UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

GEOLOGICAL SURVEY
W. C. Mendenhall, Director

Bulletin 931–R

MANGANESE RESOURCES OF THE OLYMPIC PENINSULA, WASHINGTON

A PRELIMINARY REPORT

BY

CHARLES F. PARK, JR.

Strategic Minerals Investigations, 1941
(Pages 435–457)

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1942

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - Price 35 cents

CONTENTS

	Page
Abstract	435
Introduction	435
Production and reserves	437
Geology	439
Early middle Eocene volcanic rocks	439
Red limestones and argillites	439
Structure	440
Ore deposits	441
Character and localization	441
Mineralogy	441
Genetic relations	442
Mines and prospects	442
Crescent mine	443
Manganese properties near the Crescent mine	445
Sutherland (Thompson) group	446
Bertha prospect	447
Little River deposits	448
Skookum-Hurricane group	448
F and L, Broken Shovel, Ella, and Idaho claims	449
Tubal Cain group	450
Elkhorn group	451
Lucky Creek group	452
Black and White prospect	453
Triple Trip (Brown Mule) prospect	454
Apex prospect	455
Steel Creek deposits	456
Cook Creek-Skunk Creek deposits	457

ILLUSTRATIONS

		Page
Plate	68. Geologic and topographic map of the Crescent mine area, Clallam County, Washington	446
	69. Underground workings and cross section of the Crescent mine	In pocket
	70. Geologic sketch map of the Madeline prospect	446
	71. Map of the Sutherland (Thompson) property	In pocket
	72. Geologic map of part of the Little River district, Clallam County, Washington	450
	73. A, Red limestone and manganese-ore outcrop between two lava flows at the Tubal Cain mine; B, Lens of manganese ore in red limy argillite, Cook Creek-Skunk Creek deposits	454
	74. Plan of Apex prospect, Mason County, Washington	454

Page

Figure 50. Index map of the Olympic Peninsula, Washington..... 436
51. Projection on west wall of the Madeline shaft. 444
52. Plan and section of the Clallam prospect..... 445
53. Projection on west wall of the inclined shaft, Sutherland (Thompson) deposit..... 446
54. Sketch map of the Bertha prospect..... 447
55. Sketch of face of cut on lower Skookum claim.. 448
56. Elkhorn prospect on Dosewallips River..... 451
57. Geologic map of the Black and White mine and vicinity..... 453
58. Plan and section of the Triple Trip prospect.. 455

MANGANESE RESOURCES OF THE OLYMPIC PENINSULA, WASHINGTON

A PRELIMINARY REPORT

By Charles F. Park, Jr.

ABSTRACT

The northern, eastern, and southern parts of the Olympic Peninsula, Wash., contain many small deposits of manganese. Most of the deposits consist of complex manganese silicates with some carbonates, although 16,275 tons of hausmannite (Mn_3O_4) ore was mined at the Crescent mine during 1924-26. About a hundred tons of silicates have been mined from various properties, mainly for experimental purposes. Future production probably will not be large, because the silicate ores are of low grade and are difficult and expensive to treat. Moreover, most of the deposits are difficult of access, and most of the ore bodies are small isolated lenses and thin tabular bodies.

The deposits are mostly in red limestone or red argillite near contacts with basalt, but a few of them are in basalt.

INTRODUCTION

The Olympic Peninsula, which has an area of about 5,000 square miles, forms the northwestern corner of the State of Washington. It is bordered on the west by the Pacific Ocean, on the north by the Strait of Juan de Fuca, and on the east by Hood Canal, a narrow arm of the sea; and it merges with the mainland at the south. It has been known for about 30 years to contain manganese deposits,[1/] but these have been very little

1/ Arnold, Ralph, Notes on some rocks from the Sawtooth Range of the Olympic Mountains, Washington: Am. Jour Sci., 4th ser., vol. 28, pp. 9-14, 1909.

Pardee, J. T., Manganese-bearing deposits near Lake Crescent and Humptulips, Washington: U. S. Geol. Survey Bull. 795-A, pp. 1-24, 1927; Deposits of manganese ore in Montana, Utah, Oregon, and Washington: U. S. Geol. Survey Bull. 725-C, pp. 229-242, 1921.

explored or developed. As the region is very rugged and heavily timbered, and as most of the deposits can at present be reached only by trail or blazed lines, the cost of making the deposits easily accessible would be high. A paved highway that borders tidewater in places extends around the peninsula, and a railroad, the Port Angeles Western, extends about 50 miles westward from

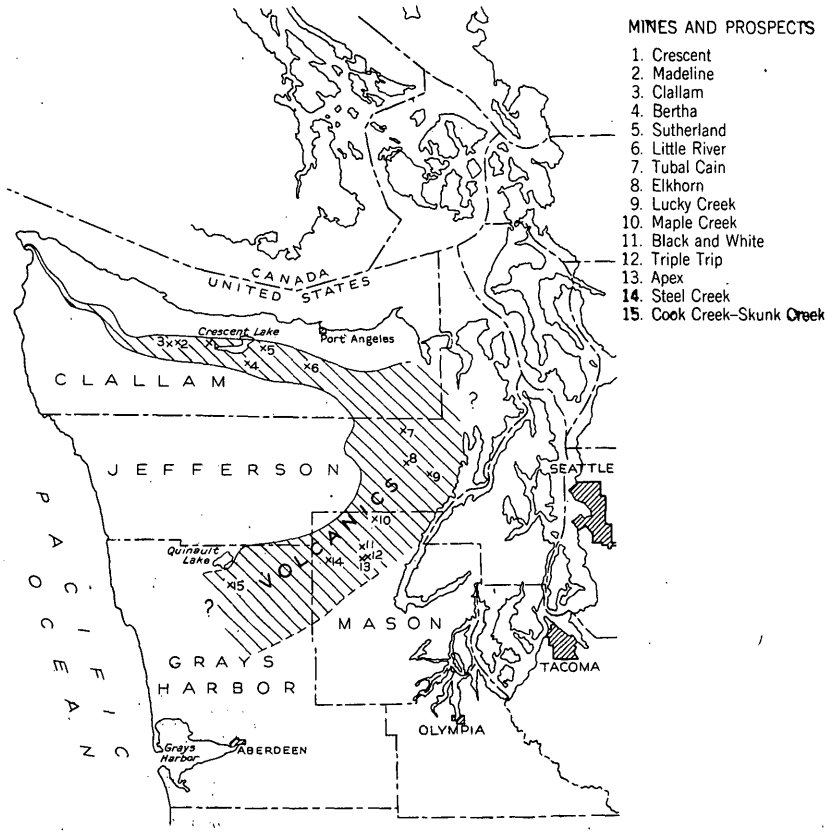


Figure 50.--Index map of the Olympic Peninsula, Washington. Ruled area shows belt of volcanic rocks and associated sedimentary beds in which the manganese deposits occur.

Port Angeles (fig. 50). Railroads used largely for logging also extend southeast from Port Angeles and north and east from Grays Harbor. A few of the deposits are near the railroads, and others are accessible by branch roads up the main valleys.

An examination of the area by the Geological Survey was begun in 1938 under a grant of funds from the Public Works

Administration, and was continued during 1939-40 as a strategic-minerals project. The project was in charge of the writer, and the following men have been employed as assistants during parts of the field seasons: J. R. Balsley, Jr., H. A. Brines, W. M. Cady, F. M. Chace, R. H. Cowie, H. L. James, J. M. Nelson, R. J. Roberts, J. W. Robinson, J. M. Straczek. and R. G. Yates. The cooperation of other men familiar with the district, particularly Ed Brooks, S. H. Green, and the late Charles Greenlee, is gratefully acknowledged. F. C. Calkins and H. G. Ferguson have kindly criticized the manuscript. This paper briefly summarizes the principal economic results of the work.

