State of Washington
ARTHUR B. LANGLIE, Governor

Department of Conservation and Development
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DIVISION OF GEOLOGY
HAROLD E. CULVER, Supervisor

Report of Investigations
No. 12

ECONOMIC ASPECTS
OF THE
Blewett - Cle Elum Iron Ore Zone
Chelan and Kittitas Counties, Washington

By
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FOREWORD

Based on the known occurrence in the State of Washington of the three essential resources, coal, limestone, and iron ore, the idea of the establishment of an iron industry in the Pacific Northwest has long been considered feasible by forward-looking citizens. Within recent years the appearance of important new factors has warranted a review of the whole situation.

An important part of this review is a careful reexamination of the actual ore deposits, a task begun by the Division of Geology in 1941. The printing of partial reports as rapidly as field and laboratory studies could be finished instead of delaying publication until all iron deposits in the State were examined has been planned in the public interest. Report of Investigations No. 8, "Results of a magnetic survey of the Buckhorn iron deposits of Okanogan County", was followed in July 1943 by a similar report, No. 10, on the "Blewett iron deposit of Chelan County". The current report, No. 12, is the third of the iron series and represents a detailed study of the entire nickel-chrome-iron belt extending from Peshastin Creek, Chelan County, to Cle Elum River in Kittitas County.

As pointed out by the author, the present investigation does not include the important ores along Cle Elum River because these are being mapped and drilled by Federal agencies. Although there is no official cooperation between State and Federal organizations, the Division of Geology has avoided any unnecessary duplication of effort in this work. It is hoped, therefore, that both the U. S. Geological Survey and the U. S. Bureau of Mines will make their data available to the citizens of the State of Washington at an early date.

It should be added that this report is based upon precise and detailed magnetic traverses of the iron belt and upon examination of every known prospect or test opening. From the information gained from this painstaking survey it is clear that all of the iron deposits are confined to a relatively narrow belt along the Swauk-peridotite boundary, and further, that any large body of ore will be found near the extreme western end of this contact.

June 10, 1944. Harold E. Culver, Supervisor.

INTRODUCTION

The Blewett-Cle Elum iron ore zone extends westward for about 22 miles from 2 miles south of Blewett on Peshastin Creek, Chelan County, to the Cle Elum River, Kittitas County. One mile south of the mouth of Boulder Creek it turns northward, following the Cle Elum River for at least 5 miles. Iron deposits covered by this report occur on the east and west sides of Peshastin Creek and along the north side of Nigger Creek in Chelan County; and on the west side of Stafford Creek, the east and west sides of Bean Creek, the south side of Iron Peak, and the east side of Cle Elum River south of Boulder Creek in Kittitas County. The iron deposits west of Cle Elum River and those east of Cle Elum River but north of Boulder Creek have recently been mapped in detail by the U. S. Geological Survey and are now being diamond drilled by the U. S. Bureau of Mines. The reports of these Federal agencies will no doubt be made public.

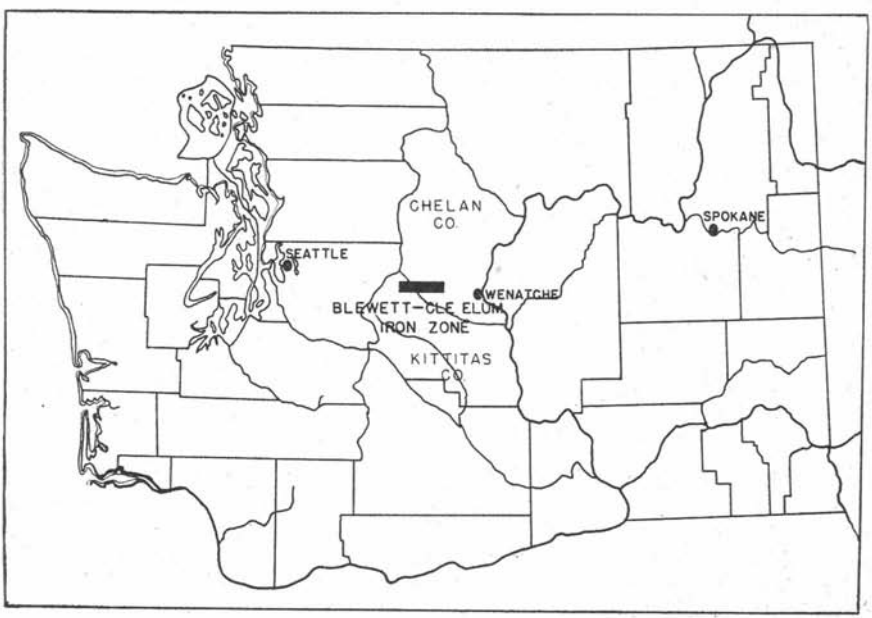


FIGURE 1—Index map of Washington showing the location of the Blewett-Cle Elum iron zone.

The Blewett-Cle Elum iron zone crosses a series of narrow, steep-sided ridges and valleys that trend approximately north. Elevations range from 2,500 feet to 6,500 feet above sea level. There is an adequate supply of timber for mining purposes and numerous streams cross the iron zone, but water is scarce on many of the steep-sided ridges. The iron zone is accessible by three roads, U. S. Highway 97, along Peshastin Creek, and county roads along the North Fork of the Teanaway River and the Cle Elum River. Other parts of the zone can be reached by trails from these roads.

Accompanying this report is an areal geologic map of the Blewett-Cle Elum iron zone and 18 detail maps of the various iron deposits. The areal geology was taken from the U. S. Geol. Survey Geologic Atlases Mount Stuart folio (no. 106) by George Otis Smith and Snoqualmie folio (no. 139) by George Otis Smith and Frank Cathcart Calkins with modifications of the Swauk-peridotite boundary based on Division of Geology field work. The 18 detail maps of the iron deposits show topography, geology, iron exposures, and possible extent of unexposed iron. The topographic contouring was based on U. S. Coast and Geodetic Survey bench marks. The geology and data on the iron beds are the results of a dip needle and sun compass survey of the iron zone made by the Division of Geology. As a rule, section corners and lines are not shown on these maps due to the scarcity of known section corners in the vicinity of the iron zone. However, the maps are referred to the approximate locations or near-by section corners. Individual mining properties and claims are not shown on any of the maps.

MINING OPERATIONS

The Washington Nickel Mining and Alloys, Inc., of Seattle, Washington, controls 11 claims covering all of the Blewett iron deposits. Mr. C. P. Davenport of Auburn, Washington, and others have 4 claims covering part of the Nigger Creek deposits. Mr. E. K. Brown of Ellensburg, Washington, and Mr. A. R. Jordin of Liberty, Washington, control 25 claims in all, covering the Stafford Creek deposits and part of the Bean Creek and Iron Peak deposits. Balfour, Guthrie & Co., Ltd. has 20 claims and one fraction, covering the major part of the Cle Elum River deposits. There are several other claims of unknown ownership along the iron zone.

The early development work consisted mainly of open cuts with a few short adits and shafts, most of which are now caved and inaccessible. A few diamond drill holes were put down on some of the Cle Elum River claims in years past. The only recent development work is the diamond drilling under the supervision of the U. S. Bureau of Mines at the Blewett and the Cle Elum River deposits.

There has been no commercial production of ore from any of the iron deposits, although small shipments of ore from the Blewett and Cle Elum River deposits have been made for experimental purposes.

FIELD WORK

Field work on the Blewett-Cle Elum iron deposits was carried on by the Division of Geology from August 16, 1942 to September 22, 1942, from April 24, 1943 to May 12, 1943, from June 11, 1943 to August 19, 1943, and from October 5, 1943 to October 21, 1943. During the course of the field work the writer was assisted by M. T. Huntting and R. E. Stevenson, geologists of the Division of Geology, and L. T. Teir, G. M. Valentine, R. E. Thomas, and I. I. Friedman, Division of Geology, field assistants.

A narrow strip, ranging from 500 feet to 3,500 feet in width, along the iron-bearing zone from Peshastin Creek on the east to Cle Elum River on the west (22 miles) was covered by dip needle and sun compass traverses and those areas that contain exposed or unexposed iron beds were geologically and topographically mapped. Plates 2-7 and figures 2-8 and 10-14 are maps of such areas. Plate 3 is the result of plane table and magnetic surveys.

ACKNOWLEDGMENTS

The writer sincerely thanks Mr. P. E. Oscarson, U. S. Bureau of Mines, and Mr. P. J. Shenon, U. S. Geological Survey, for their interest and cooperation in this work; and Mr. E. L. Davis, Mr. A. R. Jordin, and Mr. N. A. Batchelder for their splendid aid and cooperation with the field parties. Special thanks are given to Professor R. L. Lupher for helpful information and maps made available by his detailed stratigraphic studies of the Blewett-Cle Elum iron ore zone. Magnetic instruments were generously loaned by Mr. E. F. Bean, State Geologist of Wisconsin.

EARLIER INVESTIGATIONS

No report including all of the Blewett-Cle Elum iron deposits has been published, although there are numerous published reports on the geology of the region. Individual iron deposits have been briefly described in some of the geologic reports and have been mentioned in technical journals. Several unpublished private reports covering various individual iron deposits have been written. The more important of the published reports are as follows:

1892. Bethune, Geo. A., Mines and minerals of Washington: pt. 3, Second Annual Report of First State Geologist of Washington. A brief description of the Cle Elum iron beds. Several analyses of the ore are given.

1893. Russell, Israel C., A general reconnaissance in central Washington: U. S. Geol. Survey Bull. 108.
A description of the geology, lithology, and structure of the eastern portion of the Cascade Mountains from Lake Chelan southward nearly to the Oregon boundary. The iron deposits are not mentioned.

1897. Hodges, L. K., Mining in the Pacific Northwest: The Post Intelligencer, Seattle, Washington.
Iron beds along the Cle Elum River are briefly mentioned.

1898. Kimball, James P., Residual concentration by weathering as a mode of genesis of iron ores: Am. Geologist, vol. 21, no. 3, pp. 155-163.
The paper includes a description of the Cle Elum iron beds and a discussion of their origin.

1899. Russell, Israel C., Preliminary paper on the geology of the Cascade Mountains in northern Washington: U. S. Geol. Survey 20th Ann. Rept., pt. 2, pp. 83-210.

The paper includes a description of the geology, lithology, and gold deposits of the Blewett mining district.
The iron deposits are not mentioned.

1900. Smith, George Otis, and Willis, Bailey, The Clealum iron ores, Washington: Am. Inst. Min. Eng. Trans., vol. 30, pp. 356-366.
A paper covering the geology, character, and genesis of the Cle Elum iron beds.

1902. Shedd, Solon, The iron ores of Washington: Washington Geol. Survey Ann. Rept. for 1901, vol. 1, pt. 4, pp. 29-36.
A description of the Cle Elum iron beds with numerous analyses of the ore.

1903. Smith, George Otis, and Willis, Bailey, Contributions to the geology of Washington: U. S. Geol. Survey Prof. Paper 19, pp. 1-97.
A discussion of the lithology, stratigraphy, and structure of the general Blewett area is given. The ore deposits are not mentioned.

1904. Smith, George Otis, U. S. Geol. Survey Geol. Atlas, Mount Stuart folio (no. 106).
A description of the lithology, structure, and economic geology of the Mount Stuart quadrangle. The iron deposits are briefly mentioned.

1906. Smith, George Otis, and Calkins, Frank Cathcart, U. S. Geol. Survey Geol. Atlas, Snoqualmie folio (no. 139).
A description of the lithology, structure, and economic geology of the Snoqualmie quadrangle, including a description of the Cle Elum iron beds and a brief discussion of their origin.

1911. Weaver, Charles E., Geology and ore deposits of the Blewett mining district: Washington Geol. Survey Bull. 6, p. 49.
A detailed description of the gold deposits and geology of the Blewett mining district. Brief mention is made of the iron deposits.

1917. Whittier, W. H., An investigation of the iron ore resources of the Northwest: Univ. of Washington Bur. of Industrial Research Bull. 2, pp. 22-25.
A brief resume of previously published information on the Cle Elum iron deposits.

1921. Patty, Ernest N., The metal mines of Washington: Washington Geol. Survey Bull. 23, p. 43.
The Cle Elum iron ores are briefly mentioned.

1921. Patty, Ernest N., and Glover, Sheldon L., The mineral resources of Washington with statistics for 1919: Washington Geol. Survey Bull. 21, pp. 70-72.
A brief description of the Cle Elum iron ores and a short bibliography.

1922. Shedd, Solon; Jenkins, Olaf P.; and Cooper, Herschel H., Iron ores, fuels and fluxes of Washington: Washington Div. Geology Bull. 27, pp. 70-86.

A brief description of the Blewett, Cle Elum, and Iron Peak iron properties with several analyses of the ore. The Blewett iron deposits are regarded as magmatic segregations in peridotite, and the Cle Elum deposits as laterites.

1924. Shedd, Solon, Mineral resources of Washington with statistics for 1922: Washington Div. Geology Bull. 30, p. 65.
A brief description of the Cle Elum iron ore.

1936. Culver, Harold E., The geology of Washington: Washington Div. Geology Bull. 32, pt. 1, General features of Washington geology.
Includes a brief description of the rock formations of the Blewett-Cle Elum area.

1941. Melrose, J. W., Summary of information on iron ore deposits of Washington: Washington Div. Mines and Mining Inf. Circ. 6, pp. 6-8.
A brief summary of previously published information.

1942. Glover, Sheldon L., Washington iron ores, A summary report: Washington Div. Mines and Mining Rept. of Inv. 2, pp. 3-5, 10-12.
An abstract of previous publications with the addition of some unpublished information.

1942. Cle Elum nickel-iron ore deposit, Kittitas County, Washington: U. S. Bur. Mines War Minerals Rept. No. 27.
A brief description of the Cle Elum iron deposits with an outline of a tentative development program.

1942. Blewett Pass nickel-iron ore deposit, Chelan County, Washington: U. S. Bur. Mines War Minerals Rept. No. 28.
A brief description of the Blewett iron deposit with an outline of a tentative development program.

1943. Broughton, W. A., The Blewett iron deposit, Chelan County, Washington (with preliminary tonnage estimates): Washington Div. Geology Rept. of Inv. 10.
A detailed report on the geology, origin, and tonnage possibilities of the Blewett iron deposit with an accompanying topographic and geologic map showing magnetic traverses and readings.

1944. Zapffe, Carl, Memorandum report on iron ores of the Cle Elum district, Washington: Washington Div. Mines and Mining Rept. of Inv. 5.
A detailed report on five selected claims of the Balfour, Guthrie & Co., Ltd., property dealing mainly with the character and composition of the ore, the stratigraphy and structure of the iron deposits, tonnages, and possibility of treating the ore.

GEOLOGY

There are numerous published reports (listed on pages 8-10) dealing with the geology of the Blewett-Cle Elum iron ore zone, and since these reports are readily accessible only a brief summary of the general geology is given in this report.

