

State of Washington
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DIVISION OF GEOLOGY
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Report of Investigations
No. 10

The Blewett Iron Deposit
Chelan County, Washington

(WITH PRELIMINARY TONNAGE ESTIMATES)

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FOREWORD

The presence of coal, limestone and iron in the State of Washington has long been known. For almost the same length of time the idea of a vast iron and steel industry has been circulated, advanced, and then relegated to the realm of fancy. A general appreciation of the real mineral wealth of the State has been accompanied lately by a marked stimulation of public interest in the establishment of a small scale iron industry. It has been recognized that certain new factors in the problem have appeared so that the whole matter merited reconsideration.

An important part of the review of the situation is a reexamination of the actual ore deposits, a task begun by the Division of Geology in 1941. A complete volume on all of the known iron deposits was first planned, but it soon became evident that the public interest would be served better by issuing partial reports as fast as the field and laboratory studies could be completed. Earlier this year there was published Report of Investigations No. 8, giving the results of a magnetic survey of the Buckhorn Iron of Okanogan County. The presentation of results of the study of the Blewett deposits, nearly completed last season, was deferred until some additional areal and magnetic work could be finished.

Both the stratigraphic and magnetic studies have revealed an unexpectedly complex geological situation, so that the estimation of ore present, the objective of the whole investigation, is not only more difficult, but is less satisfactory than was anticipated. An earlier, unpublished, estimate of probable tonnage, based on a preliminary examination of exposures, is now shown to have probably been optimistic. The current estimates, published herewith, are thought to have a more adequate basis.

Only by drilling or other form of development can the full details of the geologic situation be learned. It is believed that the present report will be of help in determining just what drilling or other testing of the deposit is needed.

—Harold E. Culver, Supervisor.

INTRODUCTION

About 2 miles south of the old mining town of Blewett in southern Chelan County, Washington, the Blewett iron deposit trends east through secs. 13 and 14, T. 22 N., R. 17 E., crossing Peshastin Creek between the mouths of Shaser and Tronsen creeks. The major part of the deposit is west of Peshastin Creek on the high ridge north of Shaser Creek. At Peshastin Creek the iron deposit is about 2,560 feet above sea level, but west of Pestastin Creek it rises to about 3,730 feet.



FIGURE 1—Index map of Washington showing the location of the Blewett iron deposit.

The stream valleys in this area are narrow and steep-sided with a thick growth of coniferous timber on the north slopes of the hills and a rather sparse growth on the south slopes. There is an adequate supply of both timber and water for mining operations.

Accompanying this report is a geologic and topographic map of the Blewett iron deposit on which are shown the dip needle and sun compass readings. The topographic contouring was based on the elevation of the U. S. Coast and Geodetic Survey bench mark at the mouth of Scotty Creek. The dip needle and sun compass readings, shown by the red overprint, were taken at 25-foot intervals along north-south traverses spaced from 100 feet to 300 feet apart and along short east-west traverses in particular areas. No accurate claim map is available, hence the mining claims are not shown on the map.

MINING OPERATIONS

The Washington Nickel Mining and Alloys, Inc. of Seattle, Washington controls 11 mining claims, known as the Venus, Apollo, Blue Rock, Hematite No. 1 and No. 2, and Magnetite No. 1, No. 2, No. 3, No. 4, No. 5, and

No. 6, covering the Blewett iron deposit. At the present time the property is leased to the American Mineral Resources Co., Detroit, Michigan. Development work consists of several caved adits and numerous open cuts, but there has been no commercial production of iron ore. Improvements consist of one mile of truck road. United States Highway 97 cuts the eastern end of the property, and Peshastin, which is on the main line of the Great Northern Railroad, is 15 miles to the north.

EARLIER INVESTIGATIONS

The number of published detailed reports on the Blewett iron deposit is limited, although several unpublished private reports have been made. Brief mention of the iron deposits can be found in geologic reports on the surrounding area and in technical journals. The more important of the published reports are as follows:

1893. Russell, Israel C., A geologic 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.
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.
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.
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 ore deposits and geology of the Blewett mining district. Brief mention is made of the iron deposits.
1922. Shedd, Solon; Jenkins, Olaf P.; and Cooper, Herschel H., Iron ores, fuels and fluxes of Washington: Washington Div. Geology Bull. 27, pp. 70-72.
A brief description of the iron properties with several analyses of the ore. The ore bodies are regarded as magmatic segregations in peridotite.
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 area.

1941. Melrose, J. W., Summary of information on iron ore deposits of Washington: Washington Div. Mines and Mining Inf. Circ. 6, p. 6. 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. An abstract of previous publications with the addition of some unpublished information.
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.

FIELD WORK

Field work on the Blewett iron deposit was carried on by the Division of Geology from August 16, 1942 to September 22, 1942 and from April 24, 1943 to May 12, 1943. The writer was assisted by M. T. Hunting, geologist of the Division of Geology, and L. T. Teir and G. M. Valentine, Division of Geology field assistants. An area about one mile long and half a mile wide including the iron deposit was geologically and topographically mapped, and was covered by a network of dip needle and sun compass traverses. Plate 1 shows the area mapped and the magnetic readings.

During the summer of 1942 Professor R. L. Lupper, of the State College of Washington, under the direction of the Division of Geology, carried on stratigraphic and structural studies along the iron belt between Peshastin Creek and the Cle Elum River, and his report is in preparation.