PRODUCTION AND RESERVES

The only commercial manganese ore shipped from the peninsula consisted of 16,275 tons mined from the Crescent mine in 1924-26.[2/] This ore, which was largely hausmannite (Mn_3O_4), averaged more than 51 percent manganese. About a hundred tons of manganese silicates have been shipped from other properties for experimental purposes.

With the exception of a few bodies that are rich in hausmannite, the manganese deposits in this region form lenses and layers of complex silicates, most of which are too small and too widely separated to be worth mining under present conditions. Oxidation of the silicates is limited to seams and weathered surfaces, and no bodies of supergene oxide large enough to be mined profitably have been found. The only large body of the hypogene oxide hausmannite yet discovered in the peninsula is that explored and mined at the Crescent mine. The chief hope of future production seems to lie in finding other bodies of hausmannite, and recent diamond drilling at the Crescent mine by the Bureau of Mines, United States Department of the Interior, has

---

2/ Furness, J. W., Manganese and manganiferous ores in 1926: Mineral Resources U. S., 1926, pt. 1, pp. 160-161, 1929.

located one such body. This body is being developed by the Sunshine Mining Co. and is estimated by the operators to contain between 10,000 and 15,000 tons of hausmannite.

The Bureau of Mines has also drilled the deposit at the Apex prospect (see fig. 50), has explored with shafts the ore bodies at the Lake Sutherland (Thompson) and Madeline properties, and has sampled many other deposits. Although the deposits thus investigated do not include any ore bodies comparable in size and grade to that at the Crescent mine, the Bureau estimates that they contain, altogether, about 25,000 tons of ore, with 6,250 tons of metallic manganese.[3/] On the whole, however, the diamond drilling and development work have revealed little ore not previously known, and the outlook for noteworthy production, even under the stimulus of urgent need and higher prices, is not favorable. It is doubtful whether the known outcropping deposits of the peninsula contain as much as 150,000 tons of material averaging more than 20 percent manganese; doubtless, however, lenses like those that crop out could be found beneath the surface.

Some of the red limestones and argillites with which the ores just considered are associated might conceivably be mined as low-grade ores, but this is very unlikely. In 32 samples of such rocks analysis showed a maximum of 8.52 percent of manganese oxide. It is possible that at some properties, such as the Rose Astrid, which adjoins the Triple Trip (No. 12 on fig. 50) to the north, large bodies of red limestone that contain about 5 percent manganese oxide could be developed, for 8 chip samples taken at this property across a width of 21 feet of red rock averaged 7.6 percent manganese oxide. But, on the other hand, much of the red rock in this region contains almost no manganese.

3/ Exploration and sampling of domestic deposits of strategic minerals by the Mining Division, Bureau of Mines. Report of progress as of May 1, 1941: U. S. Bur. Mines Rept. Inv. 3574, May 1941.

At the Crescent mine the highest manganese oxide content in 10 samples of the limestone was 0.96 percent.

GEOLOGY

The core of the Olympic Peninsula consists of closely folded argillites, graywackes, schists, and quartzites, probably of Cretaceous or basal Tertiary age.[4/] The rocks of the core are overlain, apparently conformably, around the northern, eastern, and southern borders by at least 30,000 feet of alternating argillites, graywackes, volcanic rocks, red limestones, and red argillites of early middle Eocene age. Above these Eocene rocks are shales, sandstones, conglomerates, and volcanics of younger Tertiary age. The manganese deposits are found only in the volcanic rocks, red limestones, and red argillites of early middle Eocene age (see fig. 50); only these rocks, therefore, will be further described here.

Early middle Eocene volcanic rocks

The volcanic rocks are mainly basaltic lavas and agglomerates interlayered with softer agglomerates, tuffs, and other sedimentary material. Flows of pillow basalt that range in thickness from a few feet to a maximum of several thousand feet form the huge rock pile known as Mount Constance. Such flows are common throughout the section but are best developed in the lower parts. Diabase is found locally in sills and in the interiors of thick flows.

Red limestones and argillites

The lavas, particularly the pillow basalts and agglomerates, are associated with intergrading reddish or chocolate-colored and light-greenish limestones, argillites, and tuffs. The beds

---

4/ Weaver, C. E., Tertiary stratigraphy of western Washington and northwestern Oregon: Washington Univ. [Seattle] Pub. in Geology, vol. 4, p. 22, 1937.

of red siliceous limestones, although they are thin and lenticular and make up a very small percentage of the whole section, have particular interest because they contain most of the manganese deposits. These red limestones are widely distributed, but they are highly lenticular. The beds range in thickness from a knife edge to 300 feet, but most are less than 25 feet thick. The red sediments for the most part rest upon the tops of flows, but some red beds lie within or below flows, or lap around their ends. Locally they are found between pillows in the pillow lavas or in the cores of the pillows. Fragments of red rocks occur in the agglomerates, and blocks as much as 30 feet or more in diameter are engulfed in the lavas.

The red color of these rocks is due to finely divided hematite. Most of the impure limestone contains from 1 to 5 percent of manganese oxide (MnO), which probably is combined in the main with silica but possibly in part with carbonic oxide.

Structure

The belt of volcanic rocks and associated sedimentary beds extends in a horseshoe around the northern, eastern, and southern borders of the Olympic Mountains. The geology of the western border is not yet known except along the sea coast. In a broad way, the rocks dip steeply away from the mountains, and locally they are overturned. In the upper part of the section, the dips are progressively lower, and in the overlying younger Tertiary beds they rarely exceed 30°. Strike faults are especially conspicuous along contacts between massive rigid flows and included, less competent, deformed sedimentary beds. Faults transverse to the bedding are generally small, although a few are known to have offsets of several hundred feet; these faults tend to swing into the bedding and become lost in the incompetent layers. The rocks show progressive crystallization and deformation towards the center of the Olympic Mountains. Except

for a few small sills and dikes associated with the Eocene extrusives, no intrusive rocks are recognized in the mountains.

ORE DEPOSITS

Character and localization

The manganese deposits are lenses, thin beds, and pockets of oxides and silicates that contain from a few pounds to 10,000 or 15,000 tons. The manganese minerals--silicates, oxides, and possibly carbonates--, with jasper, generally replace the red siliceous limestones near their contacts with basalt, but locally they also replace red argillites and basalts. Bedding and other sedimentary features may be recognized in most of the deposits, and at a few places, such as Little River, pillows of lava may be identified. The deposits are thought to have been formed before the rocks of the region were deformed, for most of the lenses are shattered and many are faulted, although the offsets on most of the faults are only about 5 or 10 feet. The distribution of the deposits is, in detail, extremely irregular, as is illustrated in a map of part of the Little River district (pl. 72). Only in a very few places--possibly in the Cook Creek-Skunk Creek area and the Elkhorn group on the Dosewallips River--are several deposits near enough together to encourage small-scale mining.