The oldest rocks in the vicinity of the iron zone are slates and cherty limestones of the Peshastin formation and volcanics of the Hawkins formation. These two formations, regarded by George Otis Smith[1] as of Carboniferous (?) age, are intricately folded together and have been intruded by pre-Tertiary (Smith) peridotite that is now highly serpentinized. This complex of old rocks forms a belt from 3 to 5 miles wide on the north side of the iron beds. During pre-Tertiary times, but after the intrusion of the peridotite (Smith), the Mount Stuart granodiorite was intruded into the Hawkins, Peshastin, and peridotite and now outcrops as a circular mass about 15 miles in diameter surrounded by the older rocks. Sometime between the intrusion of the peridotite and the intrusion of the granodiorite the region was subjected to intense tropical weathering with the formation of an iron-rich laterite over the peridotite areas. This weathering was followed by considerable erosion so that the laterite was completely stripped from much of the peridotite surface. Some of the lateritic material was deposited in local basins on the peridotite surface, some was left as residual deposits on the peridotite, and some was undoubtedly carried out of the region. Following the intrusion of the Mount Stuart granodiorite the continental arkosic Swauk formation, of Eocene age (Smith), and derived largely from the granodiorite, was deposited over the Hawkins, Peshastin, and peridotite surface, burying the laterite. The Swauk now outcrops as a wide belt around the periphery of the older rocks. During the Eocene (Smith), but after the deposition of the Swauk, the Teanaway basalt was extruded and covered the entire region. Since then the region has been gently folded and tilted so that the Teanaway basalt, the Swauk, and the pre-Swauk surface have a general regional dip to the south. Erosion has truncated all of the formations so that when traveling southward from the central core of granodiorite one passes successively over the Hawkins-Peshastin-peridotite complex, the iron beds, the Swauk, and the Teanaway basalt. Numerous basaltic dikes and sills, considered by Smith to be feeders for the Teanaway flows, cut the Swauk and extend for short distances into the old rock complex. The distribution of the various rock types is shown on plate 1.

CHARACTER OF THE IRON BEDS

There is no doubt as to the lateritic origin of the Blewett-Cle Elum iron; however there are two distinct types of beds, referred to in this report as fine-grained beds and conglomerate beds. The fine-grained beds, in the main, represent residual laterite, but some of them are made up of transported lateritic material. They range

[1] Smith, George Otis, U. S. Geol. Survey Geol. Atlas, Mount Stuart folio (no. 106).

from several inches to 32 feet in thickness and are much more numerous than the conglomeratic beds. For the most part the conglomeratic beds represent transported material and have a maximum thickness of over 500 feet. The two types are interbedded in some places, as in the Blewett and Iron Peak areas, but usually only one type occurs in any one locality.

The fine-grained beds can best be described as a metamorphosed mudstone containing appreciable amounts of iron, aluminum, chromium, and nickel. The color ranges from brown, through red, to black as does the color of the streak. The material is composed mainly of extremely fine-grained aluminum oxide, limonite, hematite, and magnetite in variable amounts. Some of the magnetite occurs as oölites and pisolites up to half an inch in diameter. Many of the oölites and pisolites are solid magnetite, but some have rims of magnetite and cores of serpentine or hematite. Most of the magnetite is in the form of minute, angular grains which are probably in part residual, having weathered out of the serpentine, and in part secondary, having been produced by dynamic metamorphism of the laterite. Secondary magnetite also lines small fractures in the iron beds and sometimes takes the form of minute octahedrons. The chromium occurs as small grains of chromite that probably are residual grains weathered out of the serpentine. It is not known in what mineral form the nickel occurs, but it is probably one or more of the hydrous nickel silicates. Occasional small grains and pebbles of serpentine are scattered through the fine-grained iron-rich material.

The fine-grained beds are cut by three or more sets of closely spaced joints, so that the material usually breaks down into rectangular or triangular shaped pieces. As a rule there is little or no evidence of laminations within the beds, but occasionally one may find well-developed laminations marked by definite sizing of sedimentary grains. Zapffe[1] describes three vertically-gradational phases of the Cle Elum River iron beds and these three phases can be recognized in several places along the iron zone, but usually one or more of the phases are missing.

The conglomeratic beds are composed of a matrix, resembling the material of the fine-grained beds, and well rounded pebbles, cobbles, and boulders of serpentine, peridotite, diabase, and slate. The larger boulders, some of which are as much as 10 feet across, are usually more angular than the pebbles and cobbles and are of serpentine or peridotite. Although the matrix resembles the material of the fine-grained beds, it usually has a lighter colored streak and a lower specific gravity. Some of it is dark green in color and appears to have originally been a serpentine-rich mud. The ratio of pebbles, cobbles, and boulders to the matrix is roughly 1:1.

[1] Zapffe, Carl, Memorandum report on the iron ores of the Cle Elum district, Washington: Washington Div. of Mines and Mining Rept. of Inv. 5, 27 pp., 1944.

The conglomerate beds are practically unstratified, although there are occasional concentrations of pebbles and cobbles, and thin, clayey lenses. The conglomerate is closely jointed, with most of the joints confined to the matrix and curving around the boulders.

The fine-grained beds and the matrix of the conglomeratic beds contain a few poorly preserved fossil leaves and plant stalks which have not been identified.

Many samples of the fine-grained beds and of the conglomerate matrix were collected, and their specific gravities were determined to be 3.5 for the fine-grained beds and 3.1 for the conglomerate matrix. These specific gravities were used in the tonnage estimations.

ANALYSES

The Blewett, Iron Peak, and Cle Elum River deposits are the only ones along the entire iron zone that have received any appreciable amount of sampling for chemical analyses. The chemical composition of the various sampled beds is similar in that the same elements are found in all the beds, however, the amounts of the elements present vary from bed to bed as well as in different parts of the same bed. The composition is variable along the strike as well as from top to bottom in the individual beds. As shown by Zapffe's[1] diagrams the total iron and alumina forms a nearly constant unit in the individual beds, with the percent of iron increasing toward the bottom and decreasing toward the top of the beds. The amount of nickel and chromium is variable but appears to be slightly higher in the basal portions of the beds. Analyses show that, as a rule, the Cle Elum River beds contain a somewhat higher percentage of iron than do the Blewett beds. This is probably due to a higher degree of metamorphism in the Cle Elum River area resulting in a greater development of secondary magnetite within the iron ore.

Although samples of all of the iron beds have not been analyzed, it may be assumed, since all of the iron beds had a common origin and have undergone similar metamorphism, that the compositions of the Blewett, Iron Peak, and Cle Elum River beds are representative of the iron deposits as a whole. A compilation of all published and some unpublished chemical analyses of the ore is given in the following table. The material is presented to show the ranges in composition and a reasonable mean composition of the iron beds rather than to show definite compositions of any particular beds. No attempt is made to indicate the character of the samples nor the sources of the information.

[1] Op. cit., p. 13.

COMPILATION OF CHEMICAL DATA ON THE BLEWETT-CLE ELUM IRON

	Percent			Number of samples from represented areas		
	Maximum	Minimum	Average	Blewett	Cle Elum	Iron Peak
Fe	66.50	15.36	45.55	31	67	13
Cr	4.09	0.32	1.79	26	30	3
Ni	1.49	0.10	0.90	24	14	13
Al_2O_3	35.88	0.60	10.44	14	33	5
P	1.03	0.00	0.05	17	29	4
S	0.30	0.00	0.04	17	32	4
SiO_2	37.33	3.10	16.78	16	63	13
TiO_2	0.70	0.00	0.23	.....	3	.....
MnO	2.20	0.00	0.28	.....	29	.....
MgO	19.18	0.12	3.04	2	16	.....
CaO	3.60	0.09	1.11	2	13	.....
Ignition loss	11.26	0.67	4.05	3	14	.....

The ore contains appreciable amounts of iron, aluminum, chromium, and nickel, all of which are essential to many of the present war-time industries. However, the presence of all of these elements presents several problems, and considerable metallurgical research on this ore is needed before any commercial production is attempted. The sulphur and phosphorus content of the ore is low and should give no difficulties. The iron content averages about 45 percent, which would probably put the ore in the medium-grade class, but it must be remembered that all of this iron is not available by the common blast furnace methods of reduction, for some is combined with the silicates serpentine and olivine which are contained in variable amounts throughout the beds. The high alumina content would add to the difficulties of blast furnace reduction. It might be possible that some of the alumina could be used to produce aluminum as a by-product. The chromium and nickel would give a rather special product, suitable for some uses and unsuitable for others. The material of the iron beds might be considered as an ore of nickel, but the average of 0.90 percent nickel is probably too low at the present time when the metallurgical difficulties are considered.

IRON DEPOSITS

For the purpose of this report, the Blewett-Cle Elum iron zone is arbitrarily divided into six deposits, namely, Blewett, Nigger Creek, Stafford Creek, Bean Creek, Iron Peak, and Cle Elum River, and they are discussed in that order. Each of the iron-bearing areas is represented by two or more detail maps (pls. 2-7 and figs. 2-8 and 10-14) with the exception of the Blewett area, for which the detail map was published with Report of Investigations No. 10 in 1943. The areas covered by the detail maps are numbered from east to west for each large iron-bearing area and are discussed in that order. Iron bed outcrops are designated as 01, 02, etc. on the detail maps. Extensions of exposed beds as well as unexposed iron beds, as determined from magnetic readings, are designated on the maps as E1, E2, etc. Corresponding designations are used in the tables that give the dimensions, structure, type of ore (fine-grained or conglomeratic), and tonnage estimates of the iron beds.

The iron beds are tabular bodies, most of which dip at steep angles. In general, they represent individual lenticular beds that are not continuous along the strike for more than a few hundred feet at the most. It is reasonable to assume that these beds are no more extensive downward than they are horizontally. Tonnage estimations must be made on each individual bed, and until drilling or other underground exploratory work proves otherwise it is unsafe to assume the extension of the beds along their strikes beyond the limits indicated by the magnetic readings. As used in this report, the **exposed tonnage** estimates represent only the outcrop portion of the beds, in other words, only that part that can definitely be measured in three dimensions. The **probable tonnage** represents the block of ore beneath the outcrop, formed by projecting the bed underground along the strike from the lowest point of outcrop and down the dip from the highest point of outcrop. The **possible tonnage** represents the unexposed ore beneath the outcrop, including all extensions and unexposed ore indicated by the magnetic readings, calculated by the same method as the probable ore. All tonnages are based on a specific gravity of 3.5 for the fine-grained beds and 3.1 for the matrix of the conglomerate beds. Conglomerate bed tonnages indicate only the amount of matrix material, since the boulders and cobbles cannot be considered as iron ore. It is assumed that the ratio of boulders to matrix is 1:1.

BLEWETT DEPOSITS

A complete report on the Blewett iron deposits was published in 1943 by the Division of Geology in Report of Investigations No. 10, "The Blewett Iron Deposit, Chelan County, Washington". One feature of that report needs modification at this time. On page 17 of the earlier Blewett report an estimation of between 1,500,000 and 2,000,000 tons of fine-grained iron ore is given, but the author added the following caution: "However, it must be remembered that even these tonnage figures are purely estimations based on surface exposures and magnetic readings and that development work will undoubtedly necessitate some revision." Subsequent field work on the other iron beds along the Blewett-Cle Elum iron ore zone has provided more information for the basis of interpreting magnetic data, and has revealed that, as a rule, individual iron beds are not continuous along the strike or down the dip for any great distances. Thus it is believed that the assumed depth factors used for calculating the preliminary tonnage estimates in Report of Investigations No. 10 were much too great. Using the method of calculation as outlined on page 15, the following revised tonnage estimations give a reasonably accurate picture of the tonnage situation, considering the information at hand.

TONNAGES OF FINE-GRAINED AND CONGLOMERATIC BEDS, BLEWETT DEPOSITS

Ore type	Amount in short tons		
	Exposed	Probable	Possible
Fine-grained ore	13,800	54,300	160,000
Conglomerate matrix	1,428,000	8,568 000	11,016,000

NIGGER CREEK DEPOSITS

The Nigger Creek iron deposits are on the north side of Nigger Creek about one mile north of the Chelan-Kittitas county line. They occur along the Swauk-peridotite contact for a distance of about 1½ miles at elevations from 4,100 to 4,800 feet above sea level and about 300 feet above Nigger Creek. They are reached from U. S. Highway 97 by about 4 miles of poor truck road up Nigger Creek and then by 2 miles of trail farther up the creek.

It is estimated that the following three mapped areas contain about 100 tons of exposed and 4,240 tons of possible fine-grained iron ore, and about 59,750 tons of exposed, 45,720 tons of probable, and 431,610 tons of possible conglomerate matrix ore.

Area 1

Area 1 (see fig. 2) is on the north side of Nigger Creek in the NW¼SW¼ sec. 8, (22-17 E.)* about 4,200 feet above sea level. Fine-grained iron beds are exposed in two places by small open cuts. Magnetic readings indicate two small iron beds dipping steeply southward and cut by at least four faults. It is doubtful that future development will disclose any large reserve of iron ore in this area. The apparent small available tonnage, the thinness of the beds, and their faulted character are not favorable for economic mining.

IRON EXPOSURES AND EXTENSIONS, NIGGER CREEK AREA 1 (see fig. 2)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
.....	E1	100	.....	3	40	NE	SE	fine	.....	.....	650
.....	E2	120	.....	3	5	NE	SE	fine	.....	.....	100
01	.....	7	5	4½	.....	E	80° S	fine	20	.....	.....
.....	E3	130	.....	4½	25	E	80° S	fine	.....	.....	790
02	.....	7	5	2	.....	E	75° S	fine	10	.....	.....
.....	E4	80	.....	2	12	E	75° S	fine	.....	.....	100
								Totals (fine)	30	.....	1,640

* T. 22 N., R. 17 E.

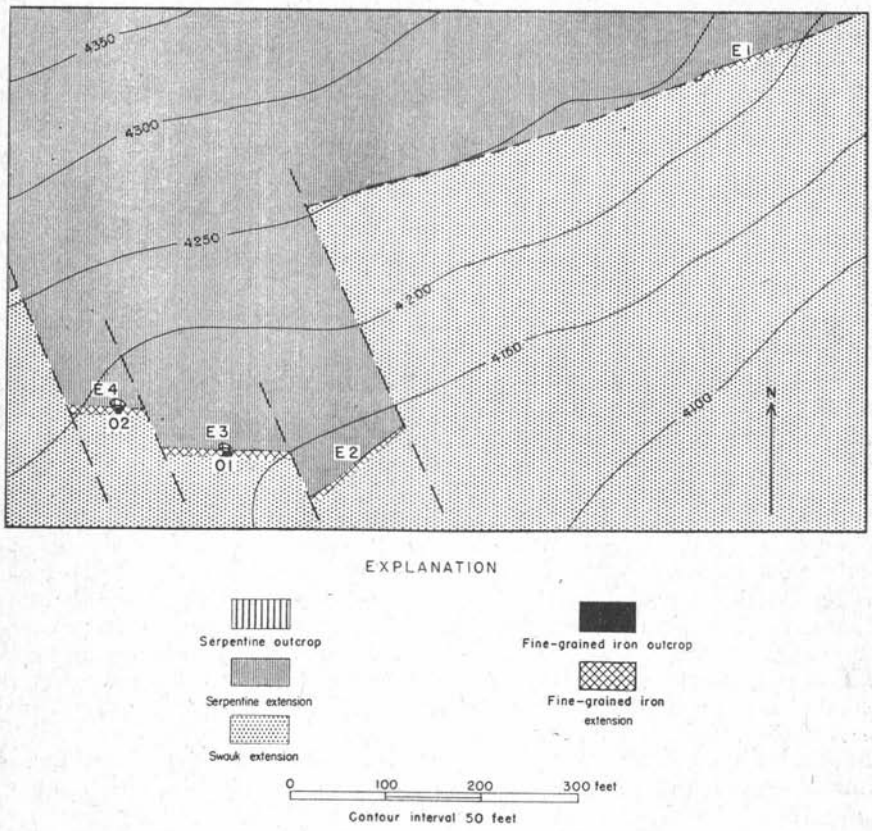


FIGURE 2—Detail map, Nigger Creek area 1, Chelan County, Washington. 01 is about 960 feet east and 2,030 feet north of the SW. corner of sec. 8, T. 22 N., R. 17 E.