ACKNOWLEDGMENTS

The writer is greatly indebted to Mr. E. L. Davis, representative of the Washington Nickel Mining and Alloys, Inc., who generously contributed information and who made it possible for the field party to camp on the company's property. Much helpful information was obtained from field conferences with Professor R. L. Lupper and from maps prepared by him. Professor J. Hoover Mackin, of the University of Washington, kindly made it possible for the writer to study his private report on the Blewett iron deposit. The magnetic instruments were generously loaned by Mr. R. H. B. Jones and Mr. H. N. Westaway of the Oliver Iron Mining Company of Duluth, Minnesota, and by Mr. E. F. Bean, State Geologist of Wisconsin.

REGIONAL GEOLOGY

The following discussion of the regional geology is based on George Otis Smith's^① report on the geology of the Mount Stuart quadrangle:

Surrounding and composing Mount Stuart in the northern half of the quadrangle is a large circular mass of granitic rock known as the Mount Stuart granodiorite and thought by Smith to be of post-Carboniferous and pre-Tertiary age. Small stocks of this granodiorite and associated granitic dikes are found as far as 6 miles from the border of the main granodiorite mass.

Bordering the granodiorite on the east, south, and west is a semicircular area of older metamorphic rocks that have been intruded by the granodiorite. This belt of metamorphic rocks is from 3 to 5 miles wide and is made up of three formations known as the Peshastin, Hawkins, and peridotite. The Peshastin formation is a thick series of unfossiliferous slates with local beds of chert and limestone, and folded with it is the Hawkins formation, which is a series of lavas and tuffs. Smith was unable to determine which of these formations is the older, but both have been intruded by the peridotite which is the predominant rock in the metamorphic belt. Much of the peridotite has been altered to serpentine. Smith regarded the Peshastin and Hawkins formations as being of Carboniferous age or older and considered the peridotite (and serpentine) to be of post-Carboniferous and pre-Tertiary age and also earlier than the Mount Stuart granodiorite.

A belt of arkosic sandstones, conglomerates, and shales, from 3 to 12 miles wide, known as the Swauk formation, borders the older metamorphics on the east, south, and west and rests unconformably on them. The Swauk comprises continental deposits, which Smith considered to have been derived mainly from the Mount Stuart granodiorite. The strikes and dips within the Swauk are variable, but in general the beds have been warped into gentle folds with axes trending northwest. On the basis of plant fossils, studied by F. H. Knowlton, Smith correlated the Swauk formation with the Denver, Laramie, and Fort Union formations and believed it to be of Eocene age. However, since Smith's report was published the age of the Laramie and Denver formations has been changed to the Upper Cretaceous.

Beds of iron-rich sedimentary rocks are frequently found where the Swauk rests directly on the serpentine. Smith regarded these as basal Swauk beds being composed mainly of material derived from the underlying serpentine. However, several isolated occurrences of similar iron beds that have been found between Peshastin Creek and the Cle Elum River raise some doubt as to the accuracy of Smith's determination.

The Swauk and the older metamorphic formations have been intruded by small masses of gabbro and are also cut by quartz veins that carry gold, silver, and copper.

Stratigraphically overlying the Swauk formation with a slight angular unconformity is the Teanaway basalt composed of lava flows and tuff beds. This basalt crops out along a belt averaging 3 miles in width along the southern border of the Swauk formation and apparently at one time extended northward covering much of the Swauk and older metamorphics,

^①Smith, George Otis, U. S. Geol. Survey Geol. Atlas, Mount Stuart folio (no. 106), 1904.

for these older rocks are cut by hundreds of basic dikes that are thought to have been "feeders" for the Teanaway flows.

South of the basalt and overlying it unconformably is another series of continental beds, the Roslyn formation. Composed chiefly of arkosic sandstone and shale, it resembles the Swauk but includes many coal beds, some of which are of commercial importance. Both the Roslyn formation and the Teanaway basalt are overlain in part by the later Yakima basalt, of Miocene age (Smith), and by still later rhyolite flows that Smith mapped as Pliocene.

North of Ingalls Creek the valley bottoms are largely covered with morainic and outwash material from glaciers originating on Mount Stuart during Pleistocene time. Remnants of these glaciers still exist on the flanks of Mount Stuart. South of Ingalls Creek the valleys are floored with Pleistocene and Recent stream deposits that carry the placer gold of the area.

LOCAL GEOLOGY

Of the various rock formations in the northern half of the Mount Stuart quadrangle only the serpentine and Swauk formations, iron beds, acidic dikes, and basic dikes are in the vicinity of the Blewett iron deposit. The iron beds lie stratigraphically between the Swauk and the serpentine.

SERPENTINE

The serpentine, and partially serpentinized peridotite, is the oldest rock formation in the vicinity of the iron deposit. It is exposed in low outcrops on both the east and west sides of Peshastin Creek Valley and the south edge of the belt of outcrops crosses Peshastin Creek about 1,200 feet upstream from Tronsen Creek.

The serpentine varies considerably in appearance with colors ranging from light yellowish-green through yellows, browns, and reds to black. Shearing has produced abundant curved and intersecting surfaces of movement. The darker colored serpentine is coarsely jointed and breaks up into blocks several feet across, whereas the lighter colored serpentine is more closely jointed and usually breaks up into a fine rubble.