Mineralogy

The mineralogy of the manganese deposits is very unusual and has not been thoroughly studied. The only mineral thus far proved to be of economic value is the oxide hausmannite (Mn_3O_4). The manganese silicates that have been recognized are bementite ($H_6Mn_5(SiO_4)_4$),[5/] neotocite (a hydrous silicate of manganese and

---

5/ Pardee, J. T., Larsen, E. S., Jr., and Steiger, George, Bementite and neotocite from western Washington, with conclusions as to the identity of bementite and caryopilite: Washington Acad. Sci. Jour., vol. 11, pp. 25-32, 1921.

iron), tephroite (?) (Mn_2SiO_4), inesite ($H_2(Mn,Ca)_6Si_6O_{19}\cdot 3H_2O$), rhodonite ($MnSiO_3$), manganophyllite (a manganese-rich biotite), and piedmontite (a manganese epidote). The deposits also contain rhodochrosite ($MnCO_3$), manganiferous calcite, and jacobsite ($(Mn,Mg)O.(Mn,Fe)_2O_3$). Laumontite and possibly other zeolites, calcite, and jasper are associated with the manganese silicates, but jasper is uncommon where hausmannite is abundant. Barite is widely distributed in small quantities and makes up a large part of one lens at the Maple Creek prospect on the Hamma Hamma River (No. 10 on fig. 50). Small quantities of native copper, cinnabar, chalcocite, chalcopyrite, and pyrite have been found in many places.

GENETIC RELATIONS

The problem of the origin of the manganese ores is too complex to be adequately discussed in a brief economic report. It may at least be pointed out that the association of basalt, red limestone, manganese minerals, and, commonly, of jasper is so general that it must be significant, and the four are thought to be genetically related. Although the jasper and the manganese silicates were formed in large part at the same time, both of them later than the basalt and the limestone, the deposition of manganese silicates apparently began before that of the jasper. The associations here emphasized should be borne in mind when prospecting for new ore bodies.

MINES AND PROSPECTS

About 150 claims and groups of claims on manganese deposits in the Olympic Peninsula have been recorded.[6/] On most of these claims, however, little or no work has been done; and on many the manganese showings are no better than those observed on

6/ Works Progress Administration, typewritten summary of investigation of Olympic manganese deposits, 1938.

unclaimed ground. For these reasons, and also for the sake of brevity, only a few representative bodies are described below. The deposits throughout the area have similar structural relations but differ somewhat in mineralogy.

Crescent mine

The Crescent mine (No. 1 on fig. 50), operated by the Sunshine Mining Co., is the only one in the region that has produced manganese ore commercially. The 16,275 tons of ore shipped was largely the mineral hausmannite (Mn_3O_4). The outcrop of the deposit, which is on the steep south side of Mount Muller ridge, about 1¼ miles west of Lake Crescent and about 900 feet above the valley floor, was found in 1923 by a party of hunters. Development was begun a few months later by Messrs. Jamison and Peacock of Duluth, Minnesota.[7/] Production began about the middle of 1924 and continued until July 1926, when the known ore supply was exhausted. The ore was mined through three short adits, numbered 2, 3, and 4. Nos. 3 and 4 (see pls. 68 and 69), the lower two openings, were the only ones accessible in 1938-40. Late in 1926 and in 1927 a considerable sum was spent in driving a long adit (No. 5) about 400 feet below the old workings.

The ore bodies of the Crescent mine occur in an impure red limestone, about 20 feet above its contact with underlying basalt. The 2,900 feet of drifts and crosscuts on the lowest level are largely in the basalt. The ore horizon was reached, however, on this level, and was explored to a slight extent (see pl. 69) by drifts and raises, and a few small bodies of ore were found. Recent diamond drilling by the Bureau of Mines below the No. 5 level has disclosed another small hausmannite body, which is being developed by the Sunshine Mining Co. and is

---

7/ Pardee, J. T., op. cit. (Bull. 795), p. 16.
Furness, J. W., unpublished memorandum to W. C. Mendenhall, July 28, 1925.

estimated by the operators to contain between 10,000 and 15,000 tons of hausmannite.

The ore is fine-grained, has a dense and massive texture, and is black, dark gray, or reddish brown in color. The ore body mined was a tabular mass from 6 to 14 feet thick, with a

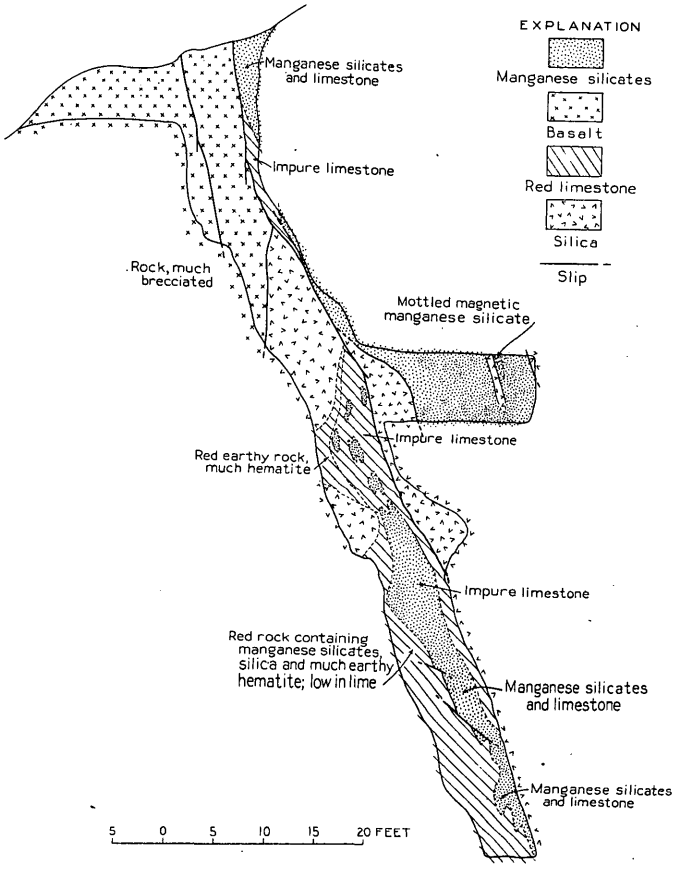


Figure 51.--Projection on west wall of the Madeline shaft.

pitch length of 180 feet and a stope length of 120 feet. Its strike was N. 60°-70° W., and its dip nearly vertical, and according to Pardee it pitched steeply westward and was cut off at the bottom by a fault.[8/] The small bodies of ore remaining in

8/ Pardee, J. T., op. cit. (Bull. 795), p. 16.

the old mine workings are badly broken and faulted, but the maximum offsets on the faults are probably less than 20 feet. The red limestone which contains the ore zone is much folded and is broken by small fractures. A sheared chloritic zone (see pl. 69) which grades laterally into unsheared greenish tuff lies near the ore zone.