Area 2

Area 2 (see fig. 3) is on the north side of Nigger Creek in the N½SE¼ sec. 7, (22-17 E.), about 1,000 feet west of area 1 and about 200 feet higher. Development work consists of several old open cuts and a 75-foot adit. Four outcrops of conglomeratic iron cut by basic dikes occur within the area. The two largest outcrops show small zones, a few feet long, with practically no boulder content, but there are no well-defined fine-grained beds present. In general, the beds strike east and dip about 55° south. Magnetic readings indicate that the four outcrops are the exposed parts of one lenticular bed about 1,380 feet long, thinning from east to west, and cut by at least two faults. There are about 118,000 possible tons of matrix material in this area. Development work may prove that the bed continues to a slightly greater depth than that used in the calculations, but it is not likely that any great increase in tonnage can be expected.

IRON EXPOSURES AND EXTENSIONS, NIGGER CREEK AREA 2 (see fig. 3)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	300	50	50	75	E	55° S	conglom.	36,000	27,000	.....
.....	E1	315	.....	75	85	E	55° S	conglom.	.....	.....	48,190
02	.....	260	30	35	60	E	55° S	conglom.	13,100	13,820	.....
.....	E2	315	.....	65	65	E	55° S	conglom.	.....	.....	31,940
03	.....	40	5	20	.....	E	S	conglom.	190	.....	.....
04	.....	40	5	20	.....	E	S	conglom.	190	.....	.....
.....	E3	750	.....	35	60	E	S	conglom.	.....	.....	37,800
								Totals (conglomerate)	49,480	40,820	117,930

Area 3

Area 3 (see pl. 2) is on the north side of Nigger Creek in the S½SW¼ sec. 7, (22-17 E.) and the SE¼SE¼ sec. 12, (22-16 E.), about 1,900 feet west of area 2 and about 200 feet higher. No development work has been done in this area. Outcrop 1, in the northeast corner of the mapped area, is a small exposure of conglomeratic iron bed terminated on the west by basic dikes and lensing out to the east. Magnetic readings do not indicate any large iron bed in this place. Outcrop 2 (see pl. 2) represents two small exposures of a fine-grained iron bed that has a maximum length of about 160 feet as indicated by the magnetic readings. No large tonnage can be expected from this bed. Outcrop 3 (see pl. 2) represents two small exposures of a conglomeratic iron bed, indicated by magnetic readings to be the exposed parts of a large lenticular bed extending southwestward to the wide basic dike. On the west side of the dike the iron bed has been displaced about 300 feet to the southeast and then continues southwestward for about 1,800 feet before lensing out. This gives a total length of about 2,350 feet for the conglomeratic bed and makes it the largest supply of possible ore in the entire Nigger Creek area. Underground development work should be done to prove the character of the unexposed parts of this bed, for the surface covering is probably too thick in most cases to make trenching practical. Outcrops 4, 5, and 6 (see pl. 2) are the exposed parts of a 430-foot conglomeratic iron bed. Magnetic readings show that this bed is definitely limited on the east by the wide basic dike, and also on the west, probably by a fault. This bed is in fault contact with serpentine on its north side. Serpentine also crops out a short distance to the south, suggesting that the iron bed was originally a piece of the large conglomeratic bed, farther to the south, and was down-faulted into this position, thus being isolated from the rest of the iron bed by later erosion. If this interpretation is true the iron-bed segment can not be expected to continue to any great depth and no large tonnage should be expected.

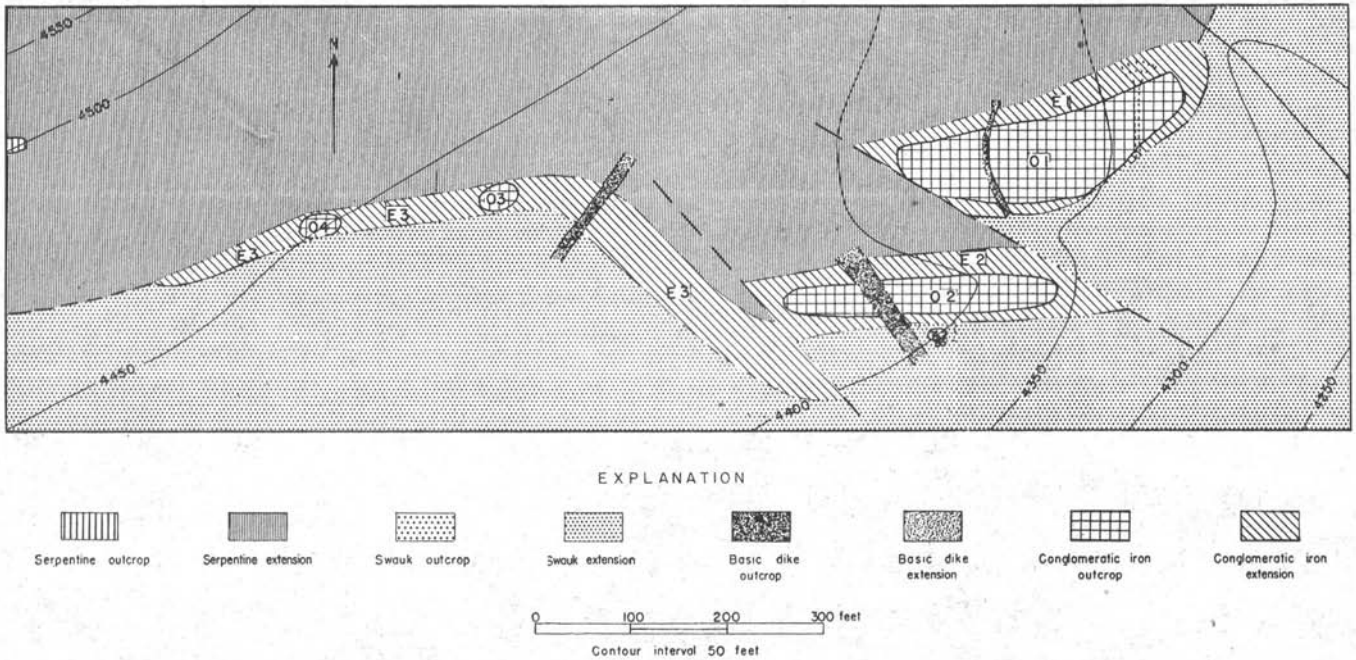


FIGURE 3—Detail map, Nigger Creek area 2, Chelan County, Washington. 01 is about 800 feet west and 2,150 feet north of the SE. corner of sec. 7, T. 22 N., R. 17 E.

IRON EXPOSURES AND EXTENSIONS, NIGGER CREEK AREA 3 (see pl. 2)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	90	15	18	20	N 70° W	90° N	conglom.	1,160	780	.....
02	.....	50	3	4	.....	E	85° N	fine	70	.....	.....
.....	E1	160	.....	4	75	E	85° N	fine	.....	.....	2,600
03	.....	80	3	30	20	NE	SE	conglom.	350	1,150	.....
.....	E2	550	.....	70	90	NE	SE	conglom.	.....	.....	83,160
04	.....	40	3	15	5	E	S	conglom.	90	70	.....
05	.....	40	3	5	5	E	S	conglom.	30	20	.....
06	.....	100	45	40	30	E	S	conglom.	8,640	2,880	.....
.....	E3	430	.....	50	70	E	S	conglom.	.....	.....	36,120
.....	E4	1,800	.....	45	100	NE	SE	conglom.	.....	.....	194,400
						Totals		(fine)	70	.....	2,600
								(conglomerate)	10,270	4,900	313,680

STAFFORD CREEK DEPOSITS

The Stafford Creek iron deposits are in northern Kittitas County on the west side of Stafford Creek about 4½ miles from its mouth. They occur along a 5,000-foot section of the Swauk-peridotite contact at elevations from 4,000 to 5,100 feet above sea level and from 200 to 1,300 feet above Stafford Creek. The deposits are reached by the county road up Stafford Creek to the mouth of Bear Creek and thence by about 2 miles of trail up Stafford Creek.

It is estimated that the following two mapped areas contain about 1,650 tons of exposed, 3,040 tons of probable, and 62,150 tons of possible fine-grained iron ore.

Area 1

Area 1 (see fig. 4) is about 600 feet west of Stafford Creek in the NW¼NW¼ sec. 14, (22-16 E.), about 4,000 feet above sea level. Development work consists of several old open cuts. Within the area there are four exposures of fine-grained iron that, as shown by the magnetic readings, are parts of the same iron bed. This bed strikes roughly east and dips about 55° south. It appears to be about 750 feet long and is faulted near its east end, with the westward part having been offset about 100 feet to the north with respect to the eastward part. Future development may prove a somewhat larger amount of ore than the 51,000 tons estimated for this bed, but great depth of ore should not be expected.

IRON EXPOSURES AND EXTENSIONS, STAFFORD CREEK AREA 1 (see fig. 4)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	80	5	10	35	E	S	fine	430	1,480	.....
.....	E1	200	.....	10	75	E	S	fine	.....	.....	7,950
02	.....	30	5	15	10	E	S	fine	240	240	.....
03	.....	40	5	12	.....	NW	SW	fine	260	.....	.....
04	.....	60	5	15	25	N 30° W	55° S	fine	480	1,190	.....
.....	E2	550	.....	12	125	NW	SW	fine	.....	.....	43,730
								Totals (fine)	1,410	2,910	51,680

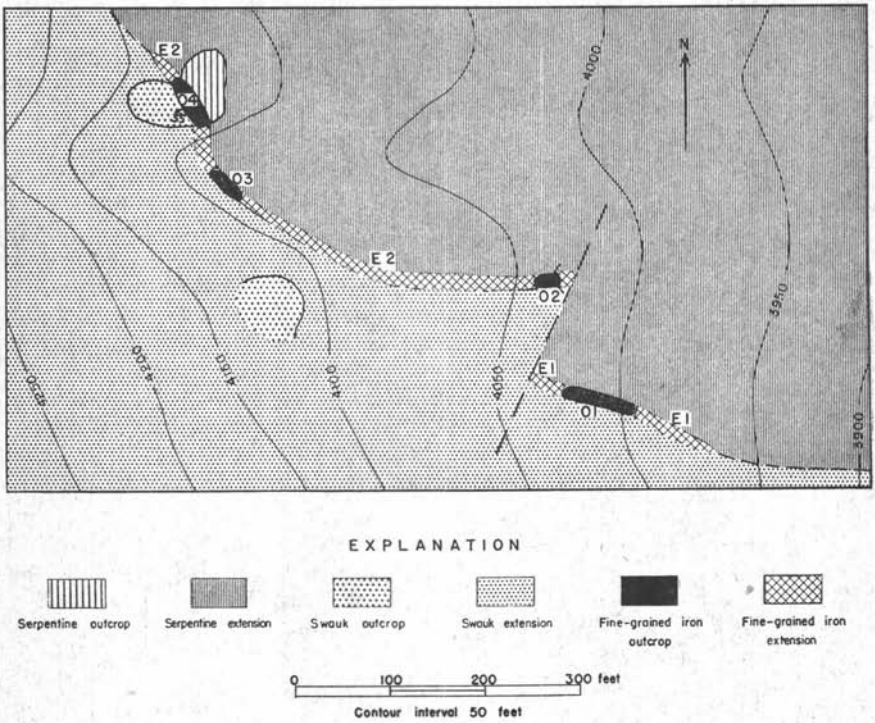


FIGURE 4—Detail map, Stafford Creek area 1, Kittitas County, Washington. 01 is about 1,390 feet east and 1,900 feet south of the NW. corner of sec. 14, T. 22 N., R. 16 E.

Area 2

Area 2 (see fig. 5) is in the NE¼NW¼ sec. 15, (22-16 E.) a little north and about half a mile west of area 1, and from 600 to 900 feet higher. No development work has been done in this area. Two small outcrops of fine-grained iron occur in the northwest corner of the area. (See fig. 5.) Magnetic readings indicate that they are part of a small iron bed about 130 feet long and faulted near its west end. This bed, as exposed, does not average over 3 feet in thickness and cannot be expected to furnish much ore. The presence of two small iron beds, striking northwest and dipping southwest, in the eastern half of the area was indicated by the magnetic readings. These two beds are about 250 feet apart and each appears to be about 200 feet in length. On the basis of the magnetic data, neither of these beds is large enough to supply much ore, but there is a possibility that they are the uneven top edge of a large bed dipping to the southwest. If this were true they would be expected to come together at depth. However, there is just as much chance that they are the uneven lower edge of a large bed already practically destroyed by erosion. Diamond drilling or other underground development work will have to be done before the true possibilities of these two beds can be determined.