A microscopic and chemical analysis of the serpentine as given by George Otis Smith^① is as follows:

"Examined microscopically, some specimens of this rock are found to contain remnants of the original constituent minerals, showing that the alteration of the peridotite to serpentine has not been complete in all cases. Olivine occurs surrounded by serpentine. The olivine is clear, but the cores are bordered with fine grains of magnetite, which has separated out in the course of the alteration of the olivine into serpentine. Mesh structure is present in the rock where this alteration has been completed. Enstatite is a less abundant constituent, and is commonly found altered to bastite, yet in a few cases it occurs unaltered. There are phases of the rock that are almost entirely composed of diallage. * * * Magnetite is an abundant constituent, being present both in crystals and in fine grains. Pyrite and calcite occur in some specimens of the serpentine.

^① Smith, George Otis, U. S. Geol. Survey Geol. Atlas, Mount Stuart folio (no. 106), p. 4, 1904.

"The following analysis, by Dr. W. F. Hillebrand, is of serpentine from the Three Brothers. This specimen is typical of the altered rock, which shows by its texture, both megascopic and microscopic, its derivation from peridotite:

	Per cent
SiO ₂	39.00
Al ₂ O ₃	1.75
Fe ₂ O ₃	5.16
FeO	1.71
MgO	38.00
CaO	trace
Na ₂ O plus K ₂ O .....	.10
H ₂ O at 110°	1.31
H ₂ O above 110°	12.43
TiO ₂	trace
P ₂ O ₅	trace
Cr ₂ O ₃ .....	.47
NiO .....	.10
MnO .....	.15
FeS ₂ ^a .....	.03

(a) Actual condition of sulphur not known."

IRON BEDS

Most of the Blewett iron beds are west of Peshastin Creek on the high ridge north of Shaser Creek. A much smaller part is east of Peshastin Creek about 1,000 feet south of the mouth of Tronsen Creek. The locations and approximate surface dimensions of the areas of outcrops of the iron beds are listed as follows: (See pl. 1.)

- A. The largest area is about 800 feet south of the quarter line of sec. 14, extending in a general east-west direction for 2,200 feet, with an average width of about 600 feet.
- B. A small area roughly 90 feet long and 70 feet wide is just north of the northernmost edge of area "A" and is 1,050 feet west and 250 feet south of the east quarter corner of sec. 14.
- C. A small area about 160 feet long and 25 feet wide is about 150 feet northeast of area "B".
- D. A small area about 45 feet long and 30 feet wide is about 550 feet west of area "B".
- E. An area about 60 feet long and 40 feet wide is 800 feet south of the east end of area "A" and is 1,700 feet south and 600 feet east of the west quarter corner of sec. 13.
- F. On the west side of Peshastin Creek about 100 feet above the valley bottom is an area about 40 feet long and 15 feet wide. It is 1,150 feet west and 350 feet south of the east quarter corner of sec. 13.
- G. East of Peshastin Creek and about 50 feet above the valley bottom is an area about 150 feet long and 25 feet wide. It is about 300 feet west of the east one-quarter corner of sec. 13.

The iron beds are all south of and stratigraphically above the serpentine. They probably rest on an old serpentine erosion surface although the contact is not exposed here, since farther to the west, at the head of Nigger Creek, similar iron beds can be seen to rest directly on the serpentine. The

iron beds appear to be stratigraphically below the Swauk, but may in part be the basal beds of that formation.

The iron beds comprise a series of thick conglomerates and thin lenses of fine-grained beds. The maximum stratigraphic thickness of the series, as shown by area "A", is at least 700 feet.

The fine-grained beds or lenses are tabular in shape with exposed lengths ranging from 20 to 320 feet and thicknesses ranging from 3 to 32 feet. These beds show no distinct banding or bedding, and the material of which they are composed can best be described as a metamorphosed mudstone containing appreciable amounts of iron, chromium, and nickel. The color ranges from reddish-brown to black and the streak ranges from red to black. The material is essentially a hematitic and limonitic clay with numerous grains and pebbles of magnetite, chromite, and highly decomposed serpentine. The magnetite grains range from microscopic size to as much as a quarter of an inch in diameter and many of them are irregular in shape and angular, although the majority are rather well rounded. Practically spherical magnetite grains are not uncommon. Occasional oolites and pisolites composed of rims of magnetite with cores of serpentine and hematite are present. These fine-grained beds are closely jointed by minute fractures and in places are highly sheared. Some of the fractures have been filled with magnetite that appears to have been secondarily produced by metamorphism of the iron-rich muds after deposition. Occasionally small masses several feet across are found with the hematite largely altered to secondary magnetite. The chromium of these fine-grained beds appears as the mineral chromite. It is not known in what mineral form the nickel occurs, but it is probably one or more of the hydrous nickel silicates.

