waves petrified against the sky." Then a silvery radiance filled the whole arch, as the brilliant disk rose over the crest and swept across the sky. The campfire seemed but a tiny prick of red in the white light, but it was warm, and in its pleasant heat the fun was soon resumed.

Camp was broken on the morning of August the twentieth. The Mazamas and their friends returned to sea-level tanned and hardy, re-vitalized in mind and body, and feeling that the outing was well worth while, in spite of rain and hail and snow.

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Glaciers of the Three Sisters

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Thirty years ago in his report to the Director of the U. S. Geological Survey, Captain C. E. Dutton expressed the opinion that, "There are few localities equal in geologic interest to the neighborhood of the Three Sisters." To those of us who have had the pleasure of visiting this region since that time, the overflowing truth of that opinion has certainly never been questioned. There we see displayed in all clearness not only the present characteristics of the three great peaks themselves, but also the story of their life, their birth, growth and beginning decay, eloquently laid bare, only waiting our attention to be read.

Nor does it require the critical, penetrating eye of the scientist to decipher the story. Its facts are so persistently thrust beneath one's very eyes that it remains only for "him who walks" to connect them into sentences, and the paragraphs and chapters, that spell out a record tinged with the romantic, 'tis true, but replete with tragedy.

We camp securely in this day at the feet and in the shadow of these towering snow-striped peaks. Mazamas make intimate friends of them. As between friends when intimacy develops, they respond with confidences that the eye and the ear attuned to the "various language" that nature speaks can appreciate. As with intimate friends, we cultivate their acquaintance and are permitted to learn of events, and of the exigencies and crises in their lives, that are not entrusted to the onlooker and the passer-by.

The Three Sisters peaks of the central Oregon Cascades, and the immediately surrounding country, is a region in which an unusual number of recent geologic events have taken place. There are two main

reasons why the nature of these events may be so readily seen. In the first place, so short a time has passed since many of them occurred that the evidence of what has happened is not yet obscured by the effects of the weather, by soil accumulation or dense forest growth. Rock surfaces are bare and clean and possess their original characteristics. Lava flows are still but little touched by erosion, and the glaciers are as busy as when they were much more extensive. Then, again, the differing nature of the various events happens to be such that the results of one have not covered up beyond recognition those of another.

What is the language in which the story of the region is made clear? Every stream in its canyon speaks out in terms unmistakable; every flow of lava with its twisted, ropy and broken surface tells its tale; each smooth and glistening ice-scored ledge, each frigid clinging glacier, the shapes of the mountains themselves with their radiating ridges, intervening snowfields, and cruelly riven sides appeal in terms not to be misread. The language, thus, while one of tongues not few, nevertheless calls out to us in universal tones that all may understand. Transformed to words of human speech, what then of romance or of tragedy is revealed? The temptation to undertake the writing of this story in all its parts is one strong to resist, so interwoven and closely related are its various incidents, and so all-absorbing is the plot and nature's setting of it. For the present moment, however, but one feature of this grand drama must claim attention, one scene only in a single act on which the curtain is not yet drawn. It is a scene of ice and snow.

And we get our first clew from the diminutive glaciers that are precariously gnawing away at the flanks of each of the Three Sisters. Diminutive they are, for the reason that, whichever one we examine, abundant evidence is found that they are each of them only the wasting remnants of ice masses, once, and not long ago, of much greater extent. Precarious is their position, for so despoiled have they become by the growing warmth of sun since the continuous winter of glacial times held sway, that some of them are now relatively, in truth, mere grasping and shriveled icy shreds of their former selves.

We need look for no hidden signs of former extensive glaciation. By no direction of approach to the Sisters can we escape their glaring testimony. Twenty miles west of the Cascade summit along the McKenzie road we begin to see the marks of glacier work. Lost Creek canyon throughout practically its entire length from where it heads against the slopes of South Sister to its union with the McKenzie, a distance of twenty miles or thereabouts, is deeply glacier cut and its U-shaped cross section is not to be mistaken. Can we conceive of the day when this great rock-walled trough was filled to the brim with frigid

blue ice, was indeed even a mere corrugation in the uneven old lava surface over which the ice spread, inundating all but the highest elevations for a great many square miles along the west slope of the Cascade range? And when we now perilously search our way down its crumbling cliffs for a thousand and more of feet into its depths to where in August the brilliant flowers of springtime that adorn acres of its level floor lure us on,—can we realize that these perfect little meadows with their sod of green through which scattered boulders peep, and across which sparkling rivulets wind a graceful way,—is it possible that they, too, are to be accounted for by the former presence and work of the same chilling stream of ice? There is no question that this is so.