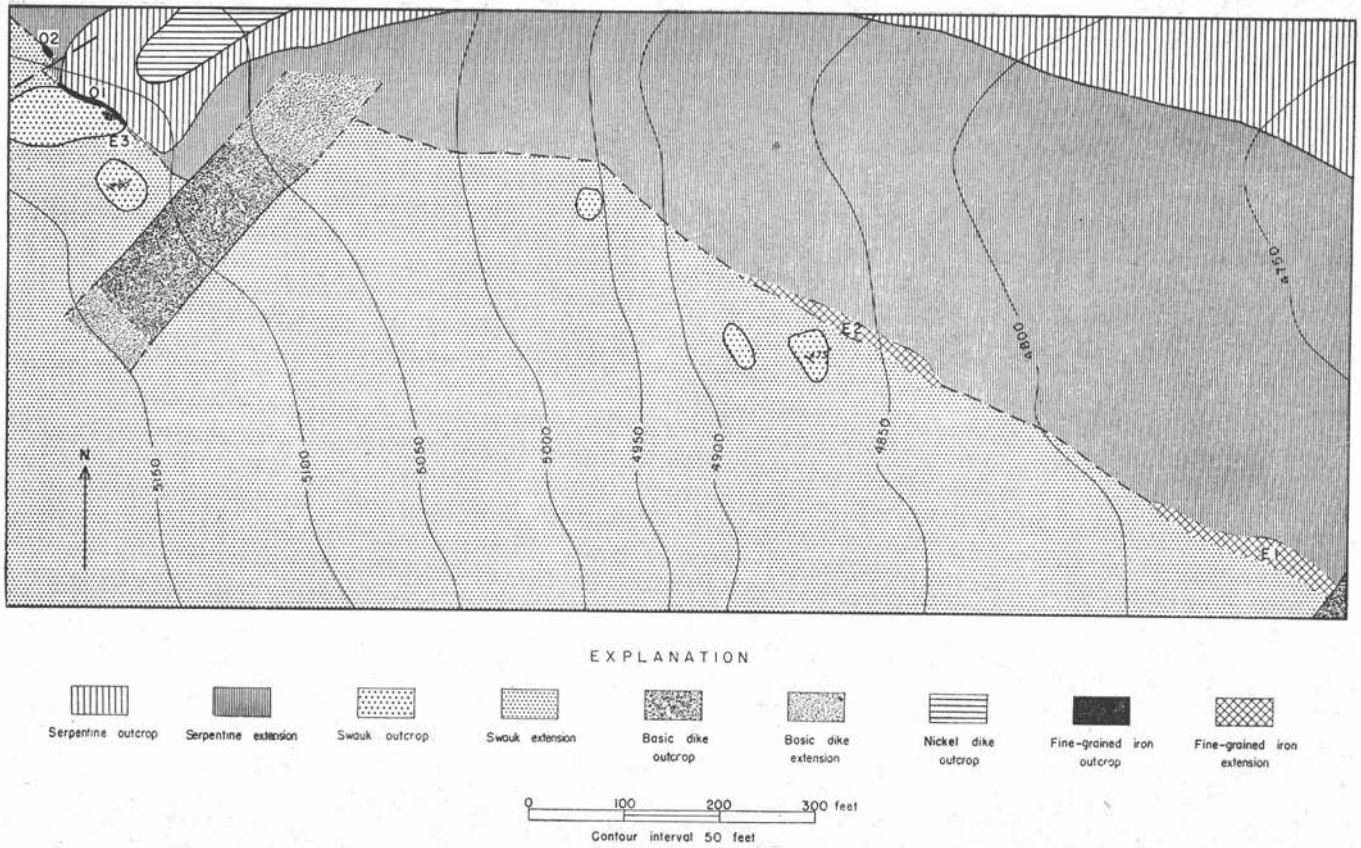


FIGURE 5—Detail map, Stafford Creek area 2, Kittitas County, Washington. 01 is about 450 feet south and 2,370 feet east of the NW. corner of sec. 15, T. 22 N., R. 16 E.

IRON EXPOSURES AND EXTENSIONS, STAFFORD CREEK AREA 2 (see fig. 5)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
.....	E1	200	.....	12	25	NW	SW	fine	.....	.....	3,180
.....	E2	220	.....	12	50	NW	SW	fine	.....	.....	7,000
01	.....	80	3	3	10	N 70° W	65° SW	fine	80	130	.....
.....	E3	130	.....	3	20	N 70° W	65° SW	fine	.....	.....	290
02	.....	20	15	5	.....	N 65° W	90° S	fine	160	.....	.....
								Totals (fine)	240	130	10,470

BEAN CREEK DEPOSITS

The Bean Creek iron deposits are in northern Kittitas County on both the east and west sides of Bean Creek about 2 miles from its mouth. They occur along one mile of the Swauk-peridotite contact at elevations from 5,100 to 5,500 feet above sea level and from 300 to 700 feet above the creek, and are reached from the Teanaway River road by about 2 miles of trail up Bean Creek. No development work has been done.

It is estimated that the following two mapped areas contain about 6,470 tons of exposed, 8,840 tons of probable, and 850 tons of possible fine-grained iron ore.

Area 1

Area 1 (see fig. 6) is about 1,200 feet east of Bean Creek in the NE¼NE¼ sec. 17, (22-16 E.) and about 5,400 feet above sea level. There are three small exposures of fine-grained iron, cropping out over a distance of about 100 feet, in the bottom of the gully that follows the Swauk-peridotite contact. Magnetic readings fail to indicate that the iron bed extends along its strike beyond the outcrop limits, or that there are other beds present. There does not appear to be any economically minable iron ore within this area.

IRON EXPOSURES AND EXTENSIONS, BEAN CREEK AREA 1 (see fig. 6)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	70	3	4	30	NE	70° SE	fine	90	460	.....
.....	E1	100	.....	4	40	NE	70° SE	fine	.....	.....	850
								Totals (fine)	90	460	850

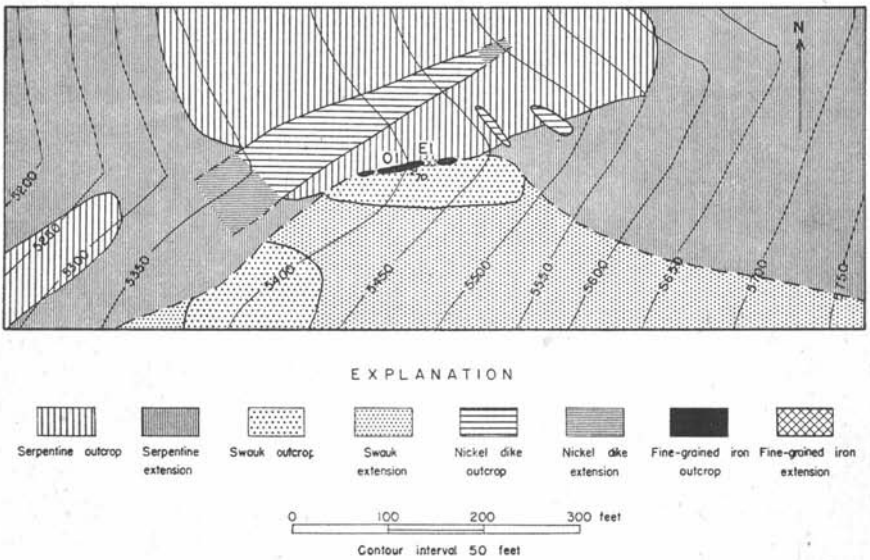
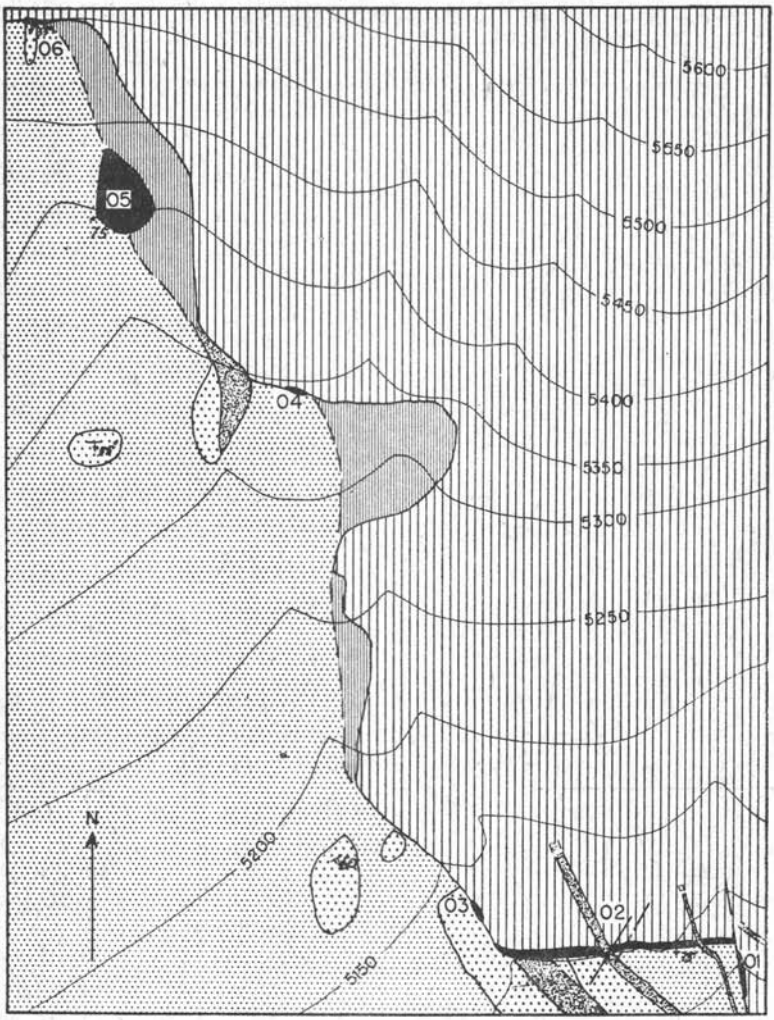


FIGURE 6—Detail map, Bean Creek area 1, Kittitas County, Washington. 01 is about 500 feet south and 550 feet west of the NE. corner of sec. 17, T. 22 N., R. 16 E.

Area 2

Area 2 (see fig. 7) is about 1,800 feet west of Bean Creek in the NE¼NW¼ sec. 17, (22-16 E.), at an elevation from 5,100 to 5,500 feet above sea level. The 190-foot fine-grained iron bed (outcrop 2) in the southeast corner of the area is definitely terminated at its east end by a nearly vertical fault. Outcrop 1 represents drag material along this fault. At its west end the iron bed either lenses out or is cut off by another fault as suggested by the fact that the Swauk beds strike at nearly right angles to the Swauk-peridotite contact. In either case, the iron bed does not extend east or west along its strike beyond the ends of the outcrop and can not be expected to continue to any great depth. Outcrop 5 is a large exposure of a fine-grained iron bed that appears to strike N. 25° W. and dip 75° SW., but there are no well defined bedding planes and the apparent bedding may not indicate the true structure. Magnetic readings do not suggest that the outcrop continues underground for even short distances in any direction, and there is nothing to suggest that the bed continues to any great depth. Outcrops 4 and 6 are very small fine-grained iron beds not over one foot in thickness. None of the iron beds within this area appear to be worth mining. In fact, the total tonnage of all the Bean Creek deposits is probably too low to even pay for the cost of building a road up from the mouth of Bean Creek.



EXPLANATION

Serpentine outcrop

Serpentine extension

Swauk outcrop

Swauk extension

Basic dike outcrop

Basic dike extension

Fine-grained iron outcrop

Fine-grained iron extension

0 100 200 300 feet

Contour interval 50 feet

FIGURE 7—Detail map, Bean creek area 2, Kittitas County, Washington. 01 is about 400 feet south and 1,950 feet east of the NW. corner of sec. 17, T. 22 N., R. 16 E.

IRON EXPOSURES AND EXTENSIONS, BEAN CREEK AREA 2 (see fig. 7)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	30	1	1	15	N 10° W	80° NE	fine	10	20	.....
02	.....	190	30	5	55	N 85° E	75° SE	fine	3,000	2,770	.....
03	.....	20	1	1	10	N 55° W	85° SW	fine	10	10	.....
04	.....	15	1	1	3	E	S	fine	10	10	.....
05	.....	70	15	30	50	N 25° W	75° SW	fine	3,340	5,570	.....
06	.....	7	1	1	.....	E	65° S	fine	10	.....	.....
								Totals (fine)	6,380	8,380	.....

IRON PEAK DEPOSITS

The Iron Peak deposits are on the south and southwest slopes of Iron Peak in northern Kittitas County. They cover a 2-mile section of the Swauk-peridotite contact at elevations from 3,700 to 5,900 feet above sea level and from 150 to 2,350 feet above the major valley bottoms. The east end of these deposits is reached from the Teanaway River road by about 2 miles of trail up Bean and Beverly creeks. The west end of the deposits is about a quarter of a mile east of De Roux forest camp on the Teanaway River road. Except for a few old open cuts no development work has been done on any of these deposits.

It is estimated that the following seven mapped areas contain about 77,940 tons of exposed, 31,390 tons of probable, and 95,700 tons of possible fine-grained iron ore; and about 98,320 tons of exposed, 2,280 tons of probable, and 2,670 tons of possible conglomerate matrix ore.

Area 1

Area 1 (see fig. 8) is about 700 feet west of Beverly Creek in the SW¼SW¼ sec. 7, (22-16 E.) and the SE¼SE¼ sec. 12, (22-15 E.), and extends from an elevation of 200 feet above the creek to the top of the ridge 800 feet higher. Exposures of fine-grained and conglomeratic iron beds occur in the large gully along the Swauk-peridotite contact from 400 feet above Beverly Creek to the top of the ridge. Within this distance of about 900 feet the iron beds are cut by at least 15 large dikes and numerous faults. Most of the dikes trend northeastward and are nearly vertical. The numerous faults have caused some duplication of the iron beds so as to give an impression of more iron than is actually present. Magnetic readings indicate an iron bed extending for about 350 feet southeast of outcrop 1. (See fig. 8.) This unexposed bed is cut by at least two large dikes, so that its actual length is not over 200 feet.

A maximum of about 43,000 tons of iron ore is estimated for this area. Economic extraction of this ore does not appear possible when one considers the low available tonnage, the numerous dikes, the faulted character of the ore bodies, and the present inaccessibility of the area by truck road. The low tonnage and inaccessibility factors might be offset if this area were mined in conjunction with the other Iron Peak areas, but the dikes and faults would have to be contended with and there is nothing to suggest that they become less numerous with depth.

FIGURE 8—Detail map, Iron Peak area 1, Kittitas County, Washington. 01 is about 850 feet east and 300 feet north of the SW. corner of sec. 7, T. 22 N., R. 16 E.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 1 (see fig. 8)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
.....	E1	200	.....	10	150	NW	SW	fine	.....	.....	15,900
01	.....	110	3	12	75	E	78° S	fine	430	5,250	.....
02	.....	30	3	8	15	E	S	fine	90	190	.....
03	.....	30	3	7	20	N 80° E	60° SE	fine	70	220	.....
04	.....	15	3	10	10	N 85° E	65° SE	fine	40	80	.....
05	.....	30	3	6	60	NW	SW	fine	70	570	.....
06	.....	70	3	6	55	NW	SW	fine	120	1,220	.....
07	.....	140	3	20	80	N 65° W	85° SW	fine	890	11,870	.....
07	.....	40	3	12	25	N 65° W	85° SW	conglom.	70	290	.....
08	.....	85	3	25	35	E	65° S	conglom.	310	1,780	.....
08	.....	80	3	10	35	E	65° S	fine	260	1,480	.....
09	.....	15	3	10	15	NW	SW	fine	40	120	.....
010	.....	25	3	10	20	E	S	fine	90	270	.....
011	.....	70	3	3	.....	NE	SE	fine	70	.....	.....
012	.....	25	3	10	10	NE	SE	conglom.	40	70	.....
						Totals		(fine)	2,170	21,270	15,900
								(conglomerate)	420	2,140	.....

Area 2

Area 2 (see pl. 3) is adjacent to the west end of area 1 in the SE¼, the NE¼SW¼, and the SE¼SW¼ sec. 12, (22-15 E.). Elevations range from 4,600 to 5,900 feet above sea level. The Swauk-peridotite contact extends westward along the southern edge of the area from about 200 feet south of outcrop 1 to outcrop 10. Along this length of the contact there are nine individual iron beds averaging about 9 feet in thickness and totaling about 580 feet in length. In general, these beds strike east and dip to the south from 50° to 80°. Numerous basic dikes cut the contact as well as the iron beds, and several faults have caused small displacements of the ore.