The conglomerate beds range from 150 to 1,200 feet in exposed lengths and the apparent thicknesses are of the order of hundreds of feet. The beds are made up of pebbles, cobbles, and boulders in a fine-grained matrix. The pebbles and cobbles are usually well rounded, some being nearly spherical. Most of them are composed of serpentine and peridotite, but some are of slate and fine-grained diabasic rock. The boulders, some of which are as much as 10 feet across, are usually angular, although sharp edges and corners have been rounded. All of the boulders examined are composed of serpentine and partially serpentinized peridotite. Much of the matrix is similar to the material composing the fine-grained beds, but it usually has a lighter streak and a lower specific gravity. Some of the matrix is dark-green in color and appears to have originally been a serpentine-rich mud. The conglomerate beds are practically unstratified, although there are occasional concentrations of pebbles, cobbles and boulders, and thin, clayey lenses. The conglomerate is closely jointed with most of the joints confined to the matrix and curving around the boulders.

A few poorly preserved fossil leaves and what appears to be a fossilized fragment of a tree trunk have been found in the matrix of the conglomerate, but to date they have not been identified. No fossils have been found in the fine-grained beds.

ACIDIC DIKES

The only acidic dike outcrops in the vicinity of the Blewett iron deposit are in the area of serpentine west of Peshastin Creek. They are seen as small disconnected outcrops up to 50 feet across and their strikes and dips are not readily determinable.

It is definitely known that these dikes are post-serpentine and they are not known to cut the iron beds or the Swauk formation. George Otis Smith[Ⓞ] correlated them with the Mount Stuart granodiorite. Their composition is essentially that of granodiorite. They range from fine- to medium-grained and are usually porphyritic with phenocrysts of plagioclase feldspar and occasionally of quartz.

SWAUK FORMATION

The Swauk formation is south of and stratigraphically above the iron beds. Good exposures can be seen just south of iron bed area "A", along the mine road, and on both the east and west sides of Peshastin Creek. It is a thick continental deposit of light-gray arkosic sandstones and conglomerates, usually cross-bedded with lenses of carbonaceous shales. Pebbles and cobbles in the conglomerate, mainly well-rounded, include granodiorite, diabase, slate, serpentine, and quartz. Some of the shale lenses contain well-preserved fossil leaves.

BASIC DIKES AND SILLS

Many diabasic dikes and sills, ranging from a few feet to several hundred feet in thickness, intrude the serpentine, iron beds, and Swauk formation. The wider intrusive bodies frequently show well-developed columnar jointing and are usually coarser-grained than the narrower ones.

Basic intrusives cut the eastern end of iron bed area "A" and a 2-foot sill cuts the main ore bed. They are particularly abundant north and west of area "A" where they surround areas "B", "C", and "D". Similar dikes nearly surround areas "F" and "G" and others can be seen along the mine road and Peshastin Creek.

STRUCTURE

The major structure in the vicinity of the Blewett iron deposit seems to be a southeast-pitching syncline which has been faulted along its axis. The synclinal axis is along the southern edge of iron bed area "A". It crosses Peshastin Creek near the mouth of Shaser Creek and then continues farther to the southeast up Scotty Creek Valley. South of this synclinal axis the Swauk beds strike NW. and dip NE. North of the axis both the Swauk and iron beds strike NE. and dip SE. (See pl. 1 and fig. 2.) The faulting is suggested by the abrupt change in the strike and dip of the beds. In places along the southern edge of iron bed area "A" this change takes place within 2 to 5 feet and the rock within this zone is a mixture of crushed Swauk and iron bed material. This zone of breccia strikes N. 55° W. and appears to dip about 75° NE., but the dip may change within a short distance. The apparent offsetting of the line of contact between the Swauk and iron bed area "A" (See pl. 1.) suggests that there are several parallel faults making up a wide fault zone. The beds on the northeast side of the fault are stratigraphically lower than those on the southwest side and appear to have been pushed up with relation to them.

[Ⓞ]Smith, George Otis, U. S. Geol. Survey Geol. Atlas, Mount Stuart folio (no. 106), p. 8, 1904.