Shortly above Alder spring on the McKenzie road we pass bare, hummocky rock surfaces which bear the indelible imprint of glacial ice. They are scored, plowed and rounded as though some gigantic rasp of uneven grain had irresistibly borne down upon them. In its passage across the summit, bare or sparsely wooded glaciated hills and knobs are seen on every hand along the McKenzie road but a few miles to the north of the Sisters group of peaks. Similarly to the south for many miles along the crest of the Cascades are uncounted lakes, in size from miles in diameter to but a few feet across, that occupy rock-bound sags or shallow pits in the hard rock. Some of them have outlets, many not; and all are eloquently reminiscent of a time not very long ago when the whole summit of the range was buried beneath an immense roof of ice and snow.

In our examination of the Three Sisters and their environs we find that very important events have transpired since the time of widespread glaciation. Great masses of liquid lavas have issued at the foot of, and in some cases upon, their slopes. So fresh are some of these flows that it is rather difficult to believe eruption is no longer taking place. The lavas have come out and spread over large areas of the glaciated country. One may be almost certain in some places that the lavas appeared while frigid conditions were still present. Can we picture the spectacular display that must have accompanied the issuance of the glowing hot lavas as they melted their way up through and flowed out upon the surface of the accumulated arctic snows of we know not how many winters? Scarcely. Yet in so many places may we see the ice-scored rock surfaces passing directly under the borders of the new lava flows that from any and every reasoning standpoint we are unable to scout the probability that glaciation and volcanism were vigorously contesting processes here in the not distant past. The net result of their contentions to date is expressed in the character of the region at the present time. Have either of these two differing forces of nature so gained the

ascendency as to henceforth discourage opposition from the other; has the battle been fought to a draw; or is it as if the declaration of a truce has temporarily allayed the conflict?

So far as man may judge, the last is the most probable status of the situation. But while peace between these two may be the order of the present day, just as in warfare among men, if not the victors, others promptly enter and begin to clear away the wreckage and debris, to remodel and to reconstruct; so that in course of time but scattered sign remains perhaps to tell the story of the past. The active erosion of the streams, the cutting action of what is left of the glaciers, and the crumbling effect of the weather, are the agents of reconstruction that are slowly, 'tis true, but so surely revolutionizing the surface features of the Sisters region that, unless they are deterred, even the mountains themselves are in the end doomed to obliteration. Such is the outcome in the measured terms of earth history, though no one of us need have serious concern that these magnificent peaks may be lost to us; for while years and hundreds of years are our units, their passage is but a mere tick of the clock of epochal time by which the crucial periods of earth events are measured.

With the superficial satisfaction of distant inspection or philosophizing, we shall not, however, be content. A real speaking acquaintance with the Sisters, all three, must be gained if to us is to be yielded up many of the intimacies of their life careers. As we approach them one may seem more or less communicative than another as to the past, but when we reflect that the facts we learn depend less upon their inclination to impart than our own ability to comprehend, it is plain after all that it is our own keenness of sense that is to determine the pleasure and satisfaction we enjoy in our association with these, our friends, the Three Sisters.

All are easy of approach, if too great intimacy at the start is not attempted. Records at the summit of South Sister show that it has been climbed from the east, south and west sides without difficulty. Upon its slopes are five living glaciers. All of them may be seen to be much shrunken from their former size and extent when examined at close range. Their lower borders are frequently rimmed with sharp ridges of loose rock detritus, that rise from a few to a hundred feet higher than the present surface of the ice. Their extremities are as a rule so entirely obscured by the accumulated rock materials which they themselves have brought down, that their limits can rarely be definitely made out. They are, in other words, blocking their own courses and, as it were, burying themselves beneath a load of their own hauling. A great deal of water is of course produced by melting of the ice in summer, and

that which issues from beneath the glaciers goes away charged and milky with the finely pulverized rock powder that the moving ice has etched from the sides and bottom of its channel. But these waters have little or no power to carry away much of the vast quantity of coarse material which rides down frozen in or upon the top of the glacier, and it therefore heaps up in ridges and embankments where it is dropped as the ice melts. At a little distance these moraines, for such they are called, are a prominent feature.