Manganese properties near the Crescent mine

Many manganese deposits have been explored along the northern border of the Olympic Mountains, both east and west of the

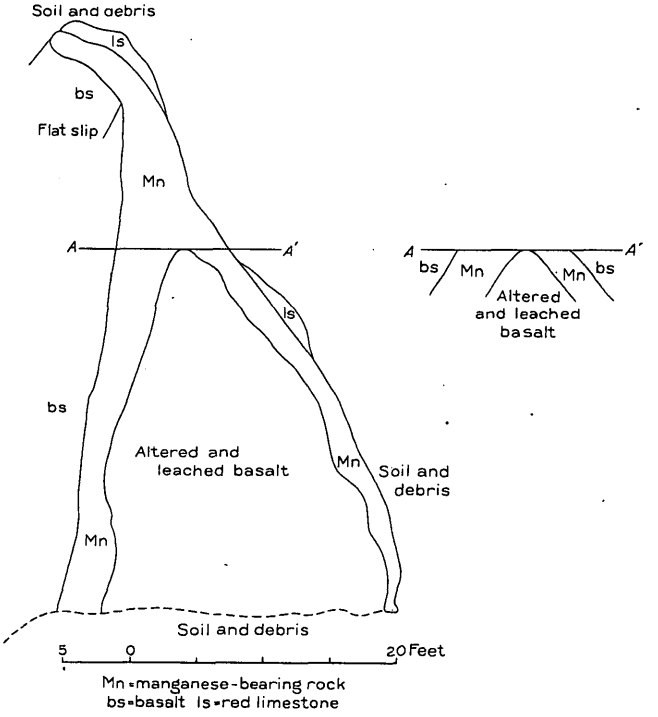


Figure 52.—Plan and section of the Clallam prospect.

Crescent mine. All of these deposits, of which the Madeline (see fig. 51) and Clallam (see fig. 52) are examples, are found in impure red limestone and contain manganese silicates and hausmannite. They are all small, and it seems unlikely that any of them could be profitably mined.

The Madeline deposit has been opened by an inclined shaft, sunk on the ore by the Bureau of Mines (fig. 51). In depth the ore is largely hard massive silicate irregularly distributed along a sheared red limestone layer between flows of pillow basalt.

Sutherland (Thompson) group

The Sutherland (Thompson) group of six claims (No. 5 on fig. 50) is on the northern slope of Storm King Mountain,

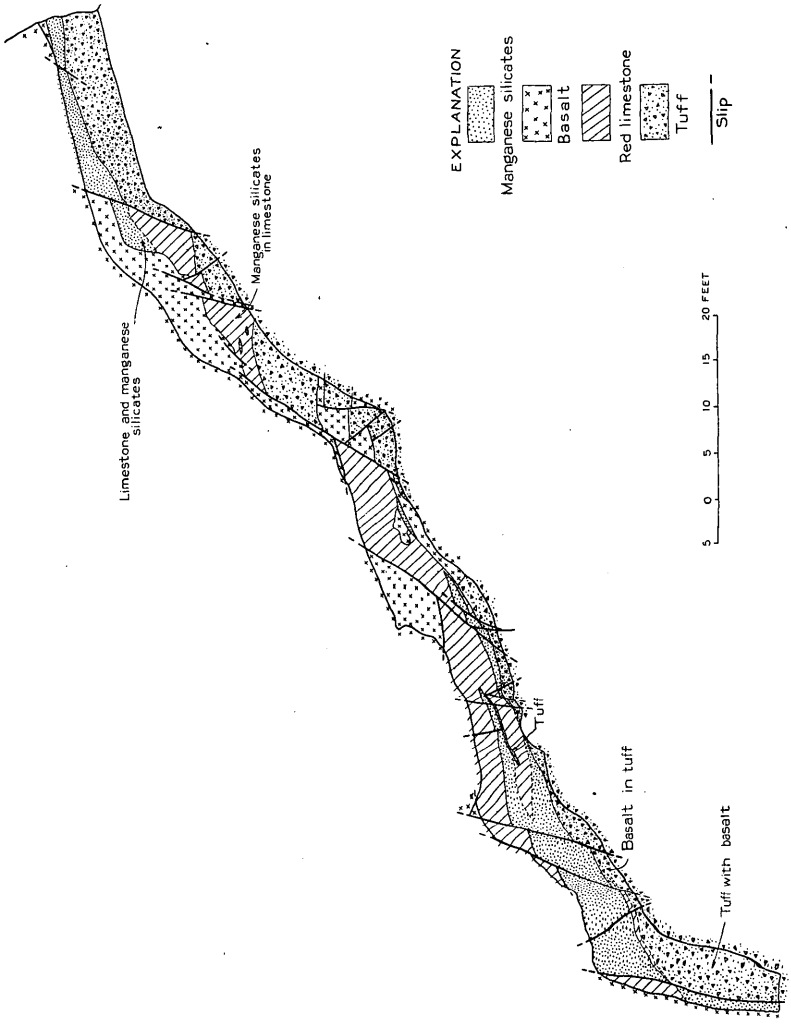
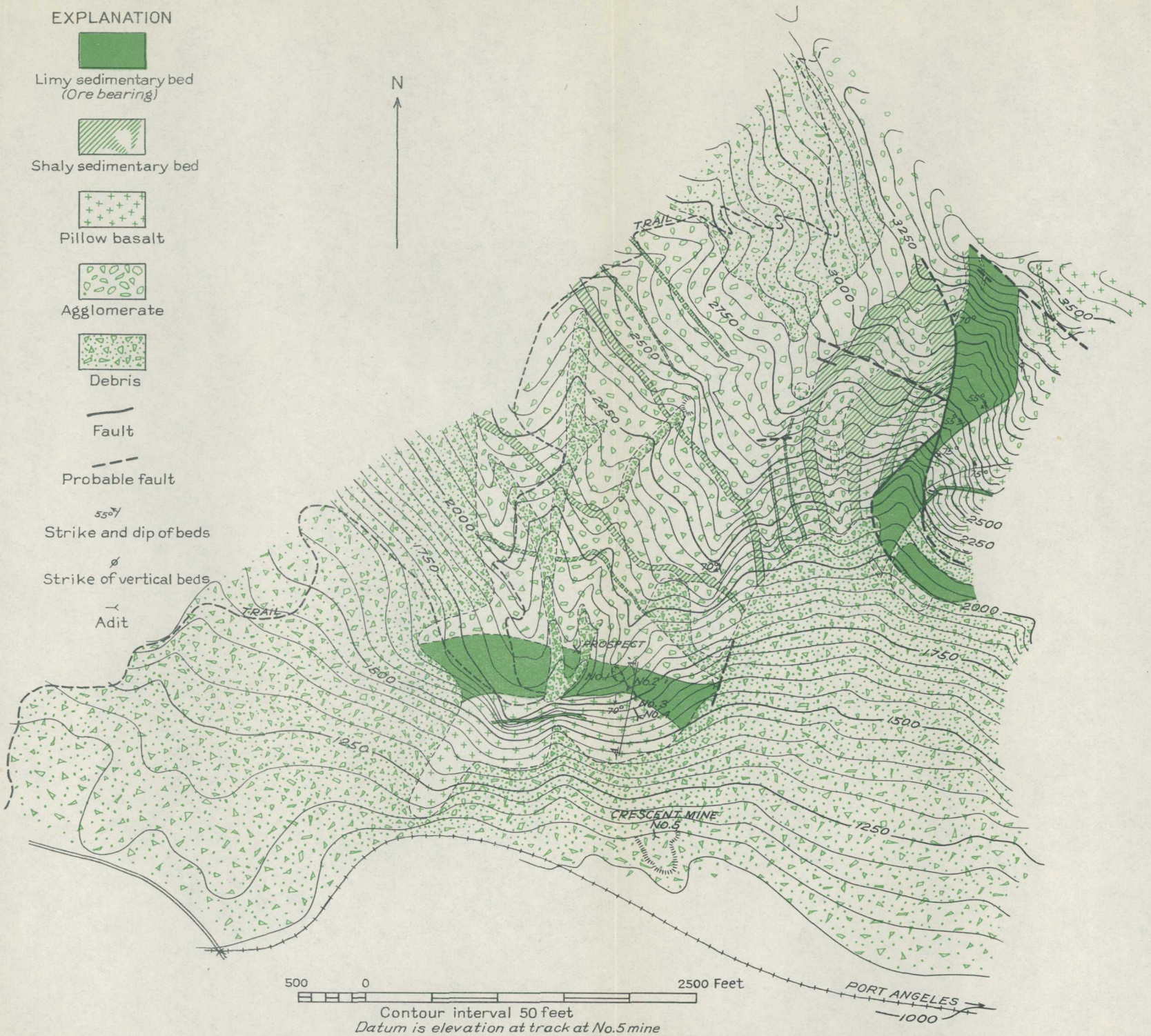


Figure 53.—Projection on west wall of the inclined shaft, Sutherland (Thompson) deposit.