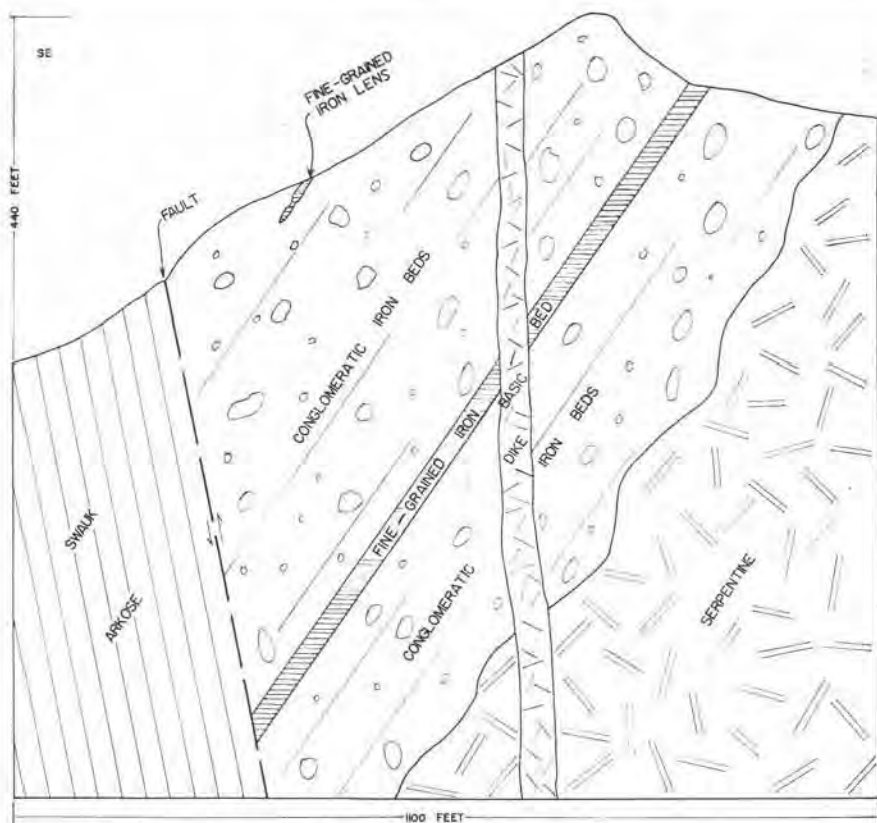


FIGURE 2—The major structure of the Blewett iron deposit shown diagrammatically in a northeast-southwest section.

Large basic intrusives more or less paralleling the strike of the iron beds, but dipping both to the northwest and southeast, surround iron bed areas "B", "C", and "D" and separate them from area "A". The intrusives have apparently displaced areas "B", "C", and "D" by lifting and shoving them to the north and west, the thickness of the intrusive bodies representing the amount of lateral displacement.

At the east end of area "A", on the west side of the mine road, a 5-foot bed of Swauk lies between iron beds and is separated from them by narrow zones of loose, crushed rock. The Swauk seems here to be interbedded with the iron beds, but the zones of crushed rock suggest that faulting or land sliding has moved it into this position.

The structure in the vicinity of iron bed area "E" does not conform to the major synclinal structure. The iron and the Swauk beds strike northward and dip to the west. This discrepancy in the structure may be due to land slides as is suggested by the topography in that area. However, area "E" is practically on the synclinal axis and the abnormal strikes and dips may be due to minor movement within the zone of faulting.

The iron beds of area "G" strike about N. 60° E. and dip 70° SE. At the east end of the area they terminate against large basic dikes that strike about N. 50° E. and dip about 75° SE. and at the west end of the area they terminate against a large dike that strikes about N. 80° E. and is practically vertical.

ORIGIN OF THE IRON DEPOSIT

The Blewett iron deposit is definitely of sedimentary origin as shown by the stratification, the detrital rock fragments, and the plant fossils.

The iron-rich sediments with their relatively high content of chromium and nickel were probably derived from a lateritic soil, covering the old serpentine land surface, and were deposited in one or more small basins on the serpentine terrain. The fine-grained beds or lenses probably represent material deposited as mud from more or less stagnant water, whereas the conglomerate probably represents deposition by torrential streams. The Swauk sandstone was laid down on top of the iron beds, but from their relations in the Blewett area it is not clear whether deposition was continuous or interrupted after the iron beds were deposited. The abrupt change from the iron sediments to the arkosic sediments suggests that sedimentation may have been interrupted. Neither is it clear whether the Swauk is conformable with the iron beds, although farther to the west in the Nigger Creek area and in the Boulder Creek area of Kittitas County it appears to be. There may have been considerable erosion and possibly some deformation of the iron beds in the Blewett area before the deposition of the Swauk.

The present condition of the fine-grained iron sediments appears to be due largely to metamorphism that probably took place at the time the beds were folded into their present position. The pressure and heat developed during this deformation undoubtedly caused much compaction of the sediments and the formation of considerable secondary magnetite. Very little metamorphism seems referable to the basic intrusives.

The sequence of geologic events that resulted in the formation of the iron deposit is probably as follows:

1. Intrusion of the peridotite.
2. Serpentinization of the peridotite—with the development of much magnetite and some chromite.
3. Weathering of the serpentine—accompanied by deposition of the iron beds in small basins on the serpentine surface.
4. Intrusion of the Mount Stuart granodiorite—possibly accompanied by some disturbance of the iron beds.
5. Deposition of the Swauk arkose—probably accompanied by some erosion and reworking of the iron beds. (Swauk deposition probably began before the granodiorite intrusion was completed.)
6. Folding of the sedimentary deposits—accompanied by compaction and the development of secondary magnetite in the iron beds.
7. Faulting.
8. Intrusion of the basic dikes and sills accompanied by local faulting.
9. Erosion.

SAMPLING AND ANALYSES OF THE ORE

There is very little published information concerning the composition of the Blewett iron ore. The analyses of four samples of the ore as given by Shedd, Jenkins, and Cooper^① are as follows:

	1	2	3	4
Iron (Fe)	42.67	49.74	42.00	47.98
Silica (SiO ₂)	18.54	9.57	12.00	10.81
Aluminum (Al)	8.55	5.32	.....	.....
Chromium (Cr)	1.08	.....	.....	.....
Calcium (Ca)	1.28	.....	.....	.....
Magnesium (Mg)	8.66	.....	.....	.....
Manganese (Mn)	1.29	.....	.....	.....
Phosphorus (P)	0.023	Tr.	0.024	0.024
Sulphur (S)	0.067	Tr.	0.07	0.009
Titanium (Ti)	0.14	8.20	.....	.....
Loss on ignition .....	.....	1.28	.....	.....