The rocks are gently folded so that the Swauk-peridotite contact is repeated several times between the south and the north borders of the area. The major structure is shown diagrammatically in figure 9. Outcrops 1, 2, and 11, in the southeast corner of the area (see pl. 3), are on the north limb of an eastward-pitching anticline, the south limb of which is represented by the main Swauk-peridotite contact. These iron beds and overlying Swauk dip northward. Outcrop 12 represents the south limb of the next anticline to the north and dips southward under the overlying Swauk. These folds narrow in the west end of area 1 and no doubt are responsible for some of the duplication of the iron beds in that area, with the crests of the anticlines marking zones of faulting. The west end of the folded Swauk and iron beds has been removed by erosion so that now only peridotite remains west of outcrop 11. Magnetic readings do not indicate that the beds of outcrops 1, 2, 11, and 12 will continue for any great distances underground nor that there is any large body of unexposed ore in the vicinity of these folds.

Outcrops 24 to 31, representing both fine-grained and conglomeratic iron beds, are on the south limb of an anticline. The iron beds dip southward at low angles about equal to the slope of the ground surface. They represent small erosional remnants of formerly wider

spread iron beds on the old peridotite surface. A thin veneer of Swauk covers the northern edge of outcrop 31 and a part of 28, and conforms with the strike and dip of the iron beds. The iron beds can be seen to rest directly on the old pre-Swauk peridotite surface, and can not be expected to have a depth greater than their stratigraphic thickness. Large basic dikes striking northeastward and dipping about 90° cut the iron bed remnants.

Outcrops 13 to 15, on the south limb of an anticline and the north limb of a syncline trending northwestward, dip to the southwest. Magnetic readings indicate that Swauk beds on the south limb of the syncline come to the surface about 100 feet southwest of the iron bed outcrops, and that the iron bed does not come to the surface southwest of the synclinal axis, so that its underground extensions appear to be limited in that direction.

Outcrops 16 and 17 represent a continuation of the iron bed of outcrops 13 to 15, but here there has been some cross-folding that has caused the beds of outcrop 16 to dip to the northeast under a cover of Swauk and the beds of outcrop 17 dip northwest on a southeast synclinal limb. The iron bed of outcrop 18 dips southeast underneath Swauk and probably represents a northwest synclinal limb. The iron bed of outcrop 18 probably continues underground to outcrops 16 and 17, but the presence of numerous large basic dikes would greatly decrease the amount of available ore as well as increase the difficulties of mining.

Outcrops 19 to 23 are on the south limb of an anticline. These iron beds dip southward at angles approximating the slope of the surface. North of the anticlinal axis, which trends east through outcrop 22, the beds dip at low angles to the north. All of these outcropping beds represent erosional remnants lying on the pre-Swauk peridotite surface and they can not be assumed to extend to a depth greater than their stratigraphic thickness.

This area contains the bulk of the Iron Peak ore reserves. However, because of the scattered character of the small ore bodies, the number of basic dikes, the structural complications, and the present inaccessibility of the area, it is doubtful that the ore can be economically mined at this time. There are no indications of a vast underground reserve of iron ore within the entire area.

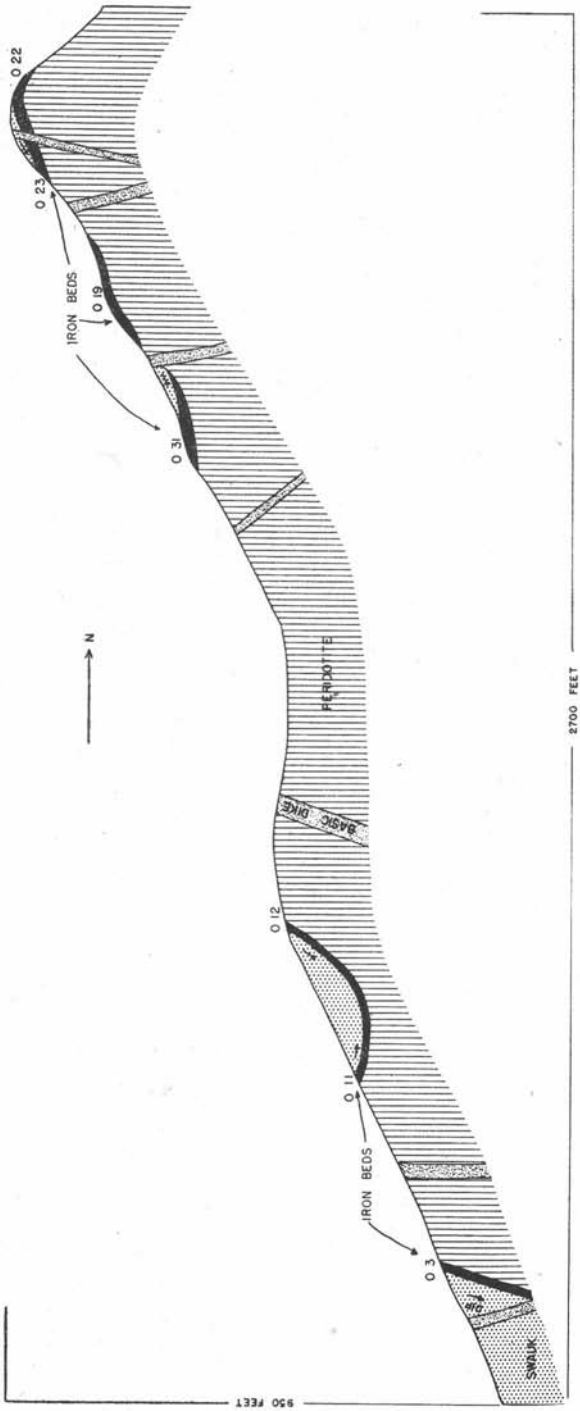


FIGURE 9—The major structure of Iron Peak area 2 shown diagrammatically in a north-south section.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 2 (see pl. 3)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	95	3	2	30	E	90° N	fine	60	300	.....
02	.....	80	3	3	25	N 45° W	40° NE	fine	80	320	.....
02	.....	40	3	6	10	N 45° W	40° NE	conglom.	40	60	.....
.....	E1	260	.....	3	55	E	N	fine	.....	.....	2,270
03	.....	40	3	4	25	NW	SW	fine	50	210	.....
.....	E2	100	.....	4	40	NW	SW	fine	.....	.....	850
.....	E3	20	.....	3	10	NE	SE	fine	.....	.....	30
04	.....	20	15	7	5	N 80° E	80° SE	fine	210	40	.....
04	.....	20	15	2	5	N 80° E	80° SE	conglom.	30	10	.....
05	.....	30	15	10	10	N 70° W	50° SW	fine	480	160	.....
06	.....	10	10	5	.....	E	55° S	fine	50	.....	.....
07	.....	10	3	2	.....	NW	SW	fine	10	.....	.....
.....	E4	230	.....	2	45	NW	SW	fine	.....	.....	1,100
08	.....	55	3	2	25	N 70° W	75° SW	fine	40	150	.....
09	.....	48	3	7	10	N 75° E	60° SE	fine	110	170	.....
010	.....	70	15	2	20	NW	SW	conglom.	100	70	.....
011	.....	70	3	5	5	NE	NW	fine	110	90	.....
012	.....	25	3	2	10	NW	65° SW	fine	20	30	.....
.....	E5	100	.....	2	50	NW	65° SW	fine	.....	.....	530
013	.....	100	3	3	50	NW	35° SW	fine	100	800	.....
.....	E6	50	.....	3	20	NW	SW	fine	.....	.....	160
014	.....	110	3	3	35	NW	20° SW	fine	100	610	.....
.....	E7	85	.....	3	55	NW	SW	fine	.....	.....	740
015	.....	10	3	4	.....	N 25° W	45° SW	fine	10	.....	.....
.....	E8	190	.....	4	80	NW	SW	fine	.....	.....	3,220
016	.....	70	4	5	30	N 40° W	80° NE	fine	150	560	.....
017	.....	120	15	3	10	N 10° W	15° SW	fine	570	190	.....
018	.....	70	10	3	40	N 75° E	30° SE	fine	220	450	.....
.....	E9	400	.....	3	290	NE	SE	fine	.....	.....	18,440
019	.....	400	112	8	.....	E	S	fine	38,000	.....	.....
019	.....	110	40	2	.....	E	S	conglom.	420	.....	.....
.....	E10	300	100	8	.....	E	S	fine	.....	.....	25,440
020	.....	210	60	10	.....	E	20° N	fine	13,260	.....	.....
021	.....	60	30	5	.....	NW	SW	fine	950	.....	.....
022	.....	260	95	5	.....	E	50° N	fine	13,090	.....	.....
022	.....	50	15	2½	.....	E	50° N	conglom.	90	.....	.....
023	.....	200	30	3	.....	N 55° W	65° SW	fine	1,910	.....	.....
.....	E11	360	40	3	.....	N 75° E	25° SE	fine	.....	.....	4,580
024	.....	310	120	50	.....	N 85° W	25°SW	conglom.	89,280	.....	.....
025	.....	25	15	7	.....	N 45° E	22° SE	conglom.	130	.....	.....
026	.....	20	10	5	.....	E	S	conglom.	50	.....	.....
027	.....	150	10	1	.....	N 80° W	20° SW	conglom.	70	.....	.....
028	.....	150	70	3	.....	N 45° E	18° SE	fine	3,340	.....	.....
.....	E12	70	30	3	.....	N 45° W	25° SW	fine	.....	.....	670
029	.....	140	30	25	.....	NW	30° SW	conglom.	5,040	.....	.....
029	.....	30	30	2	.....	NW	30° SW	fine	200	.....	.....
030	.....	170	30	3	.....	E	45° S	conglom.	730	.....	.....
031	.....	200	100	2	.....	N 65° W	15° SW	conglom.	1,920	.....	.....
.....	E13	100	20	3	.....	E	S	conglom.	.....	.....	290
.....	E14	300	30	3	.....	NW	SW	conglom.	.....	.....	1,300
.....	E15	150	50	3	.....	NW	SW	conglom.	.....	.....	1,080
							Totals	(fine)	73,120	4,080	58,030
								(conglomerate)	97,900	140	2,670

Area 3

Area 3 (see pl. 4) is just west of area 2 in the SW¼SW¼ sec. 12 and the SE¼SE¼ sec. 11, (22-15 E.) at elevations from 4,300 to 4,800 feet above sea level. The mapped area shows the westward extension of the Swauk-peridotite contact of area 2. Five distinct fine-grained iron beds occur within this area. The general trend of the beds is northwest and the dip is from 70° to 90° southwest, although minor folding has produced some divergences from these directions. The largest iron bed, as indicated by the magnetic readings, is in the southeast corner of the area and is exposed in outcrops 1 to 3. This bed is about 410 feet long and averages 5 feet in thickness. The

next largest bed is represented by outcrops 4 and 5. The several spots of iron bed material around outcrop 4 are small erosional remnants on the pre-Swauk peridotite surface and constitute practically no commercial tonnage. It is estimated that between 20,000 and 25,000 tons of iron ore might be obtained from this area, but it would necessitate the mining of small individual beds from 2 to 10 feet thick. The thinness of most of the beds would probably prohibit profitable mining of them.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 3 (see pl. 4)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	80	10	8	50	N 75° W	75° SW	fine	690	1,700	.....
02 & 03	.....	20	3	6	.....	N 75° W	75° SW	fine	40	.....	.....
.....	E1	410	.....	5	150	NW	SW	fine	.....	.....	16,300
04	.....	25	3	2	.....	E	S	fine	20	.....	.....
05	.....	120	3	10	60	E	85° S	fine	390	3,820	.....
.....	E2	90	.....	3	45	N 80° E	SE	fine	.....	.....	640
06	.....	30	20	8	10	NW	90° SW	fine	510	130	.....
.....	E3	50	.....	8	15	NW	90° SW	fine	.....	.....	320
07	.....	10	3	2	.....	NW	SW	fine	10	.....	.....
.....	E4	100	.....	2	30	NW	SW	fine	.....	.....	320
								Totals (fine)	1,660	5,640	17,580

Area 4

Area 4 (see fig. 10) is about 400 feet north and just west of area 3 in the NE¼SE¼ sec. 11, (22-15 E.) at an elevation of about 4,400 feet above sea level. Five exposures (designated as one outcrop in the table) of fine-grained iron occur in this area. Magnetic readings indicate that these outcrops are the exposed parts of one bed about 280 feet long. Exposures show that the bed strikes northwest, dips about 85° southwest, and averages 4 feet in thickness. Underground development may prove that this bed increases in size with depth, but it is doubtful that a large tonnage of ore can be expected.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 4 (see fig. 10)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	75	10	4	25	NW	SW	fine	320	400	.....
.....	E1	280	.....	4	50	NW	SW	fine	.....	.....	2,970
								Totals (fine)	320	400	2,970

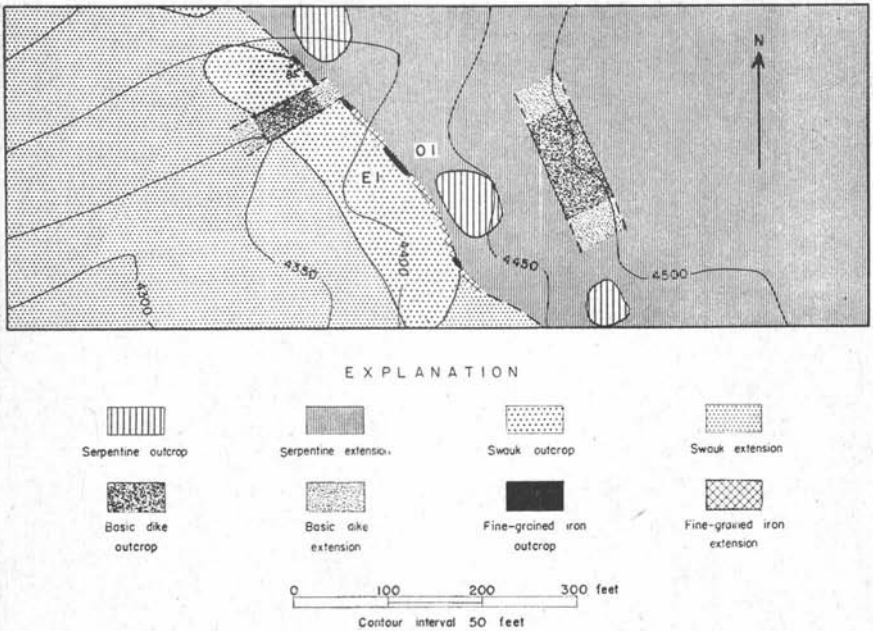


FIGURE 10—Detail map, Iron Peak area 4, Kittitas County, Washington. 01 is about 2,400 feet north and 800 feet west of the SE. corner of sec. 11, T. 22 N., R. 15 E.