GEOLOGIC AND TOPOGRAPHIC MAP OF CRESCENT MINE AREA, CLALLAM COUNTY, WASHINGTON

Section along line A–A′ shown on plate 69

GEOLOGIC SKETCH MAP OF THE MADELINE PROSPECT

directly above the eastern end of Lake Sutherland and at an average altitude of about 3,400 feet (fig. 50). Exploration has revealed lenses of manganese minerals in a zone of tuff and limestone for a distance of about 600 feet along the strike. Plate 71 shows the appearance of the lenses after the surface was cleaned for sampling by the Bureau of Mines. The zone of tuff and limestone which contains the ore lies between basalt flows. The zone grades westward into red limy argillite and eastward into agglomerate. The Bureau of Mines has sunk an inclined prospect shaft on the ore (see fig. 53) in order to determine its character in depth. The ore continues irregularly to the bottom of this shaft, in a red limy zone between pillow basalt and basaltic tuff, without appreciable change of character. The ore zone strikes S. 55° E. and dips less than 45° S., being apparently overturned, for the regional dip nearby is steep to the north. The thickness of the ore lenses reaches a maximum of 5 feet but is generally less than 3 feet. The lenses are broken and are bordered by slip surfaces, on which the known offsets are small.

The ore consists largely of manganese silicates but contains some hausmannite.

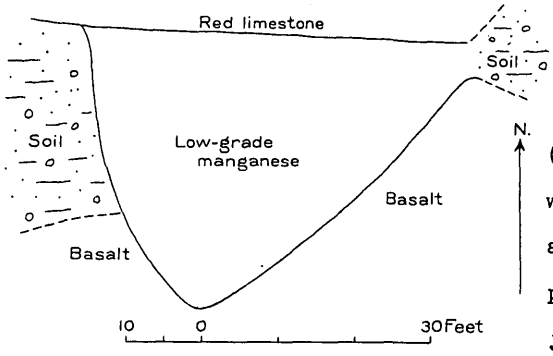


Figure 54.--Sketch map of the Bertha prospect.

Bertha prospect

The Bertha prospect (No. 4 on fig. 50), which can be reached by a poor trail from Olympic Hot Springs, lies just below the crest on the north slope of Happy Lake-Aurora Ridge, about 1½ miles west of Lizard Head Peak or 4 miles south of the east end of Crescent Lake. The manganiferous zone lies between red argillaceous limestone to the

north and basalt to the south. The principal outcrop is about 50 feet long, but in this distance it pinches northeastward from a maximum width of 30 or 40 feet to 6 feet. (See fig. 54.) The regional dip here seems to be nearly vertical. The deposit contains considerable jasper and red limestone, and probably 10 to 15 percent manganese. The minerals are oxidized on the surface, but the freshest specimens appear to contain manganese silicates; no hausmannite has been recognized.

A layer of low-grade manganiferous rock about a foot thick, in a wider jasper zone, extends eastward along the strike of the red limestone as far as the next northward-trending spur from Aurora Ridge. Still farther eastward a layer of jasper 10 feet wide, in red limestone, is exposed, but the jasper contains little or no manganese. The slope northwest of the prospect is covered by debris, but patches of red limestone, possibly at the same horizon as that in the Bertha property are exposed for several miles to the west.

Little River deposits

The Little River deposits (No. 6 on fig. 50), which include the Skookum-Hurricane, F and L, Broken Shovel, Ella, and Idaho, are on a branch of the Elwah River, about 8 miles in an air line south of Port Angeles. They are reached by trail either up the river from the Little River road or from the Hurricane Lookout road to the south.

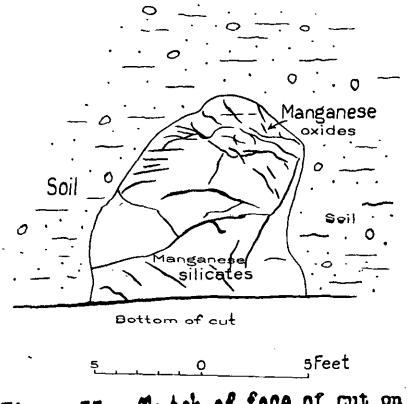


Figure 55.—Sketch of face of cut on lower Skookum claim.

Skookum-Hurricane group.—

The Skookum-Hurricane group of claims is on the slope west of Little River at and above an altitude of 3,700 feet. The largest of several cuts on the property is at an altitude of 3,800

feet (see fig. 55), and for several hundred feet downhill from this cut manganese ore is exposed in pits. In no place can the enclosing country rock be seen, but judging from the red appearance of the nearby soil at least one wall is red limestone or red argillite. The zone strikes about N. 55° W., but the dip is unknown. Basalt and red limestone are exposed a few hundred feet south of the workings.

About N. 75° W. from the cuts described above, and at an altitude of 4,250 feet, there is an opening known as the upper Skookum. Here, in a small cut, an 8-foot lens of manganese minerals lies between red limestone to the north and basalt to the south. Manganese float is found on the surface between the Skookum and upper Skookum but was not seen in place.

The Hurricane No. 1 cut, at an altitude of 4,030 feet, is in alluvium on Hutton Creek, a small tributary of Little River, south of the Skookum claims. The cut, 16 feet long by 4 feet wide and 4 feet deep, exposes blocks of manganese minerals, which may be essentially in place, for there is an outcrop of manganese-stained red siliceous limestone about 200 yards east of the cut, and a zone of red soil obscured by surface debris extends from the one to the other. About 300 feet farther east, at an altitude of 3,900 feet, is another open cut in which red limestone and manganese ore are exposed. Farther down the creek, at an altitude of about 3,600 feet, a 25-foot adit was driven in manganese-stained red limestone in search of copper.

The exposures on the claims of this group are poor, but enough work has been done to show that manganese is widely distributed. Some of the ore appears to contain hausmannite, and it is possible that small bodies of high-grade ore can be found.