One may with slight difficulty walk clear round South Sister in a day's trip, in which each of its five glaciers may be crossed at altitudes between 8,000 and 9,000 feet. In places the going is across the glaring snowfields, elsewhere a meandering path upon bare ice amongst the crevasses where calks and alpenstock, if not indispensable, are certainly reassuring safeguards to secure progress. Again it is a scramble over long rock slides or the scaling of the cliffs of crumbling lava that frequently rise from the glacier's edge and separate one from another.

Against the northwest slope of South Sister and in plain view in the photograph (opposite page 18) Lost Creek glacier clings. It has diminished greatly in size in recent times, and although it displays many crevasses in the ordinary season, in 1916 little else could be seen than a wide expanse of boulder-strewn snow. At its head it is cruelly eating into the mountain by a process of undercutting known as "plucking" where by freezing fast to the rocks the ice of the glacier literally plucks out great masses as gravity draws it down the steep slope of the mountainside. The distal or lower end of Lost Creek glacier is so thoroughly obscured by rock detritus that the exact location of the front of the ice is not to be seen. The snowfield of this glacier connects with the great mass of snow which fills the crater of South Sister.

Nestling in a shallow rock-walled niche of its own on the north slope is a mass of snow and ice whose glacial character is not very evident except in seasons when melting has been unusually active so as to expose the ice near its lower end. At such times a series of crevasses is in view, and while the area covered by both snowfield and the ice tongue itself is small, the common characteristics of the alpine glacier are present. The most typical and unmistakable confirmation of our observations as to its glacial nature is the presence about and below its lower border of well-defined embankments of morainal materials. Below it, too, are one or more small lakes into which the waters from its melting seep their way.

High up on the northeast slope of South Sister is the most extensive snowfield on the mountain. It is more than a mile across and from it as a feeder four small tongues of glacial ice creep well down the moun-

Summit of South Sister looking across Lost Creek glacier.

Middle and North Sisters from summit of South Sister, showing Hayden and Diller glaciers on the right.

tain side. At the present time these individual ice lobes are separated only by what appear to be elongated morainal ridges, that is, heaps of broken rock, gravel pebbles, boulders of all sizes, and sand, that the ice itself has dug out, carried down and deposited. We are left no other inference here than that the position of what we see today as four separated small ice streams was formerly occupied by one large mass of moving glacial ice that emanated from a snow-filled amphitheatre of probably considerably greater dimensions. In the course of its shrinkage this once large glacier has been forced to seek its way out through a series of channels rather than a single one, on account of the obstructions which it, itself, has dropped in its old course.

Could one visualize the present condition of this great body of ice and snow that is slowly smothering itself with its own burden, no better picture of its position and outlines could be found perhaps than to conceive of the snowfield area as the palm of a huge hand from which the ice streams push out as the fingers. Between each two fingers is a morainal ridge, often rising a hundred feet higher than the fingers themselves. Against the uphill ends of these ridges, where the fingers attach to the hand, as it were, the ice mass splits and, as if crowded far beyond its plastic limit, here is usually a group of radiating wide open crevasses running, not across, but up and down the slope of the mountain and of the glacier. Each finger of ice reaches down to nearly 7,500 feet until dwindled by melting and obscured by its own load; its waters, usually surcharged with fine sediment, accumulating in a series of little lakes, either directly or by seepage, drain away into some of the smaller headstreams of Squaw creek and thence to the Deschutes.

The size of this glacial field on the northeast slope of South Sister, and the distinctive and typical features of the ice streams leading from it, are such as should give it a recognized standing among the glaciers of, at least, the Oregon Cascades. In my study of the region the past summer, the desirability of dignifying it with a name came to me very strongly. Little then did I suspect that by now there might be occasion to commemorate the passing of any one of the congenial group gathered in the 1916 Mazama camp. Were Mr. Prouty here today I know that his modesty would urge against such recognition. What to us were his superior attainments seemed to him mere incidents in his everyday life. In acknowledgment of those attainments, however, which were his only because he possessed a poise and judgment that never failed him in the most crucial of moments, and as a testimony to his character and his knowledge of mountaineering and of the mountains of the Pacific coast ever placed, in his most kindly manner, at the service of whomsoever he might assist, the writer of this paper proposes to christen

this largest of the glaciers on South Sister, Prouty glacier. A humble testimonial this, perhaps, yet one by which, it is hoped, Mazamas and others of Mr. Prouty's acquaintance may in the future be frequently reminded of him whose memory will no doubt be perpetuated in other more conspicuous manner, yet by no monument more fitting or substantial.