Area 5

Area 5 (see fig. 11) is about 400 feet west and a little north of area 4 in the SW¼NE¼ sec. 11, (22-15 E.) at an elevation of about 4,600 feet above sea level. Near the center of this area are five small exposures of fine-grained iron material. The two most easterly exposures are designated as outcrop 1 in the table and the three most westerly exposures as outcrop 2. These exposures represent a small iron bed about 250 feet in length and divided into two nearly equal parts by a fault that has moved the outcrop 2 portion about 100 feet to the northwest relative to the outcrop 1 portion. The iron bed, as a whole, trends about east, dips about 85° south, and as exposed averages 1 foot in thickness. The small size of the lens and its faulted condition will probably prevent the ore from being economically mined.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 5 (see fig. 11)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	30	3	1	.....	E	S	fine	10	.....	.....
.....	E1	180	.....	1	10	E	S	fine	.....	.....	100
02	.....	45	3	1	.....	E	S	fine	10	.....	.....
.....	E2	70	.....	1	10	E	S	fine	.....	.....	40
								Totals (fine)	20	.....	140

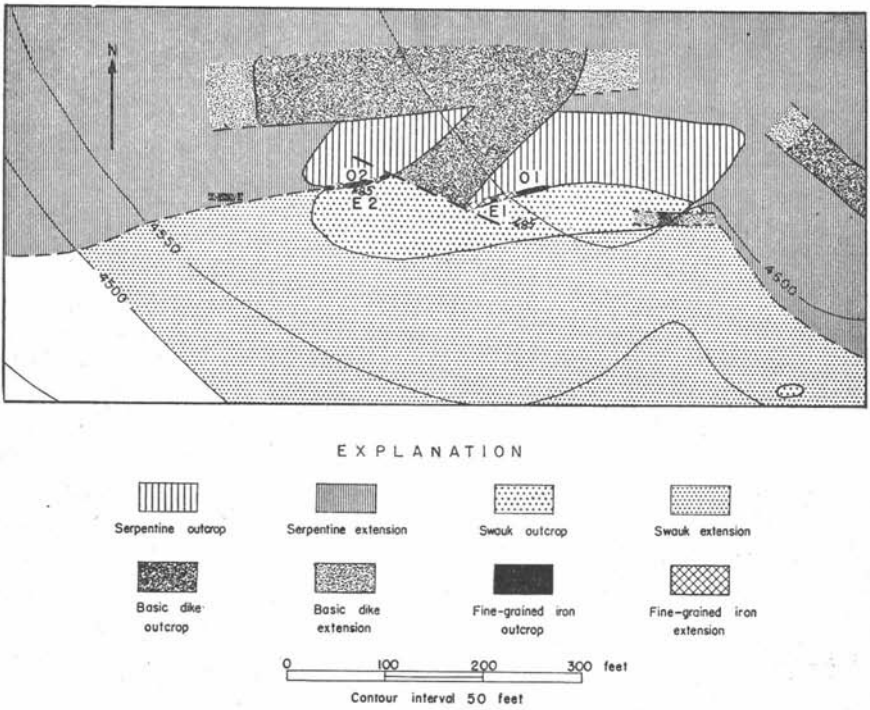


FIGURE 11—Detail map, Iron Peak area 5, Kittitas County, Washington. 01 is about 2,400 feet south and 2,000 feet west of the NE. corner of sec. 11, T. 22 N., R. 15 E.

Area 6

Area 6 (see fig. 12) is in the SE¼NW¼ sec. 11, (22-15 E.) about 600 feet west and 500 feet north of area 5 at an elevation of about 4,100 feet above sea level. There are two small exposures (outcrops 1 and 2) of fine-grained iron material near the center of the area. The iron beds are practically flat-lying and rest with fault contact on Swauk. Magnetic readings indicate that outcrop 1 extends about 50 feet to the southeast, but there is no evidence of other iron beds or extensions within the area. Although the exposures show that the iron beds are about 6 feet thick, only a few hundred tons of ore could be expected.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 6 (see fig. 12)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	30	20	6	.....	NW	15° SW	fine	380	.....	.....
.....	E1	50	20	6	.....	NW	15° SW	fine	.....	.....	320
02	.....	25	20	5	.....	N 75° E	35° NW	fine	270	.....	.....
								Totals (fine)	650	.....	320

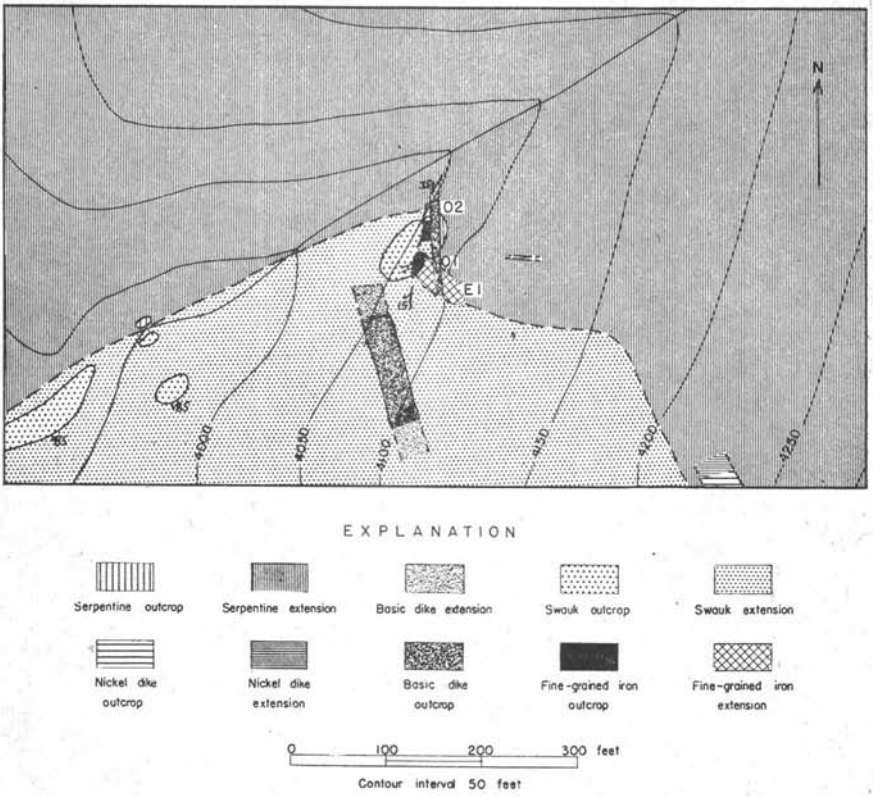


FIGURE 12—Detail map, Iron Peak area 6, Kittitas County, Washington. 01 is about 1,500 feet south and 1,600 feet east of the NW. corner of sec. 11, T. 22 N., R. 15 E.

Area 7

Area 7 (see fig. 13) is about 500 feet west of area 6 in the NW¼NW¼ sec. 11, (22-15 E.) at an elevation of about 3,700 feet above sea level. There are no iron bed exposures in this area, but magnetic readings indicate the presence of a small buried iron bed striking about west and dipping steeply to the south. The indicated length of this bed is about 220 feet and it is probably not over 1 or 2 feet thick. It is doubtful that underground development work will disclose any large ore body in this area.

IRON EXPOSURES AND EXTENSIONS, IRON PEAK AREA 7 (see fig. 13)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
.....	E1	220	.....	1	65	NW	SW	fine	.....	.....	760
								Totals (fine)	.....	.....	760

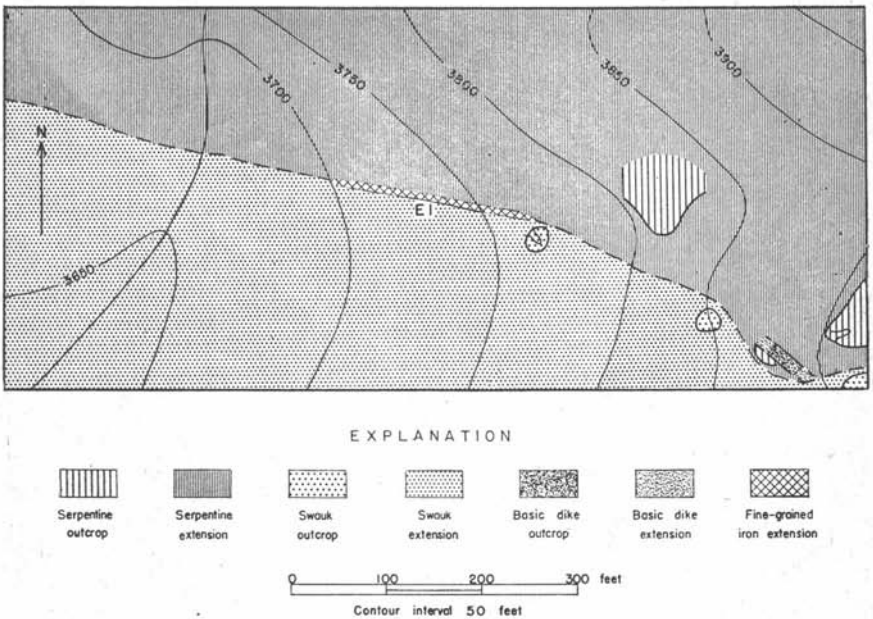


FIGURE 13—Detail map, Iron Peak area 7, Kittitas County, Washington. E1 is about 1,250 feet south and 300 feet east of the NW. corner of sec. 11, T. 22 N., R. 15 E.

CLE ELUM RIVER DEPOSITS

The Cle Elum River iron deposits mapped by the Division of Geology are those east of Cle Elum River and south of Boulder Creek in northern Kittitas County. They cover a 2-mile section of the Swauk-peridotite contact ranging in elevation from 2,700 to 5,000 feet above sea level and reaching a maximum elevation of 2,300 feet above Cle Elum River. The Cle Elum River road cuts the west end of these deposits.

It is estimated that the following four mapped areas contain about 3,370 tons of exposed, 21,550 tons of probable, and 191,360 tons of possible fine-grained iron ore.

Area 1

Area 1 (see pl. 5) is on the nose of the north-south ridge about half a mile south of Boulder Creek in the SE¼ and the SW¼NW¼ sec. 1, (22-14 E.). Development work consists of several old open cuts and two caved adits. Iron exposures occur on the east side of the ridge between elevations of 4,900 to 4,975 feet above sea level. Outcrops 1 to 4 represent a fine-grained iron bed about 600 feet long striking N. 65° W., dipping about 18° SW., and averaging 4 or 5 feet in thickness. Outcrop 5 represents a much smaller bed with the same general strike and dip. Magnetic readings show that outcrops 6 and 7 are the exposed parts of a 350-foot fine-grained bed that strikes N. 10° W. and dips about 20° SW. The south end of the bed is cut

by at least two faults that have caused successive portions of the bed to be displaced short distances to the west. The north end of the bed terminates against peridotite and has apparently been cut off by faulting. (See pl. 5.) Exposures of fine-grained iron also occur on the west side of the ridge at elevations from 4,775 to 4,900 feet above sea level. Magnetic readings indicate that outcrops 8 to 10 may be parts of a long fine-grained iron bed that has been faulted so as to produce a duplication of the bed. (See pl. 5.) However, this duplication could also be explained by slumping or small-scale landsliding on the steep slope of the ridge. In either case the iron bed has a total length of about 1,000 feet and an apparent thickness of 3 to 6 feet. Both segments of the bed trend about N. 10° E., but due to the lack of recognizable bedding planes the true strike and dip were not determined.

A possible interpretation of the major structure of the area is that a relatively thin capping of Swauk beds, striking northwest and dipping at low angles to the southwest, covers the top of the ridge. Due to erosion the Swauk is thickest on top of the ridge and thins out on both the east and west sides, with the west edge of the Swauk being lower than the east edge. This capping of Swauk is interpreted as lying on a remnant of the pre-Swauk peridotite surface that is at least partially covered by several fine-grained lenticular iron beds. If this interpretation is correct, relatively short diamond drill holes put down through the Swauk should prove the presence or absence of commercial ore bodies in the area. There seems to be a good possibility that considerable tonnage of ore might be located in this way.

IRON EXPOSURES AND EXTENSIONS, CLE ELUM RIVER AREA 1 (see pl. 5)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	280	4	6	20	N 65° W	15° SW	fine	710	1,780	.....
02	.....	10	3	3	.....	N 65° W	18° SW	fine	10	.....	.....
03	.....	10	3	2	.....	N 65° W	18° SW	fine	10	.....	.....
04	.....	85	3	3	5	N 65° W	20° SW	fine	80	70	.....
.....	E1	600	.....	5	25	N 65° W	18° SW	fine	.....	.....	3,980
05	.....	10	3	2	.....	NW	SW	fine	10	.....	.....
.....	E2	60	.....	2	5	NW	SW	fine	.....	.....	30
06 & 07	.....	50	3	5	.....	N 10° W	20° SW	fine	80	.....	.....
.....	E3	350	.....	5	10	N 10° W	20° SW	fine	.....	.....	930
08 & 09	.....	15	3	3	.....	.....	.....	fine	10	.....	.....
.....	E4	700	.....	3	90	.....	.....	fine	.....	.....	10,020
010	.....	130	3	6	35	.....	.....	fine	250	1,450	.....
.....	E5	300	.....	6	70	.....	.....	fine	.....	.....	6,680
								Totals (fine)	1,160	3,300	21,640

Area 2

Area 2 (see pl. 6) is approximately 1,800 feet west of area 1 in the SW¼NE¼ and the SE¼NW¼ sec. 2, (22-14 E.). It extends from the top of Magnetic Ridge, at an elevation of about 5,000 feet, down the west slope to an elevation of about 4,000 feet. Development work consists of several old open cuts. Fourteen outcrops of fine-grained iron occur within the area. Magnetic readings indicate

that these outcrops are the surface exposures of two large iron beds, both of which have been distorted and broken by faulting. (See pl. 6.) The eastern iron bed, represented by outcrops 1 to 12, is about 1,000 feet long, having a general strike of N. 70° E. and dip of 45° SE. Eight hundred and fifty feet of the western iron bed, which continues into area 3, has been mapped in this area. This bed strikes about N. 80° E. and dips about 40° SE. It is estimated that there are about 144,000 possible tons of iron ore within this area. Since the iron beds dip southward at fairly low angles, a few diamond drill holes put down through the Swauk south of the Swauk-peridotite contact could easily prove or disprove the existence of the estimated tonnage. It might also be found that the iron beds continue to greater depths than those used in estimating the possible tonnages.

