

IRON-ORE DEPOSITS NEAR STANFORD, MONTANA.

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LOCATION.

The iron ores known as the Running Wolf hematite deposits are in Cascade and Fergus counties, in central Montana, on Running Wolf and Dry Wolf creeks, 12 miles southwest of Stanford, on the Great

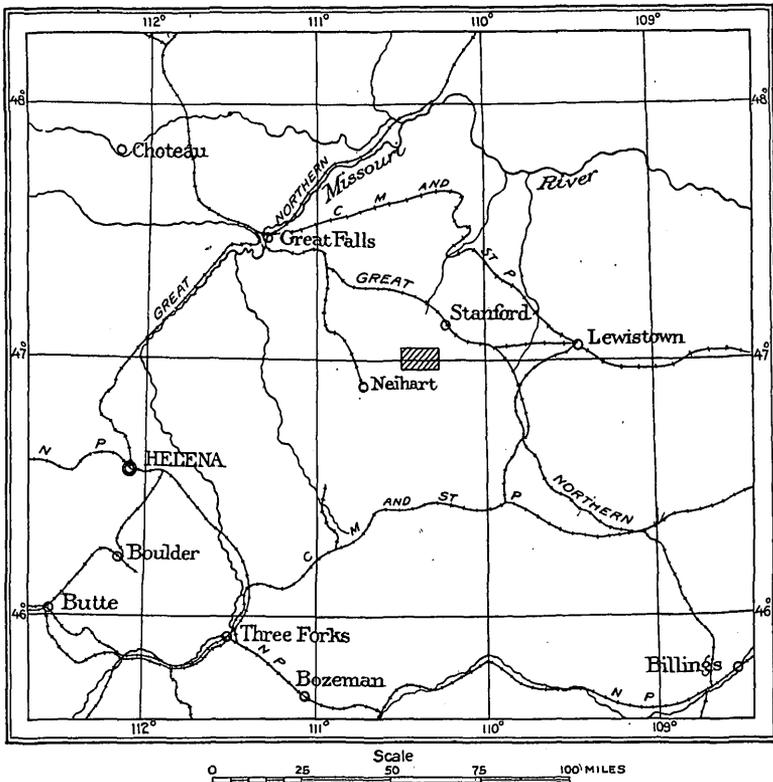


FIGURE 8.—Map of a part of north-central Montana showing the location of the hematite deposits near Stanford.

Northern Railway, and about 54 miles southeast of Great Falls. (See fig. 8.) They lie just within the northern border of the Little Belt Mountains, in an area where the altitudes range from 5,200 feet at stream level to 7,000 or even 8,000 feet on the adjoining summits. The outcrops of the ore cross hill and valley and show variations in height nearly equal to those of the surface.

ACKNOWLEDGMENTS.

The deposits were visited by the writer August 27 and 28, 1918. It is a pleasure to acknowledge the aid of Mr. Paris Gibson, of Great Falls, chief owner of the claims, who lent reports and plans, and of Mr. Frank C. Whittaker, of Stanford, who showed the writer over the property.

GENERAL GEOLOGY.

The broader geologic features of the region have been described by Weed.¹ A great series of sedimentary rocks, ranging in age from Algonkian to Cretaceous, here rests unconformably upon Archean