- 1-3. Analyses of iron ore from Magnetite No. 1 claim, by Dr. E. H. Rothert, Rothert Process Steel Co., Seattle.
4. Specimen of higher grade hematite with some magnetite, from McCarthy property, Sec. 14, T. 22 N., R. 17 E. H. H. Cooper, collector. R. P. Cope, analyst, (1922).

The prospectus of the Washington Nickel Mining and Alloys, Inc., gives the analyses of twelve samples of the iron ore. The average, minimum, and maximum of these analyses are as follows:

	Ave.	Min.	Max.
Iron (Fe)	39.3	17.8	51.12
Manganese (Mn)	0.37	0.206	0.505
Chromium (Cr)	2.02	1.16	3.48
Nickel (Ni)	1.32	0.553	1.33

The analyses of two samples of the ore, taken by the Northern Pacific Railway Company, are given by Sheldon L. Glover^②. The description of the samples was, "Channel samples from the 22-foot (No. 2) member." The results of these analyses are as follows:

	A	B
Iron (Fe)	26.21%	36.06%
Alumina (Al ₂ O ₃)	2.64	4.64
Silica (SiO ₂)	25.30	19.68
Lime (CaO)	1.97	1.52
Magnesia (MgO)	19.18	8.86
Phosphorus (P)	0.018	0.023
Sulphur (S)	0.027	0.018
Manganese (Mn)	0.44	0.42
Nickel (Ni)	0.57	0.76
Chromium (Cr)	1.36	2.41
Water (H ₂ O)	2.88	1.81
Loss	11.26	10.41

^①Shedd, Solon; Jenkins, Olaf P.; and Cooper, Herschel H., Iron ores, fuel and fluxes of Washington: Washington Div. Geology Bull. 27, p. 72, 1922.

^②Glover, Sheldon L., Washington iron ores, a summary report: Washington Div. Mines and Mining Rept. of Inv. 2, p. 5, 1942.

It is unknown exactly where and how any of the samples of the above three groups were taken, and although they give some information as to the composition of the ore it is unsafe to regard them as representing the entire iron deposit.

The Blewett iron deposit was not extensively sampled by the Division of Geology. However, in order to secure some definite information on the composition of the iron ore, one channel sample was cut across the largest of the fine-grained iron beds 180 feet west of the open cut at the upper end of the mine road. The channel was 29 feet long, about 3 inches wide, and about 1 inch deep and represented a section from top to bottom across the fine-grained ore bed. The analysis follows:

Iron (Fe)	36.32%
Titanium (Ti)	0.005
Phosphorus (P)	0.03
Sulphur (S)	0.01
Chromium (Cr)	1.42
Nickel (Ni)	0.83

Analyst: Laucks

The specific gravity of this sample was determined, by the Division of Geology, to be 3.2, and this figure was used in the estimation of ore tonnages.

During the summer of 1942 the U. S. Bureau of Mines analyzed samples of the iron deposit, but the results have not been made available to the Division of Geology for study.

The iron ore is definitely low grade, but the rather high content of nickel and chromium may make it valuable for alloy steels. The ore is remarkably low in titanium, phosphorus, and sulphur. It is very probable that further sampling and analysis will show considerable variation in the chemical composition of the several fine-grained beds, and of different parts of the same bed.

INDICATED AMOUNT OF ORE

It is very probable that only the fine-grained iron beds or lenses can be regarded as ore at this time. Locally the matrix of the conglomerate beds contains enough iron, nickel, and chromium to be considered as ore, but such bodies are in most places only a few feet across. On the whole, the iron content of the matrix is less than that of the fine-grained beds, and the boulders, which frequently make up more than 50 per cent of the volume, will greatly reduce the percentage of iron, nickel, and chromium of the material to be handled.

The total reserves of iron ore can only be roughly estimated. Very little development work has been done and the exposures of the fine-grained beds are small. Reasonably good estimation of the probable extent of the ore bodies can be made on the basis of the magnetic readings.

EXPOSURES OF IRON BEDS

For the purposes of this report only the fine-grained beds are regarded as potential ore bodies. The beds are shown on plate 1 and are listed as follows:

Location	Length (ft.)	Thickness (ft.)	Strike	Dip
Area "A"				
Main open cut	300	15-30	N. 80° E.	55° SE.
400 feet SE of main open cut	60	2-3	N. 50° E.	50° SE.
400 feet S of main open cut	25	3		
400 feet S of main open cut	50	2-3	N. 55° E.	50° SE.
870 feet W of main open cut	25	4-5	N. 60° E.	45° SE.
1,100 feet SW of main open cut	25	4		
Area "B"	65	10-15	N. 75° E.	65° SE.
Area "C"	140	15		
Area "E"	50	4-5	N. 15° W.	75° SW.
Area "G"	120	15-20	N. 60° E.	70° SE.

ESTIMATION OF TONNAGES

Any estimation of possible iron ore tonnages in this deposit must be confined to those ore bodies that can be mined profitably. It has been pointed out that the conglomeratic iron beds probably can not be considered as ore because of the low ratio of iron matrix material to serpentine boulders. It is equally improbable that the thin (2 to 5 feet) fine-grained iron lenses can be mined profitably, especially as there is no indication that they are continuous for any great distances either along the strike or down dip. It is also very improbable that the thick fine-grained beds can be mined profitably in those places where they have been intruded and displaced by numerous basic dikes and sills.