IRON EXPOSURES AND EXTENSIONS, CLE ELUM RIVER AREA 2 (see pl. 6)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	60	3	11	10	N 30° W	40° SW	fine	220	380	.....
02	.....	20	3	5	15	NE	SE	fine	30	90	.....
03	.....	40	3	6	5	NW	SW	fine	90	70	.....
.....	E1	140	.....	5	75	E	S	fine	.....	.....	2,780
04	.....	80	3	3	6	E	S	fine	90	90	.....
05 & 06	.....	30	3	5	5	NE	SE	fine	40	40	.....
.....	E2	250	.....	4	12	NE	SE	fine	.....	.....	640
07	.....	135	3	10	55	NE	SE	fine	430	3,940	.....
08-011	.....	90	3	5	60	N 80° E	50° SE	fine	150	1,430	.....
.....	E3	520	.....	5	450	N 80° E	50° SE	fine	.....	.....	62,010
012	.....	30	3	2	45	N 80° E	SE	fine	20	150	.....
013	.....	150	3	5	45	N 70° E	35° SE	fine	220	1,790	.....
014	.....	280	3	5	95	N 85° E	40° SE	fine	460	7,050	.....
.....	E4	850	.....	5	350	N 85° E	40° SE	fine	.....	.....	78,840
								Totals (fine)	1,750	15,030	144,270

Area 3

Area 3 (see pl. 7) continues westward from area 2 at elevations from 3,200 to 4,000 feet above sea level in the SW¼NW¼ sec. 2 and the SE¼SE¼ sec. 3, (22-14 E.). Development work consists of several old open cuts, one caved adit, and one 500-foot adit. Seven outcrops of fine-grained iron occur within this area and, as shown by magnetic readings, are the exposed parts of one large iron bed having a general strike of N. 70° E. and dip of 50° SE. Magnetic readings also indicate that the iron bed is cut by at least seven faults that have caused as much as 100-foot displacement of the several segments. (See pl. 7.) This iron bed is a continuation of the western bed shown in area 2, and could easily be prospected by a drilling program similar to that suggested for area 2. The probably shallow depth of the iron is suggested by the findings in the 500-foot adit at the western and lowest end of the bed. A short distance from the portal the adit cuts the Swauk-peridotite contact and follows it to the face, which is about 180 feet below the surface. No sign of iron ore was found along the entire length of the adit, although an iron bed 6 feet thick is exposed on the surface above the adit. (See pl. 7.)

IRON EXPOSURES AND EXTENSIONS, CLE ELUM RIVER AREA 3 (see pl. 7)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
.....	E1	350	.....	4	110	E	S	fine	.....	.....	8,160
.....	E2	340	.....	2	115	E	S	fine	.....	.....	4,040
01	.....	30	3	2	15	E	S	fine	20	60	.....
02	.....	45	3	1	10	NE	SE	fine	20	70	.....
03	.....	30	3	2	10	NE	SE	fine	20	40	.....
.....	E3	180	.....	3	95	NE	SE	fine	.....	.....	2,720
.....	E4	190	.....	2	50	E	S	fine	.....	.....	1,010
.....	E5	200	.....	6	100	E	S	fine	.....	.....	6,360
04–07	.....	150	3	6	60	E	50° S	fine	300	2,860	.....
								Totals (fine)	360	3,030	22,290

Area 4

Area 4 (see fig. 14) is on the east bank of Cle Elum River in the SW¼NE¼ sec. 3, (22-14 E.), at elevations from about 2,700 to 2,800 feet above sea level. It is about 1,000 feet west and a little north of area 3. Development work consists of one caved shaft and several old open cuts. Three outcrops of fine-grained iron, interpreted as being exposed parts of the same iron bed, occur along the steep east bank of the river. This bed has a total length of about 310 feet and an exposed thickness of 2 to 5 feet. Faulting, producing duplication of the iron bed, has moved the west part of the bed about 250 feet northeast relative to the east portion. (See fig. 14.) Magnetic readings fail to show the presence of other iron beds within this area and it is doubtful that underground development will locate any ore bodies large enough to be economically mined.

IRON EXPOSURES AND EXTENSIONS, CLE ELUM RIVER AREA 4 (see fig. 14)

Iron exposures	Iron extensions	Dimensions in feet				Strike	Dip	Ore type	Amount in short tons		
		Length	Width	Thickness	El. diff.				Exposed	Probable	Possible
01	.....	10	3	2	.....	N 80° W	70° SW	fine	10	.....	.....
.....	E1	120	.....	2	70	N 80° W	70° SW	fine	.....	.....	890
02	.....	35	3	5	20	N 60° E	60° SE	fine	70	190	.....
03	.....	30	3	2	.....	N 60° E	85° SE	fine	20	.....	.....
.....	E2	190	.....	3	75	N 60° E	70° SE	fine	.....	.....	2,270
								Totals (fine)	100	190	3,160

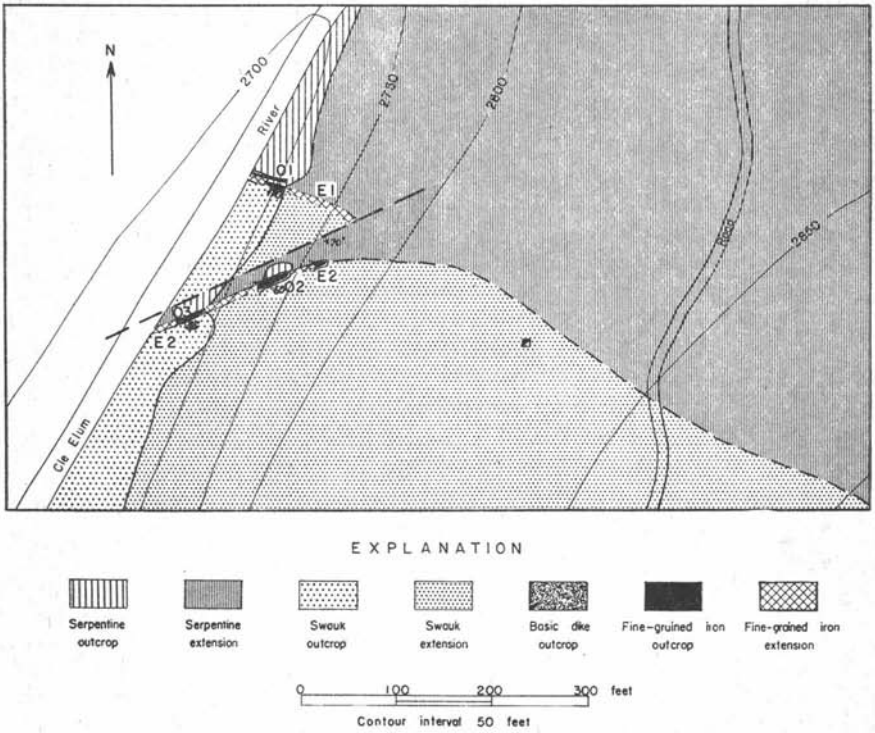


FIGURE 14—Detail map, Cle Elum River area 4, Kittitas County, Washington. 01 is about 2,300 feet west and 2,000 feet south of the NE. corner of sec. 3, T. 22 N., R. 14 E.

Deposits not mapped

Iron deposits west of Cle Elum River and those east of the river but north of Boulder Creek were not mapped by the Division of Geology. These deposits have recently been mapped in detail by the U. S. Geological Survey and have been diamond drilled by the U. S. Bureau of Mines. They are covered by 14 mining claims and include the bulk of the Cle Elum River iron ore reserves. Estimates of ore tonnages as given by Glover① are: 500,000 tons of known ore, 2,000,000 tons of probable ore, and 5,000,000 tons of possible ore. By comparing these tonnage figures, which probably represent all of the Cle Elum River deposits, with those for the deposits mapped by the Division of Geology it can be seen that by far the greatest part of the ore must be in the unmapped area. Zapffe② estimates the tonnage of fine-grained iron material within five claims as about 384,000 tons above river level and about 6,210,000 tons down to 1,000 feet

① Glover, Sheldon L., Washington iron ores, a summary report: Washington Div. Mines and Mining, Rept. of Inv. 2, p. 10, 1942.

② Zapffe, Carl, Memorandum report on the iron ores of the Cle Elum district, Washington: Washington Div. Mines and Mining, Rept. of Inv. 5, p. 23, 1944.

below river level. Based on available information it seems probable that the Cle Elum River deposits not mapped by the Division of Geology have in the neighborhood of 5,000,000 tons of available iron ore, regardless of grade, in beds from 5 to 28 feet thick.

The mining of these iron beds to great depths below the level of Cle Elum River may be prohibited by excessive pumping costs. The ore lies in the bottom of a major drainage valley in a region of rather heavy precipitation. High pumping costs together with narrow mining widths, structural complications, expensive transportation, and a relatively low grade ore may not leave much margin for profit.

SUMMARY

Assuming that a commercial iron or steel product can be made from these iron ores, reserves large enough to support an industry for a number of years must be assured. It is estimated that there is a total of about 5,650,000 tons of available fine-grained ore and about 13,000,000 tons of conglomerate matrix along the entire Blewett-Cle Elum iron ore zone, with about 5,000,000 tons of the fine-grained ore being confined to the Cle Elum River deposits and about 12,400,000 tons of the conglomerate matrix confined to the Blewett deposits. There is some question as to whether or not the conglomerate matrix is of high enough grade to make its separation from the cobbles and boulders economically feasible. The above figures include all known iron beds regardless of thickness. It is obvious that there is a minimum iron bed thickness that can be profitably mined and that this thickness will vary somewhat depending on the composition of the ore, the accessibility, and the mining methods employed. Assuming a minimum mining width of 5 feet, a tabulation of available tonnages for those deposits mapped by the Division of Geology would be as follows:

TONNAGES ASSUMING A 5-FOOT MINIMUM MINING WIDTH OF ORE

Deposits	Ore Type	Amount in short tons		
		Exposed	Probable	Possible
Blewett	fine	13,000	54,000	160,000
	conglom.	1,428,000	8,568,000	11,016,000
Nigger Creek	fine	.....	.....	.....
	conglom.	59,750	45,720	431,610
Stafford Creek	fine	21,550	2,910	61,860
	conglom.	.....	.....	.....
Bean Creek	fine	6,340	8,340	.....
	conglom.	.....	.....	.....
Iron Peak	fine	70,830	27,940	58,280
	conglom.	94,960	2,200	.....
Cle Elum River (mapped portion)	fine	3,050	21,070	161,580
	conglom.	.....	.....	.....
Totals	fine	95,500	114,560	441,720
	conglom.	1,582,710	8,615,920	11,447,610

Lack of development work has necessitated that tonnage estimations be based on surface exposures and magnetic data. Nevertheless, it is believed that the tonnages presented in this report are reasonable estimations of ore reserves for the Blewett-Cle Elum iron zone as a whole, regardless of the fact that tonnage estimations of individual deposits based on future development may vary somewhat from these figures.

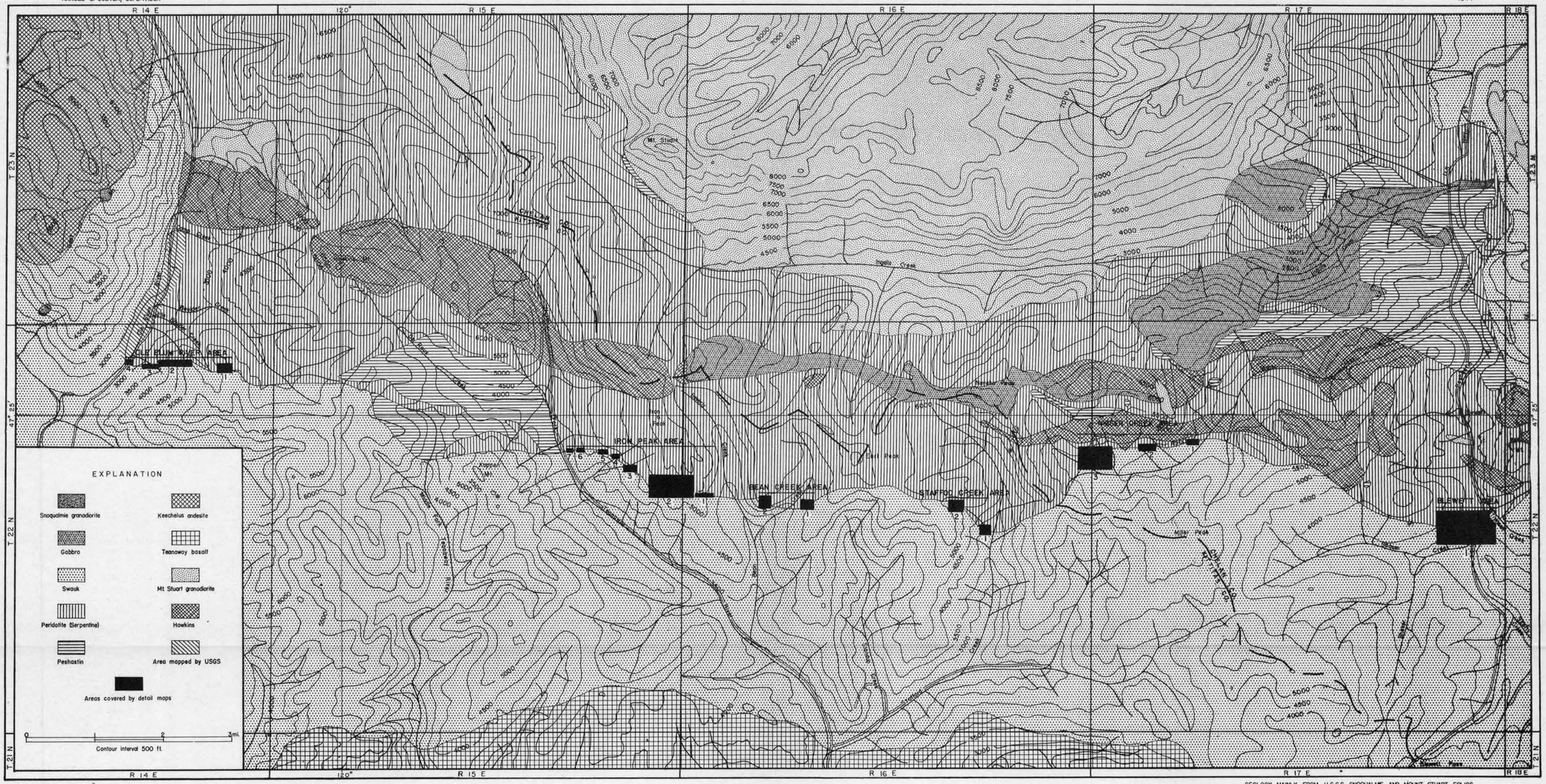
The main supply of fine-grained iron ore must come from the Cle Elum River deposits. The Blewett and Iron Peak deposits could furnish additional fine-grained ore, but neither appear to constitute adequate reserves to support an iron or steel industry of their own. If the matrix of the iron conglomerate can be considered as ore the Blewett deposit could support a small-scale reduction plant. The Nigger Creek and Iron Peak deposits also could furnish considerable matrix material. It does not appear that the Stafford Creek and Bean Creek deposits are large enough to be considered as potential iron ore reserves.

The iron deposits are made up of medium-grade ore, low in phosphorus, sulphur, and titanium, but containing appreciable amounts of aluminum, nickel, and chromium. The high aluminum content makes the ore unsuited for common blast-furnace reduction and the nickel-chromium content presents unsolved metallurgical problems. Several methods for beneficiating the ore have been discussed briefly by Zapffe.[1]

[1] Op. cit., pp. 20-21.