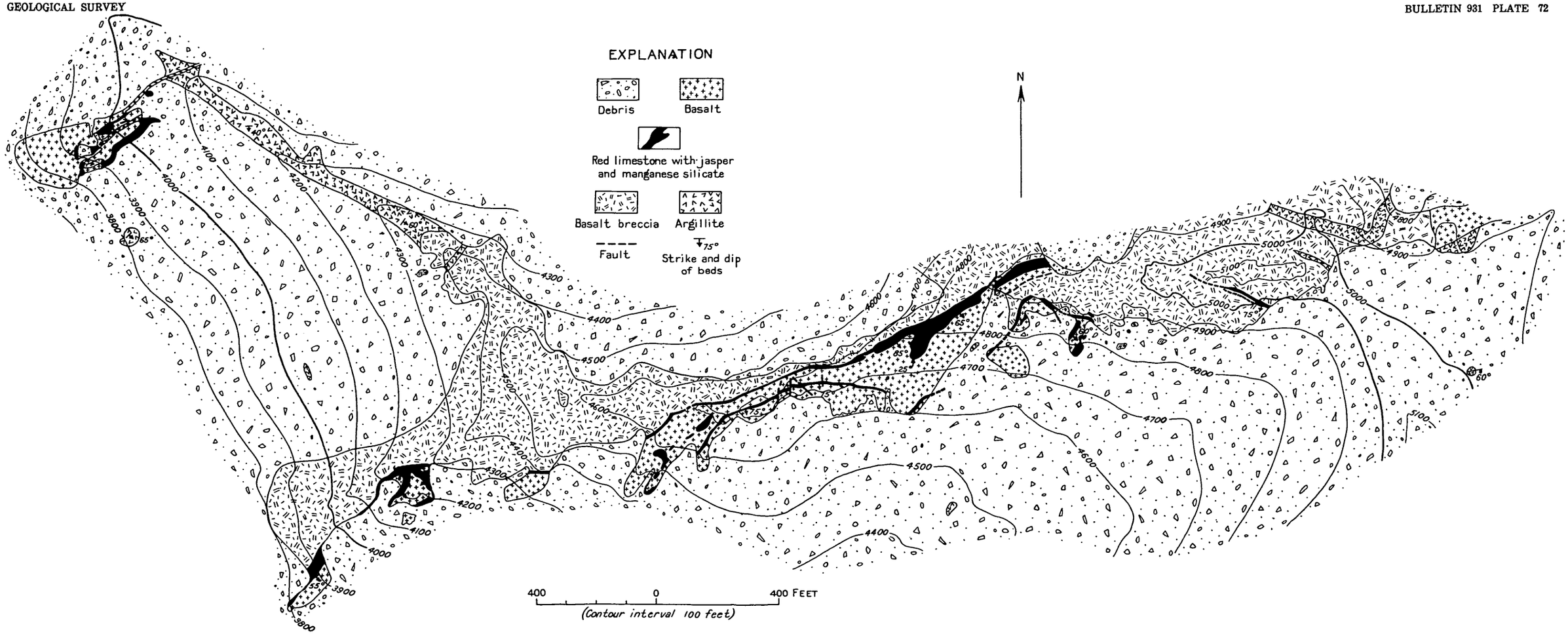
F and L, Broken Shovel, Ella, and Idaho claims.--The F and L, Broken Shovel, Ella, and Idaho claims are on a ridge east of the Skookum claims and on the eastern side of Little River. The deposits are small, scattered masses of low-grade silicates,

associated with abundant jasper, in red limestone, and it seems altogether unlikely that they have commercial value. The map (see pl. 72) clearly shows the scattered, erratic distribution of the limestone lenses, although in general they are concentrated between two basalt flows. In each limestone body, the jasper and manganese silicates are distributed in much the same haphazard pattern as the limestones and lavas shown on the map (pl. 72). Jasper is much more abundant than manganese silicates. The flows and beds are overturned and dip to the south, and the larger patches of limestone, jasper, and manganese silicates are in part on dip slopes.

Tubal Cain group

The Tubal Cain group of 11 patented claims (No. 7 on fig. 50) is on a small tributary of the upper Dungeness River (see fig. 50), about 12 miles by trail from the dirt road at the Dungeness Forks. The old mine adit, about 2,000 feet long, at an altitude of 4,400 feet, was originally driven in search of copper. It is mainly in basalt, and although it cuts a 75-foot red limestone bed 114 feet from the face it shows no manganese or copper.

About half a mile by air line northeast of the Tubal Cain camp is another old copper prospect, the Tull City. This prospect, at an altitude of 4,900 feet, is connected by trail with the Tubal Cain. Between the two camps and extending southward there is a craggy ridge that reaches an altitude of about 6,900 feet. The manganese showings are just east of the crest of these crags about half a mile to a mile south of the Tull City cabin, and they can be reached by scaling the cliff from either the eastern or the western side (pl. 73, A). Manganese minerals were first found in talus at the foot of the cliffs. The Tubal Cain adit is directed about S. 55° E. toward the manganese showing, but it is several hundred feet shorter than it would have



GEOLOGIC MAP OF PART OF THE LITTLE RIVER DISTRICT, CLALLAM COUNTY, WASHINGTON

464994 O - 42 (Faces page 450)

to be in order to intersect the projected plane of the ore zone. It is, moreover, extremely doubtful whether the ore body continues for 2,000 feet down the dip. The ore body, consisting principally of manganese silicates, is tabular; it is about 300 feet long, and its width attains a maximum of 8 feet but probably averages between 1 and 2 feet. Basalt forms both walls, but a little red limestone is generally present, and to the north the ore zone is a well-defined bed of red limestone which contains scattered pockets of manganese minerals. Southward, small scattered and irregular lenses of ore-bearing limestone continue. Several other layers of red limestone crop out near the bed shown in plate 73, A, but none is known to contain manganese.

Elkhorn group

The Elkhorn group of claims (No. 8 on fig. 50) is on the slope north of the Dosewallips River, about 13½ miles by road from the Olympic Highway. About 20 small cuts that show manganese minerals have been dug on the hillside above the road; these range in altitude from about 1,250 to 5,700 feet, the highest being near the top of the ridge. Basalt and tuff form most of the hillside, but three principal red limestone beds, known as the eastern, middle, and western beds, are recognized, and other irregular red limestone beds are present. In general the limestone beds trend approximately north and stand vertically, but locally they are much deformed and broken. The middle limestone bed seems to contain the best manganese-bearing bodies, though manganese

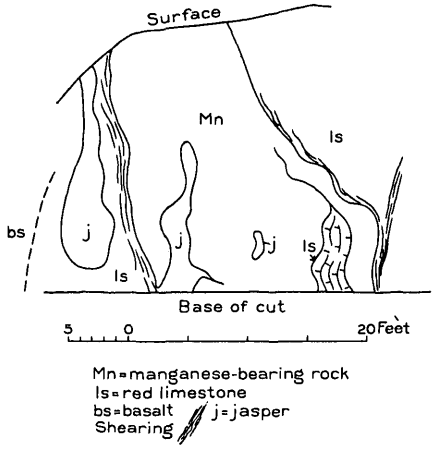


Figure 56.--Elkhorn prospect on Dosewallips river. Section on face of lowest cut, middle bed.

showings (see fig. 56) are found in the other limestones. The cut shown in figure 56 reveals a 15-foot zone of manganese silicates, bordered on each side by jasper and red limestone, but the length of this zone could not be observed. The bodies are thought to be in lenses, because the widths shown in the numerous small cuts differ widely, but the exposures are too poor to prove that that is so. Only manganese silicates and their oxidation products are present; hausmannite has not been recognized.

On these claims a greater number of manganiferous deposits are known to occur within a small area than anywhere else on the Olympic Peninsula, and these deposits are comparatively accessible by road. Whether or not they have commercial value must remain uncertain until the size and grade of the individual lenses have been determined by further exploration and adequate sampling.

