizing the wealth of scenic advantages existing in parts of the Cascade range. Scenery depends primarily upon the working of geologic processes, and its development in a state like Oregon is in large part a problem of economic geology.

A portion of the large scale relief map and a great many photographs are used in the paper and the discussion concentrated principally upon two parts of the summit that are little known, yet are of abundant interest from the pleasure and scenic standpoint. These two localities are Jefferson Park and the Three Sisters Region.

Jefferson Park is an area of a few square miles at the immediate north base of Mt. Jefferson. It is accessible by trail from the west only, but can be reached also from the north in midsummer, entrance being made from along the rocky and in part snow-covered Cascade divide. The park proper is a flat area squarely upon the summit of the range that has been scoured out by the once much more extensive glaciers than today exist on Mt. Jefferson. It is sparsely wooded with mainly alpine fir and hemlock, dotted with lakes of all dimensions, and sprinkled with brilliant flowers. Its surroundings are intensely pleas-

Jefferson
Park

ing, its sporting possibilities unlimited, and, though not at present easy of access, Jefferson Park and Mt. Jefferson should in the near future rank as one of Oregon's greatest scenic assets, comparable in economic importance with Mt. Hood and Crater lake.

**Three Sisters
region**

The Three Sisters Region is not difficult to reach by way of the McKenzie automobile road from Eugene in the Willamette valley or from any one of several railroad points on the Deschutes river east of the range. The Three Sisters are a group of prominent peaks situated at the corners of a flattened triangle whose longest side is not over five miles in length. All three are former volcanoes, South Sister still showing a well developed crater in its top. North Sister is by far the most rugged and, to all appearances, of considerably greater age than the other members of the group.

South Sister is 10,351 feet in altitude, Middle Sister 10,039, and North Sister 10,067 feet high. On the slopes and in the crater of South Sister are large snowfields and clinging about its sides are at least five active glaciers. Emanating from Middle Sister are four glaciers, all having names; one, the Collier, being probably the most extensive in the mountains of Oregon. At the east side of North Sister the remnants of two or three once more extensive glaciers still remain.

Round about the Three Sisters peaks are many evidences of recent volcanic activity. Besides the peaks themselves, small cinder craters are quite numerous and flows that have oozed out from the base of these peaks. Many of the flows are very recent, so new in fact, that their lavas are practically unaltered and upon their surface no vegetation has yet gained a foothold. These recent lavas have been erupted since the period of maximum glaciation, and in many places are seen to rest immediately upon the scored surfaces of earlier lavas, though at times separated by a veneer of volcanic sand that no doubt came from the many cinder craters.

The country about the Sisters peaks is ruggedly scenic and one of attractiveness to the tourist and the mountain climber. It is openly forested and there are uncounted lakes, mostly small, pretty streams and flower-trimmed glacial meadows. Obsidian ridge is a prominent shoulder of glassy lava extending westward from the base of Middle Sister. Red Lava Crag, and a conspicuous cinder cone at the north base of North Sister standing directly in the path of Collier glacier, are objects of scenic interest and study.

**Rocks of
Cascade
range**

It is found that the upper portion of the Cascade range is built entirely of volcanic materials. From altitudes of a few hundred feet to two or three thousand feet in places there is a great thickness of bouldery volcanic tuffs, depending upon their exact character, sometimes properly called volcanic conglomerates, volcanic or tuff-breccia. In some of the deeply eroded canyons, bodies of intrusive, usually

largely crystalline igneous rock will probably be found that have pushed up beneath or broken through the tuff strata. It is in connection with such intrusives that ore bodies are most commonly to be expected.

Resting upon these fragmental volcanic rocks are heavy flows of lava of intermediate acidity known as hypersthene andesite. This type of lava covers not only much of the summit but is also the capping of a large number of conspicuous peaks and ridges throughout the entire width of the range. The lavas of Mt. Hood, Mt. Jefferson, and the Sisters are prevailingly of this same general type.

These great flows of andesite came prior to glacial times and are responsible in considerable degree for the present bulk of the Cascade range. In all the higher parts their surface was covered by the ice of the glacial period and deeply scored by the moving glaciers. While evidence of glacial action is unmistakable and abundant about many of the peaks far toward the Willamette valley front of the Cascade range, the most spectacular display of glacier work in the area treated in this paper is to be observed for better than 100 miles along its summit, chiefly from somewhat north of Mt. Jefferson south to Crater lake and beyond. The myriads of beautiful lakes and meadows, many of the canyons, the sculpture of the peaks, and what is left of the glaciers themselves clinging about the slopes of the major elevations, exist today for our enjoyment and pleasure largely because of the former frigid period of ice and snow that we have come to call the Glacial period.

Glaciation in
Cascade
range

Following and probably in part during the time of profound glacial activity, and, to date, the latest epoch in the history of the making or growth of the Cascade range, there came the great lava flows and ash and cinder eruptions whose products we now see at many points along the summit. Lavas broke out in places about the lower slopes of the larger peaks or issued from fissures or separate vents to deluge the surrounding country. Cinder cones were built and ash and scoria scattered about by the force of explosive eruption. The evidences of this recent activity may be best observed at a great many places from Mt. Jefferson southward for more than a hundred miles. The McKenzie road skirts a long tongue of this lava known as the White branch flow that extends far down the canyon of Lost creek; and upon the summit of the range the road crosses for several miles the roughened, broken and barren surface of the newer lavas that have come from Belknap crater at the north and from vents at the foot of North Sister to the south.

Recent
volcanic
activity

The newer lavas are, in the main, somewhat more basic than those of earlier date. Some are augite andesites, while those crossed by the McKenzie road which represent the most extensive flows upon the summit of the range, are dense, black, brown or red, usually porphyritic, and show every indication of being true basalts.

"See Oregon
First"

Within the higher parts of the Oregon Cascades there are a number of intensely interesting scenic places that are at present frequented only by those who can endure a trip of some length on foot or in the saddle. There are also many other scenic spots that are accessible and equally satisfying to the sportsman and the tourist.

Facilities for reaching the less accessible localities are being rapidly perfected. Oregon scenery is not to be excelled anywhere on the continent, which in this day of exploiting the resources of our own country, is equivalent to saying that Oregon scenery is unsurpassed the world over. The development of Oregon's scenic resources is going on apace, and from the financial standpoint promises to become of importance equal to that of her other established industries. *See America—but See Oregon First!*