Against the east of south slope of South Sister in a niche which it has excavated for itself is a small glacier that, in a similar way, terminates in two narrow extending fingers that reach very little below 9,000 feet. Between the two fingers is a high morainal ridge against which the ice mass appears to split into the two parts. This entire body of ice and snow has an exceedingly steep slope, in general too steep to traverse with perfect security, and does not occupy, all told, more than a few acres. At the tip, or snout, of the easterly branch of the two ice streams is a sheer front of clean ice forty to fifty feet in height which shows many of the characteristics of the true alpine glacier. It is jointed, broken by crevasses and exhibits the horizontal bandings that mark the cumulative snowfalls of successive seasons. Below this ice front the solid lava slope is so steep that morainal material cannot remain, but when released from its icy bond rolls, or is promptly moved by the series of copious glacial streams of water far down towards the base of the mountain. Blocks of ice at times part from the parent mass to be similarly precipitated headlong down for a thousand feet or more to more stable positions and to where once, without question, the glacier itself extended and dumped its load.

Upon the southwest slope of South Sister is yet another small glacier. Its surface is usually pretty thoroughly snow-covered, the crevassed blue ice showing toward its lower end only in late summer when melting has exposed it. About the upper rim of its cirque is another remarkable example of undercutting or plucking of rock masses by freezing and the downward gravitational movement. A very good idea of the character of the volcanic materials of which the top part of the mountain is composed may be obtained by a study of these great overhanging cliffs that are developed to a greater or less extent round the head of all the glacial fields on South Sister.

We may again say, then, that this peak has five glaciers of a size worthy of recognition. Each of them is but what is left of ice streams once more extensive. We may properly regard what we see today as the dwindled remnants of a series of feeders that contributed, from this elevated peak, to the more widespread glacial fields that buried the whole Cascade summit for a hundred miles or more. It seems highly probable that South Sister was an actively erupting volcano during, at

least, the period of greatest glaciation; otherwise we would expect to find it more deeply cut into and its cone shape more seriously marred than it is at the present time.

Middle Sister is the source of four active glaciers. Of these, two are on the east side, one upon the north of west, and the fourth and largest passes down to the northwest, its lower portion being along the west base of the North Sister. Each of these glaciers has been mentioned in the past by various writers, so no detailed separate descriptions will be given. In the photograph (page 19) the position of the two glaciers on the east slope of Middle Sister may be seen. The one to the south is Diller glacier while Hayden glacier passes to the north near the foot of North Sister. The two spring from the same gathering ground above, but separate against a great jutting crag to become thence individual streams of moving ice. Both are excellent examples of the alpine glacier, exhibiting well in their various parts all stages of consolidation from granular snow, half-ice, half-snow or névé, to the solid ice of blue or blue-green cast. Fissuring is a common feature and in places near the extremity of Hayden glacier particularly, in a season of ordinary melting and flowage, wonderful development of seracs, a pinnacled maze of crevassed and broken ice, may usually be seen. Deserted and ancient moraines lead from their present termini far down the lower mountain slopes and into the bordering forests.

Renfrew glacier hangs against the north of west side of Middle Sister. It is, in part, across its snowfields that two Mazama official ascents of the mountain have been made, in 1910 and 1916. The Renfrew presents a most striking display of both lateral and terminal moraines around its borders, and at its lower edge appears to be split into two or more separate tongues of ice. It is ordinarily so obscured by its mantle of snow that, aside from the broad snowfield, few distinctive features are in evidence. It is worthy of mention that at the south side and near its head the rim of its amphitheatre is made of a much more recent lava than is the bulk of the mountain. A great quantity of viscous lava has oozed from a subsidiary vent at a little over 9,000 feet at the west side of the peak, and the present surface of the main rock ridge down that slope for 1,500 to 2,000 feet is due to the fresh veneer of what appears to be a porphyritic andesite of cellular texture extruded in this final eruptive paroxysm of Middle Sister. This ridge which in places has been narrowed by glacier cutting to a vertically walled causeway of but comfortable width, offers a most attractive course of ascent for those who prefer solid rock to a climb across the snow.