Lucky Creek group

The Lucky Creek group of 10 claims (No. 9 on fig. 50) is on the south side of the Dosewallips River, three-fourths of a mile south of the Corrigenda Ranger Station and about 6 miles west of the mouth of the river. The deposit, a tabular body between basalt to the east and tuff to the west, is best exposed about 1,400 feet above the river. It ranges from 6 inches to 3 feet in width, strikes about N. 30° W., and dips 55°-75° E. It was explored laterally for about 400 feet, from an altitude of 1,500 feet to 1,790 feet. To the north it goes under surface debris, and to the south it apparently is cut out along a slip. A few inches of red limestone, red hematitic clay, and jasper commonly adjoin the manganiferous body, particularly on the west or footwall side.

The deposit, though narrow, is one of the longest in the region. It is largely made up of manganese silicates.

Black and White prospect

The Black and White property (No. 11 on fig. 50), 3 miles northwest of Lake Cushman, lies at an altitude of 4,250 feet and is reached by a 5-mile trail from the Lake Cushman road. The property was staked for copper in 1907, and the presence of manganese was not recognized until 1918. A shipment of 5.012 dry

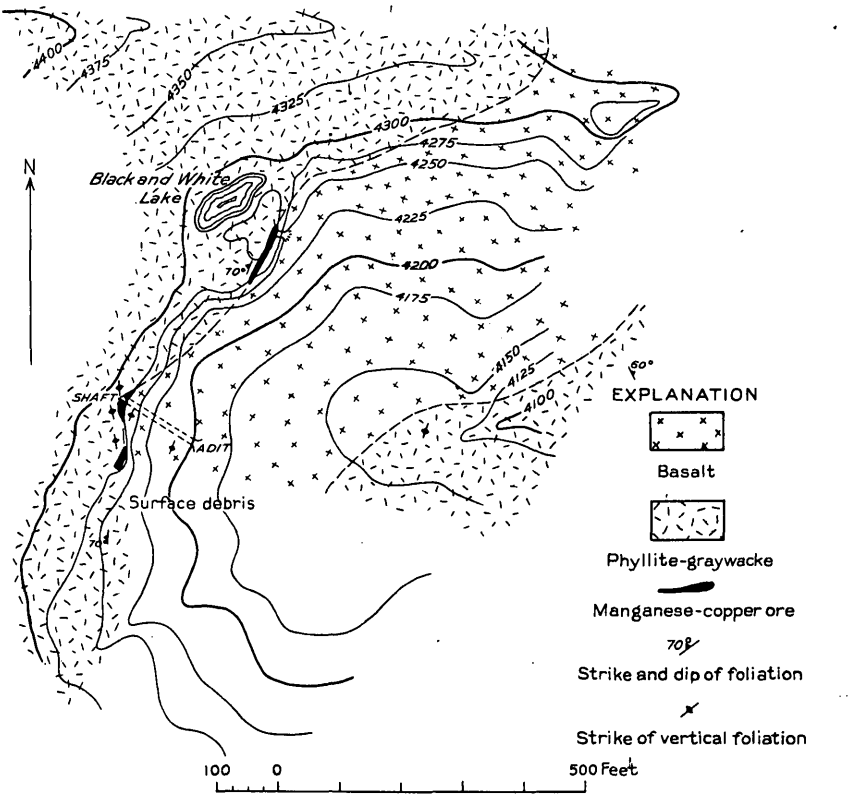


Figure 57.—Geologic map of the Black and White mine and vicinity.

tons to the Tacoma Smelter in 1915 contained 0.40 ounces of silver per ton, 7.85 percent copper, 3.2 percent iron, and 65 percent of insoluble material. An analysis of a composite sample of about 125 tons of broken ore on the dump of the shaft (see fig. 57) is given by Dewsnap [9] as shown on the following page.

9/ Dewsnap, S. G., private report to the owners, Oct. 23, 1919.

Insoluble	57.2
Cu	5.63
Ni+Co	.12
Fe_2O_3	7.44
MnO	19.72
$CaCO_3$	3.84
H_2O at low red heat	5.15
Zn	Trace.
Mg	Trace.
	99.10

An analysis of an 8-foot sample taken by Pardee [10] showed 29.63 percent MnO, 12.38 percent Fe_2O_3, 0.706 percent $CaCO_3$, and 24.35 percent SiO_2.

The mineralogy of the Black and White deposit has not been studied in detail, but silicates appear to predominate. The deposit shows more native copper than any other deposit on the peninsula, and copper oxidation products such as cuprite, chalcotrichite, malachite, and azurite are conspicuous in the outcrops, which also contain a little chalcocite and jasper.

The Black and White prospect, staked as the Three Friends claim, explores three lenses along a contact between phyllite-graywacke and a greenish altered basalt. The lode is opened by an adit about 190 feet long, a 40-foot shaft above the adit but not connected with it, and several small open cuts. One lens, at the collar of the shaft, has a maximum width of 8 feet, but it pinches and swells abruptly both on the strike and down the dip. No red limestone was seen near the ore, but red limestone probably in the same stratigraphic position as the ore is found to the northeast. About 750 feet north-northwest from the southwestern end of the Black and White shaft is another small showing of manganese, known as the Arkansas Traveler.

Triple Trip (Brown Mule) prospect

The Triple Trip (Brown Mule) prospect (No. 12 on fig. 50) is on the north bank of Boulder Creek or Copper Creek, a small tributary to the North Fork of the Skokomish River, about a

---

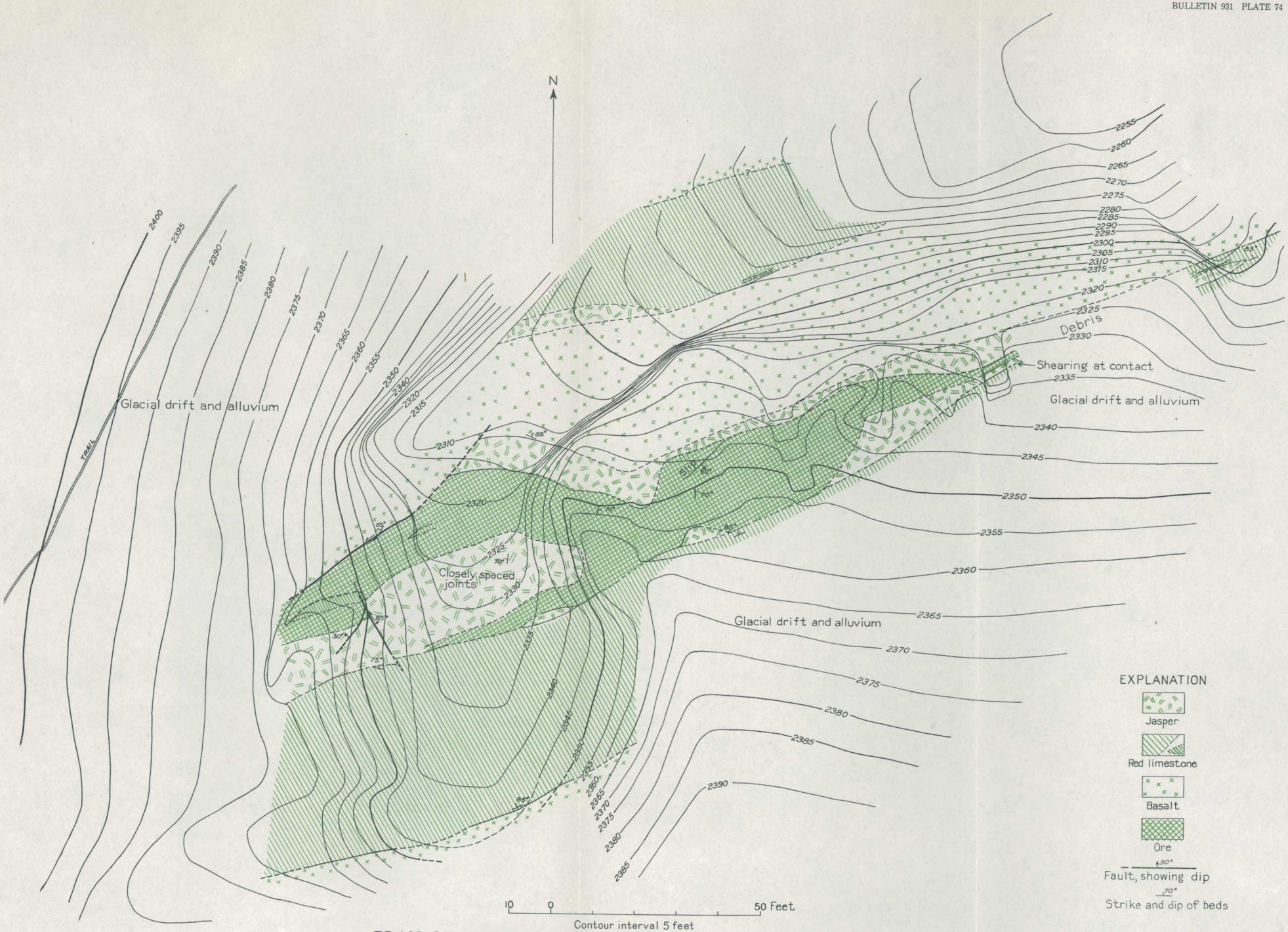
10/ Pardee, J. T., op. cit. (Bull. 725-C), p. 240.