During the summer of 1942 the Division of Geology stated that there might possibly be 5,000,000 tons of ore in the Blewett iron deposit. This statement, made after preliminary investigation, was based on the assumption that the fine-grained iron bed of area "A" would continue along the strike to iron bed area "G" and extend down dip to the level of Peshastin Creek. This basic assumption is not borne out by the detailed geologic and structural mapping and the magnetic studies now completed, and

therefore the estimate of probable ore tonnage must be considerably reduced.

The largest body of iron ore is the thick fine-grained iron bed in area "A" at the upper end of the mine road. This bed strikes N. 80° E., dips 55° SE., crops out for 300 feet along the strike, and averages about 25 feet in thickness, with a difference in elevation of 115 feet between the highest and lowest exposures. The triangular-shaped block, formed by projecting the bed into the hill along the strike from the lowest exposure, and down the dip from the highest exposure, would contain about 52,500 tons of ore, if the thickness averages 25 feet. Assuming that the ore is continuous down dip to the major fault along the Swauk-iron bed contact, and assuming further that the dip of this fault is unchanged at depth, the tabular block of ore would have a possible down-dip length of about 825 feet. Such a block of ore 825 feet long, 300 feet wide, and averaging 25 feet in thickness would contain about 724,000 tons of ore.

The magnetic readings indicate that the large fine-grained bed does not extend more than about 325 feet east of its easternmost exposure and that it probably extends about 150 feet west of its westernmost exposure. (See p1, 1.) This gives a total possible strike length of about 775 feet instead of 300 feet and a total of about 1,619,000 tons from the surface down to the projected intersection of the fault and the ore bed. However, it is not at all certain that the ore bed continues down dip to the fault nor that the thickness will average 25 feet for the whole distance. Diamond drilling or other development work will have to be done to prove that the iron bed extends east and west of the exposed area and that it continues with relatively uniform thickness and composition down dip to the fault. Similarly, it must be determined whether the dip of the fault remains constant with depth.

The surface dimensions of the large iron bed in areas "B" and "C" are definitely limited by the surrounding basic dikes and sills, hence it is probable that they can not be extended to any great depth below the surface. Assuming that both of these ore bodies extend to 100 feet below the surface (an assumption that is improbable and that must be proven by diamond drilling or other development work) they would contain a total of about 72,500 tons of ore with 20,000 tons in area "B" and 52,500 tons in area "C".

The large fine-grained iron bed of area "G" is terminated on its north-east and southwest ends by basic dikes, and the magnetic readings do not indicate that it can be extended beyond the area of surface exposures. Assuming that this ore body extends to a depth of 100 feet below its lowest exposure, it will contain about 29,000 tons of ore. However, some form of development work must be done to prove even a 100-foot depth.

From these estimated tonnage figures it can be seen that there are possibly between 1,500,000 and 2,000,000 tons of ore in the thick fine-grained iron beds with by far the largest tonnage being confined to the large ore bed of area "A". 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.

LIST OF PUBLICATIONS

Division of Geology

HAROLD E. CULVER, Supervisor

PULLMAN, WASHINGTON

The following publications are distributed, for the prices indicated, from Olympia, Washington. Money orders or checks should be made payable to the Department of Conservation and Development and sent with the order to that office, Olympia. Stamps are not accepted.

Publications marked with an asterisk (*) are no longer available for distribution but may be consulted in the larger libraries.

Publications issued by the first State Geologist, 1890-1892; by the Washington Geological Survey, 1901-1921, and by the Division of Geology, 1921-.....

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- *Annual Report of First State Geologist, 1890: Mines and minerals of Washington, by George A. Bethune, 1891. 122 pp. Free.
- *Second Annual Report of First State Geologist: Mines and minerals of Washington, by George A. Bethune, 1892. 187 pp. Free.
- *Volume 1. Annual Report for 1901. 6 parts.
 - *Part 1. Creation of a State Geological Survey and An outline of the geology of Washington, by Henry Landes. 1902. 33 pp. 5 pl. Free.
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- *Volume 2. Annual report for 1902. 1903. 277 pp. 23 pl. Free.
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 - *Part 2. Coal deposits of Washington, by Henry Landes and C. A. Ruddy, pp. 167-277, pl. 23.

BULLETINS

Separate geologic maps indicated in parentheses.

1. Geology and ore deposits of Republic mining district, by Joseph B. Umpleby. 1910. 67 pp. 13 pl. 50¢.
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- *17. A geographic dictionary of Washington, by Henry Landes. 1917. 346 pp. 10 pl. \$1.00.
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- *25. The magnesite deposits of Washington, their occurrence and technology, by George Whitwell and Ernest N. Patty. 1921. 194 pp. 13 pl. \$1.00.
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- *30. The mineral resources of Washington, with statistics for 1922, by Solon Shedd, with an article on coal and coke by George W. Evans. 1924. 224 pp. \$1.00.
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32. Geology of Washington, by Harold E. Culver.
 - Part I. General features of Washington geology (with preliminary geologic map in colors.) 1936. 70 pp. \$1.00.
 - Part II. Index to the stratigraphy of Washington. In preparation.
33. Nonmetallic mineral resources of Washington, with statistics for 1933, by Sheldon L. Glover. 1936. 135 pp. 75¢.
34. Tungsten resources of Washington. In preparation.
35. Bibliography and index of geology and mineral resources of Washington, by W. A. G. Bennett. 1939. 140 pp. 75¢.
36. Chromite resources of Washington. In preparation.
37. Magnesite and dolomite resources of Washington. In preparation.