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE I
1944



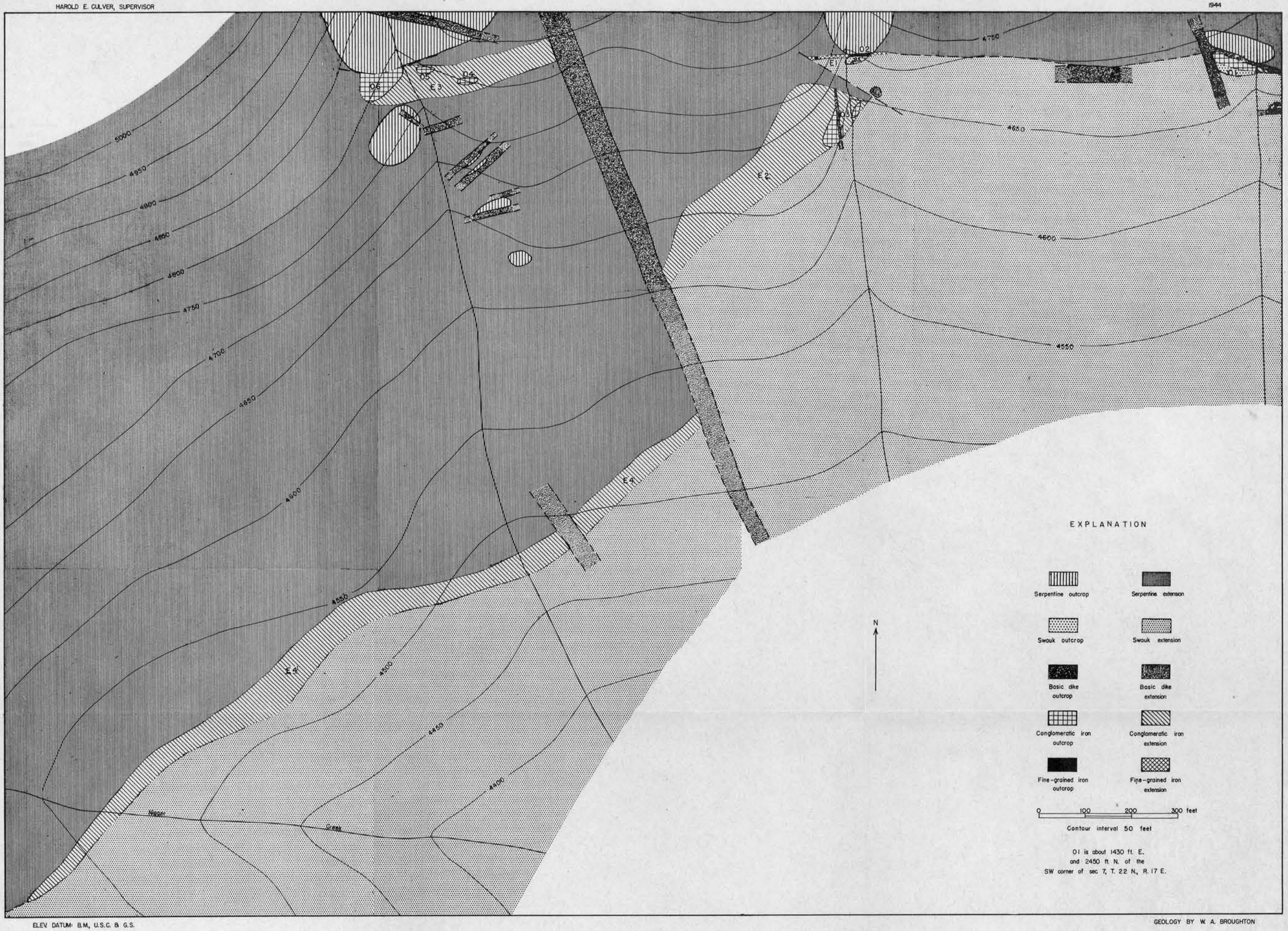
BASE AND TOPOGRAPHY FROM
U.S.G.S. SNOQUALMIE AND MOUNT STUART
QUADRANGLE SHEETS

GEOLOGY MAINLY FROM U.S.G.S. SNOQUALMIE AND MOUNT STUART FOLIOS.
(MODIFICATION OF SWAUK-PERIDOTITE BOUNDARY BASED ON FIELD WORK BY W. A. BROUGHTON)

AREAL GEOLOGY, BLEWETT-CLE ELUM IRON ZONE
CHELAN AND KITTITAS COUNTIES, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE 2
1944



EXPLANATION

- Serpentine outcrop
- Serpentine extension
- Swauk outcrop
- Swauk extension
- Basic dike outcrop
- Basic dike extension
- Conglomeratic iron outcrop
- Conglomeratic iron extension
- Fine-grained iron outcrop
- Fine-grained iron extension

0 100 200 300 feet

Contour interval 50 feet

01 is about 1430 ft. E.
and 2450 ft. N. of the
SW corner of sec. 7, T. 22 N., R. 17 E.

ELEV. DATUM: B.M., U.S.C. & G.S.

GEOLOGY BY W. A. BROUGHTON

DETAIL MAP, NIGGER CREEK AREA 3
CHELAN COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE 3
1944

EXPLANATION

Serpentine outcrop
Serpentine extension
Swauk outcrop
Swauk extension
Basic dike outcrop
Basic dike extension
Acidic dike outcrop
Acidic dike extension
Fine-grained iron outcrop
Fine-grained iron extension
Conglomeratic iron outcrop
Conglomeratic iron extension

0 100 200 300 feet
Contour interval 50 feet

01 is about 180 ft. W.
and 420 ft. N. of the
SE. corner of sec. 12, T. 22 N., R. 15 E.

N

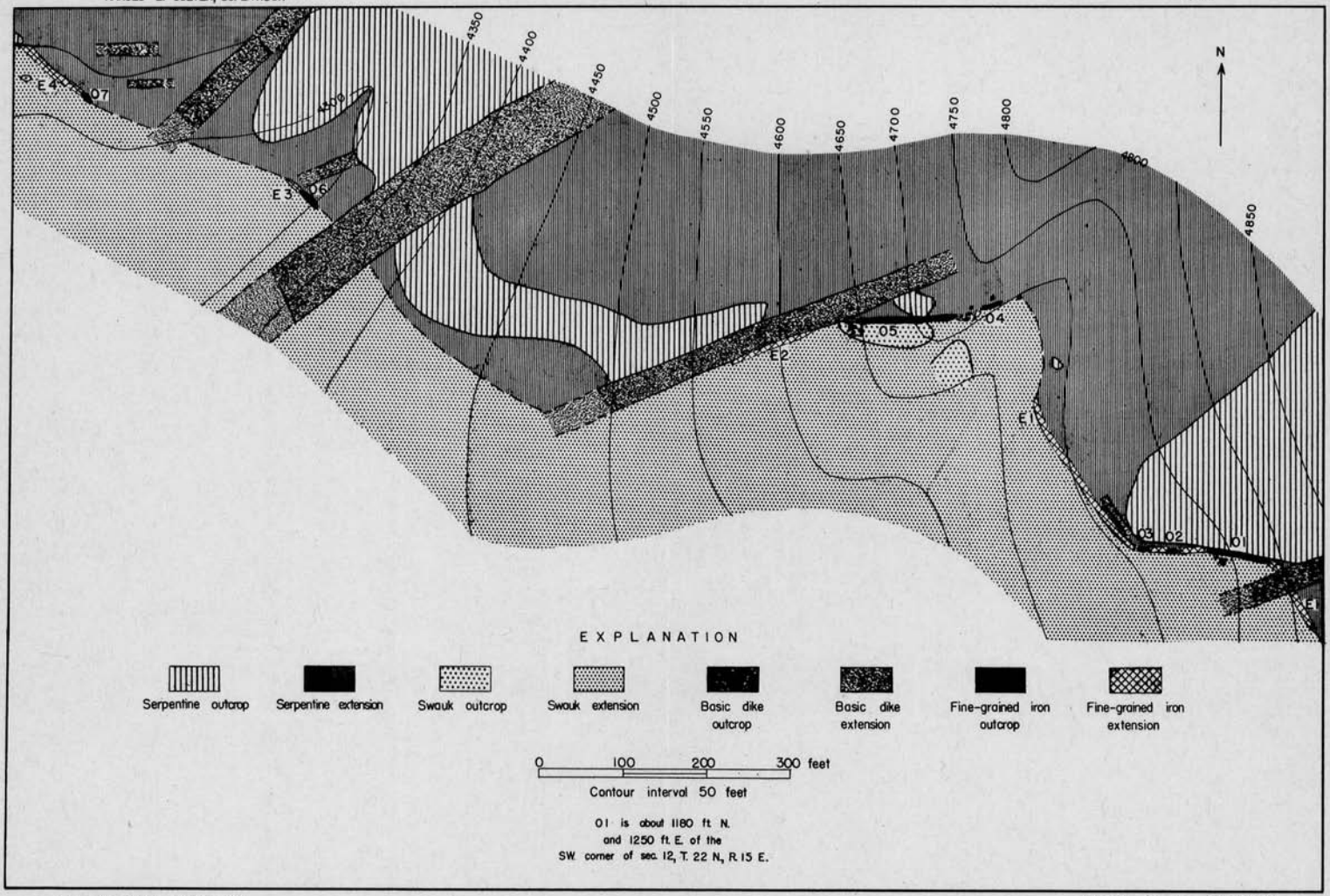
ELEV DATUM U.S.C. & G.S.

GEOLOGY BY W. A. BROUGHTON

DETAIL MAP, IRON PEAK AREA 2
KITTITAS COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE 4
1944



ELEV. DATUM: B.M., U.S.C. & G.S.

GEOLOGY BY W. A. BROUGHTON

DETAIL MAP, IRON PEAK AREA 3
KITTITAS COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE 5
1944

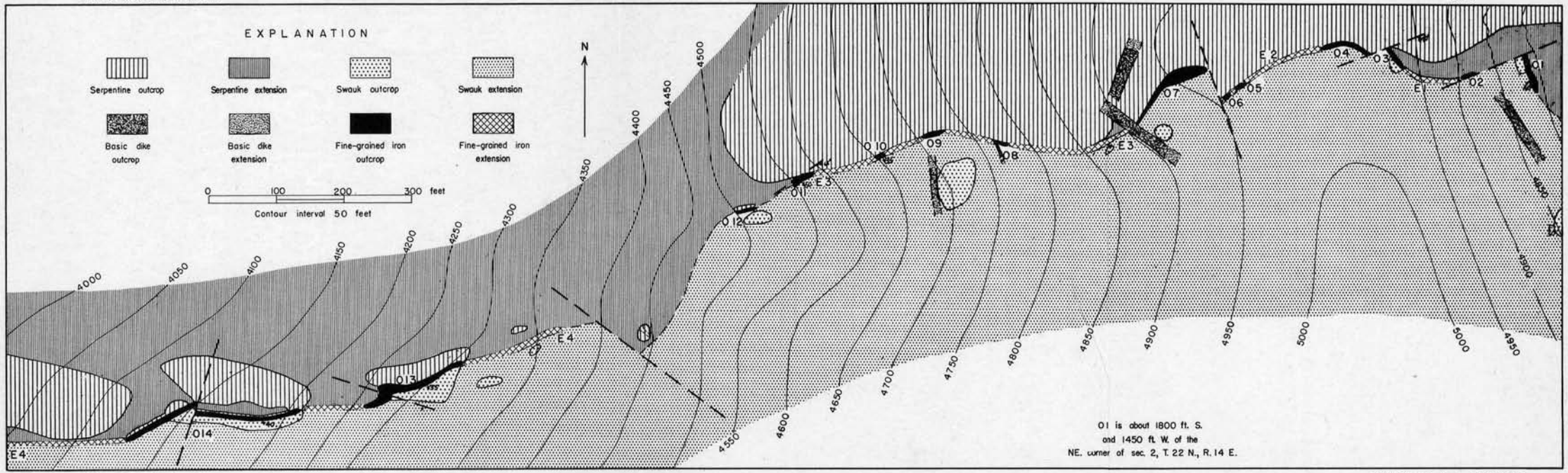
ELEV. DATUM: B.M., U.S.C. & G.S.

GEOLOGY BY W. A. BROUGHTON

DETAIL MAP, CLE ELUM RIVER AREA I
KITTITAS COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE 6
1944



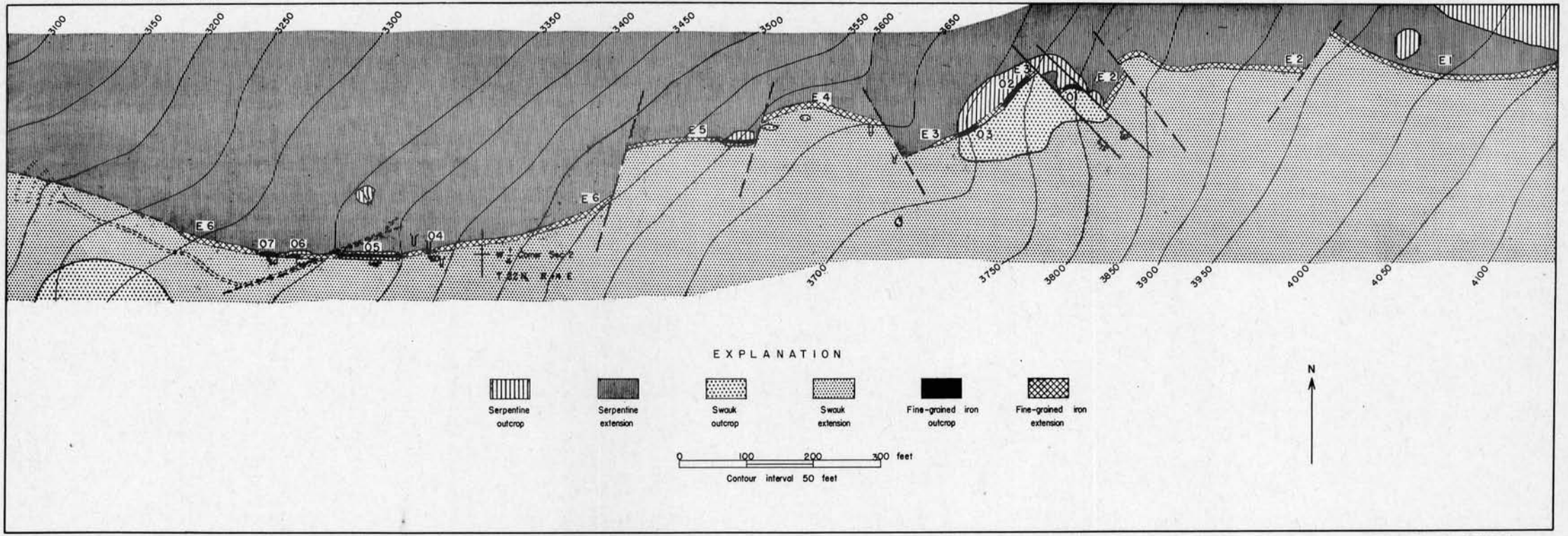
ELEV. DATUM: B.M., U.S.C. & G.S.

GEOLOGY BY W. A. BROUGHTON

DETAIL MAP, CLE ELUM RIVER AREA 2
KITTITAS COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 12, PLATE 7
1944



ELEV. DATUM: B.M., U.S.C. & G.S.

GEOLOGY BY W. A. BROUGHTON

DETAIL MAP, CLE ELUM RIVER AREA 3
KITTITAS COUNTY, WASHINGTON