A. RED LIMESTONE AND MANGANESE ORE OUTCROP BETWEEN TWO LAVA FLOWS AT THE TUBAL CAIN MINE.

Note two men on the bed near the center of the picture. The manganese ore and limestone are gradational and cannot be distinguished in the picture.

B. LENS OF MANGANESE ORE IN RED LIMY ARGILLITE, COOK CREEK-SKUNK CREEK DEPOSITS.

Hammer handle 18 inches long.



PLAN OF APEX PROSPECT, MASON COUNTY, WASHINGTON

quarter of a mile west of the head of Lake Cushman. According to Pardee,[11/] a carload of ore shipped from the property was said to contain 35 to 45 percent Mn and 17 to 30 percent SiO_2. Analyses of six samples from the lode, given by Pardee, showed from 6 to 25 percent Mn, 8 to 21 percent Fe, 11 to 37 percent SiO_2, and 4 to 36 percent $CaCO_3$. One sample tested for phosphorus and sulphur gave only a trace of each.

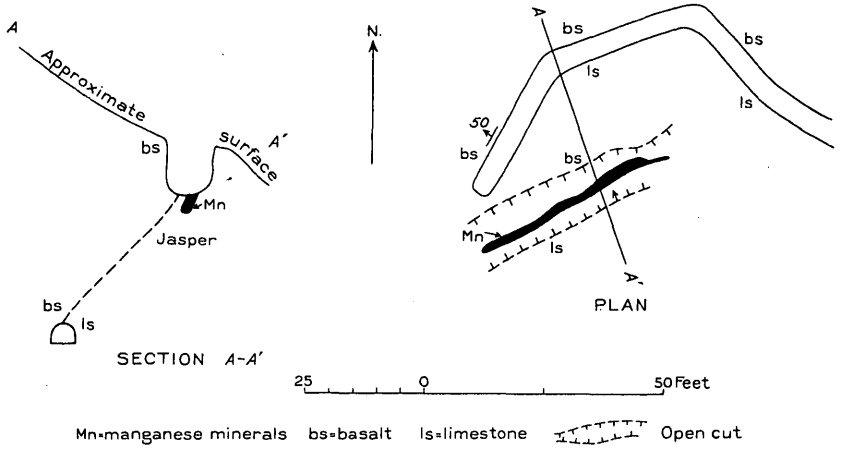


Figure 58.—Plan and section of the Triple Trip prospect.

A small lens of manganese silicates and jasper is exposed in an open cut along a contact between basalt and red limestone (fig. 58). The lens, which has a maximum width of about 2 feet, trends in general southwest and dips about 60° NW. An adit driven on the contact about 35 feet below the open cut shows no manganese or jasper. Southwestward the lens grades into limestone, and to the northeast it ends at the surface of the ground. To the northwest, several other similar small lenses are exposed along the strike of the contact.

Apex prospect

The Apex prospect (No. 13 on fig. 50) is on Copper Creek, at an altitude of 2,400 feet, about three-fourths of a mile south-

11/ Pardee, J. T., op. cit. (Bull. 725-C), pp. 236-237.

west of the Triple Trip and a mile west of the head of Lake Cushman. A sample taken by Pardee from a 6-foot section across the lode and analyzed in the Geological Survey laboratory contained 43.10 percent MnO, 12.65 percent Fe_2O_3, 3.87 percent $CaCO_3$, and 18.91 percent SiO_2.[12/] This sample, however, represented selected material and contained more manganese than most of the lode.

The lode, shown on plate 74, was cleaned off and sampled by the Bureau of Mines, and in the autumn of 1940 the Bureau explored the deposit with the diamond drill. The general trend of the deposit is N. 70°-75° E., parallel to Copper Creek. The manganiferous material, which contains silicates, oxides, and carbonates, together with much jasper, lies near the contact between basalt and red limestone. The deposit is about 25 feet in maximum width, and it has been explored along the strike for at least 250 feet. Exploration demonstrated that the deposit continued to some depth with about the same size and grade that it had on the surface. It gradually thins out eastward; how far west of the prospect it extends has not been shown. About 50 feet north of the main manganese-bearing streak on Copper Creek, there is another outcrop, chiefly jasper, about 4 or 5 feet wide.

Steel Creek deposits

The Steel Creek deposits (No. 14 on fig. 50) are about 6 miles a little south of west from the head of Lake Cushman. They are on the steep south slope of Wonder Mountain and are reached by a good trail, 11 miles long, up the south fork of the Skokomish River.

The manganiferous material, which appears to consist mainly of silicates, forms several small lenses in siliceous red limestone near its contact with basalt. These lenses lie parallel

12/ Pardee, J. T., op. cit. (Bull. 725-C), p. 238.

to the bedding, which strikes nearly east and dips 35°-50° S., forming a dip slope on the south side of the mountain. As the ore bodies thus lie flat on the hillside, they give an exaggerated impression of the quantity of ore that they contain. The three principal lenses, which lie at altitudes of 2,600 to 2,900 feet, apparently contain in all only about 1,000 tons of manganese silicates.

Cook Creek-Skunk Creek deposits

The Cook Creek-Skunk Creek deposits (No. 15 on fig. 50) are about 5 miles south of Quinault Lake and a little east of the Olympic Highway, from which they are reached by short trails. The exposures in the area are poor, but the owners have dug numerous cuts in which many small lenses of ore have been exposed (pl. 73, B). These lenses, though small, are comparatively accessible, and about 20 of them have been found within a few square miles. It is possible that a few thousand tons, mostly manganese silicates and supergene oxides, could be obtained from the area without great expense.

Some of the manganiferous lenses are in red limy argillite and others are in basalt; the country rock of several is unidentified because of weathering and poor exposures. The ores are as deeply oxidized here as anywhere on the peninsula, but supergene oxides are limited to the surface and to seams, from which they extend no more than about 3 inches laterally into the silicates.