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- *1. Abstract of the report by Solon Shedd on the geology and resources of the Pasco and Prosser quadrangles, by Harold E. Culver. 1926. 4 pp. (Mimeographed.) (1 map.) 25¢.

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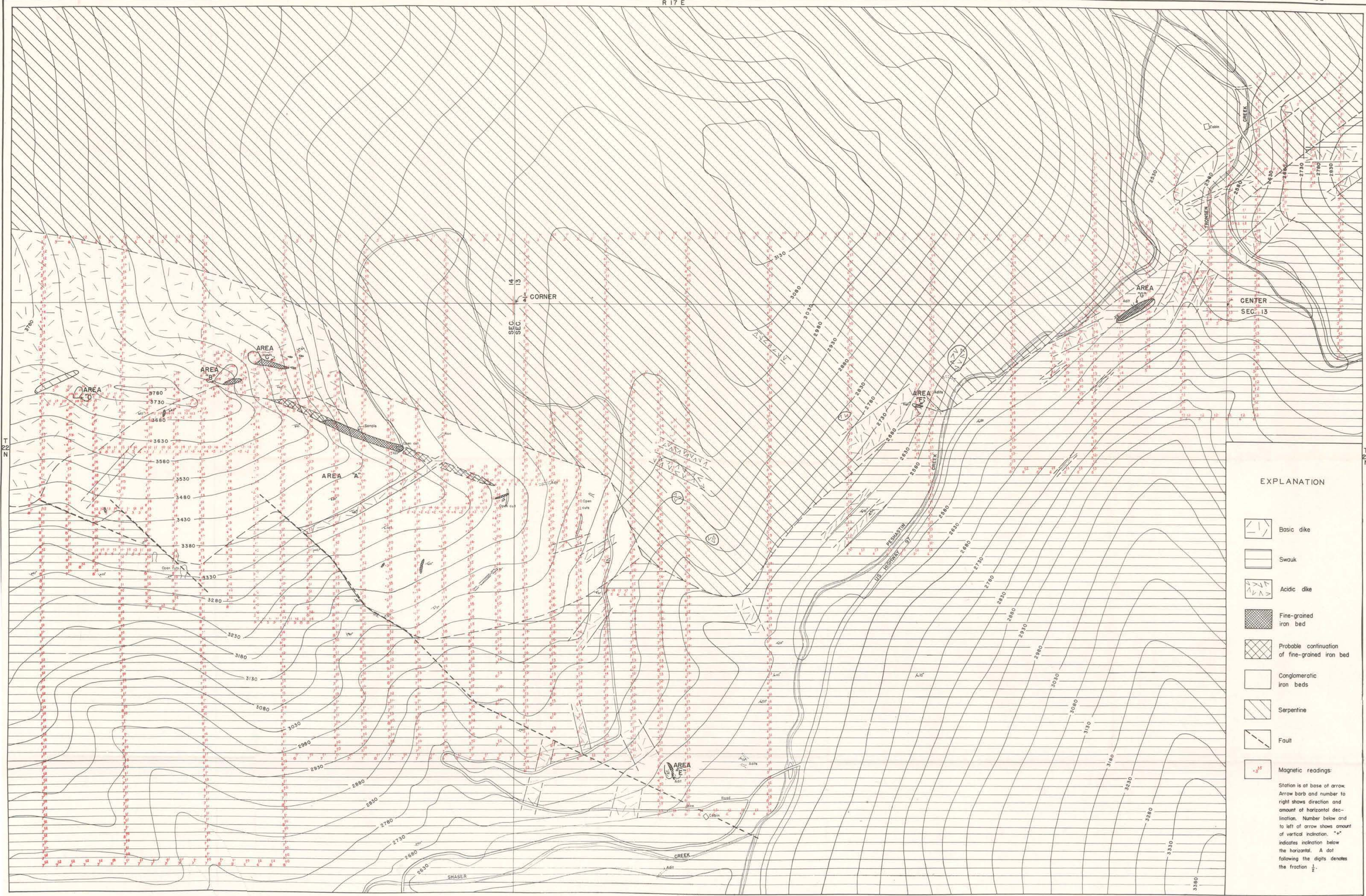
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








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R 17 E



EXPLANATION

-  Basic dike
-  Swalk
-  Acidic dike
-  Fine-grained iron bed
-  Probable continuation of fine-grained iron bed
-  Conglomeratic iron beds
-  Serpentine
-  Fault
-  Magnetic readings:
 Station is at base of arrow.
 Arrow barb and number to right shows direction and amount of horizontal declination. Number below and to left of arrow shows amount of vertical inclination. "+" indicates inclination below the horizontal. A dot following the digits denotes the fraction $\frac{1}{2}$.

ELEV. DATUM: BM U.S.C.G.S.

R 17 E

GEOLOGY BY W. A. BROUGHTON

GEOLOGIC MAP OF THE BLEWETT IRON DEPOSIT
 CHELAN COUNTY, WASHINGTON
 SHOWING MAGNETIC DATA