Collier glacier originates on the west of north slope of Middle Sister,

flows along the west foot of North Sister, and terminates rather more than three miles from the upper rim of its cirque, giving rise to White Branch, a stream of fair size and one of the headwaters of Lost creek which flows into the McKenzie river. In length and volume the Collier is as large as any other, if not the largest, glacier in the Oregon Cascades. Nor is there one that exhibits more typically the many interesting features of a stream of flowing ice. Great moraines, single, double, even triple crested, fringe its lower borders, rising in places more than 100 feet above its surface. This of course indicates a great shrinkage in its bulk within comparatively recent times. In August, 1916, practically its entire surface was covered with snow. In 1915 and in 1910 to the writer's knowledge, practically the lower mile of its length was an expanse of boulder-strewn firm ice, pinnacled and crevassed in part, elsewhere coursed with uncountable hurrying rivulets of snow water. Its front was then one high wall of solid ice, down the face of which when the sun shone bright, glinted and gleamed and flashed innumerable rills, brooks, cascades of purest quill, as if in uncontrolled haste to join the mud-reeking waters of White Branch, which was milk white indeed with its charge of rock "flour" from the ponderously grinding glacier mill, as it issued with sullen gurgle from its somber cavern at the glacier's base. In the view we can see far up its icy surface, which is an estimated full mile or more in width, a cross-break which on approach proves to be an open crevasse of the type known as bergschrund. The bergschrund differs from the ordinary crevasse or yawning fissure in that the wall on the lower side of the break has settled down, sometimes slightly, sometimes many feet, so as to leave a bare upstanding wall of ice of corresponding height on the up-hill side of the opening.

Although North Sister seems from all appearances to have received far more harsh treatment at the hands of the erosive agencies, it does not have upon its slopes today a glacier to compare with those on the other two mountains. The upper portion of North Sister is a jagged rock ridge with exceedingly steep faces on all sides. The precipitancy of its slopes very likely accounts in part for the lack of glaciers of any size, since there is little space sufficiently flat for snow to accumulate. There is evidence, however, of the existence of a once full-fledged glacier on its northeast side where a succession of well-defined moraines may be seen extending down beyond the range of vision and into the forest. Within a sharp deep cleft in the mountain, which was no doubt once perennially filled with snow, there is now a small body of glacial ice. From a little distance the writer could discern some blue ice cut by crevasses at its lower end. The surrounding walls of this former cirque are so precipitous and crumbly that both snow and ice are abundantly

over-strewn with rock debris. In fact the place itself fairly resounds with the crash of falling boulders. Each in its descent starts a myriad of others, all joining in a grand competitive relay of midair leaps from cliff to crag, from crag to snow, and then a racing ricochet across snow and ice far down, often to the limit of one's vision, to be finally lost within the depths of yawning crevasses, or mingle with others of its kind and become a part of some morainal heap at the glacier's border. Where is there more exhilarating sport than to watch boulders take their bounding course, after having been unfastened from their resting place by our puny human efforts? But what is this compared to the thrill of delight and pure satisfaction that is ours when we catch glimpses, as here, of nature's own invisible hand at work!

In a similar cleft on the south of east slope of North Sister there is what appears, when viewed from the country to the east, a second glacial remnant. The deserted moraines appear to be there, and although the writer has not had opportunity to make a close examination of this portion of the mountain, its general appearance is such as to strongly suggest that here too is the site of a former glacier of some magnitude that contributed its mite to the summit ice-cap, and that was an important factor in reducing North Sister to its present jagged, eaten-away, and relatively almost skeletal condition of decay.

A recounting of the glaciers of the Three Sisters thus totals eleven. All are within a north-south limit of not over seven miles, and fifteen square miles will amply enclose the entire group, as they stand, with space to spare. No other area in the United States so small, and withal so accessible, surrounds so many glaciers as the Three Sisters region affords. Besides these, it is the overwhelming presence of the great peaks, the widespread new lava flows with their tale of smoldering fires now burned low, far-away rock-cut canyons, and the enchantment of lake, and of flower-besprinkled meadow where winding rivulets purl a restless way—these it is that call us back again and again to this one of Oregon's beauty spots.

The thronging mountains, crowding all the scene,
Are like the long swell of an angry sea,
Tremendous surging tumult that has been
Smitten to awful silence suddenly.

—*Celia Thaxter.*