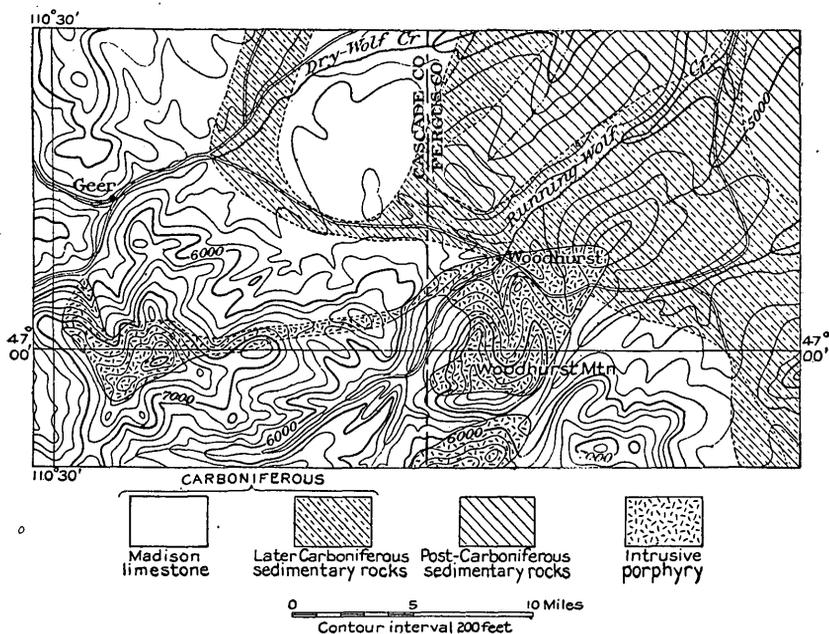


FIGURE 9.—Geologic map of the vicinity of the hematite deposits near Stanford, Mont.

granite and gneiss. The belt series, comprising the Algonkian rocks of the region, thus belongs above the great unconformity near the base of the section. Folding and some faulting took place at the end of Cretaceous time. Intrusions of igneous rocks accompanied or followed the mountain making. Subsequent erosion has laid bare the Paleozoic and older rocks and the igneous intrusions in the Little Belt Mountains.

The deposits, which are essentially hematite, occur in the Madison limestone (Carboniferous), at the contact with intrusive porphyry. Two bodies of porphyry are shown on the map (fig. 9)—the larger one on Woodhurst Mountain, the other 4 miles west, on Dry Wolf Creek.

¹ Weed, W. H., U. S. Geol. Survey Geol. Atlas, Fort Benton folio (No. 55), 1899; Little Belt Mountains folio (No. 56), 1899.

It is likely that they are nearly if not quite connected by dike-like masses. The rock of the western body is described by Weed as a diorite porphyry, and that of the eastern body as a syenite porphyry. Near the hematite the larger body is nonporphyritic except toward the border, where there are local porphyritic facies. It is a medium-grained rock, probably equivalent to monzonite in composition, and shows orthoclase and a little plagioclase feldspar and crystals of biotite and hornblende. On some of the eastern claims the border facies is a white nonporphyritic aplitic rock. Both bodies will be referred to as porphyry.

The Madison limestone is a blue-gray, well-bedded, and in places rather thinly banded limestone with gentle dips, mainly to the east in the small area under consideration. Here and there, especially about the Woodhurst stock, the limestone is a fine-grained yellow marbled rock.

MODE OF OCCURRENCE OF THE HEMATITE.

Figure 10 shows the location of the claims. Beginning on the southeast, they follow the south and then the west side of the Woodhurst Mountain porphyry intrusion. Then crossing Running Wolf Creek they follow the dike connection over the mountain to the western body and continue along the northern and eastern contacts of this body down to Dry Wolf Creek. The following notes on the claims give an idea of the character of the ore body and the degree of development. The numbers and names of the claims can be identified on figure 10.

The ore body does not show on the Willow Creek claim (1).

Stripping has shown steel-gray solid hematite in a body as much as 8 feet in width on the Geroux claim (2). Ore shows in a pit to a depth of 20 feet. It is fractured and broken at the top but becomes solid and massive within a few feet. No limonite occurs. Yellow limestone is found south of the ore body. (See analysis 17, p. 91.)

The width of the ore on the Iron Crown claim (3) is 35 feet. Yellow fractured limestone occurs on the south. (See analysis 18, p. 91.)

Over 40 feet of ore is shown in a cross trench on the Iron Cross claim (4). The ore is a fine-grained gray hematite, with minute specks of cleavable hematite. (See analysis 19, p. 91.)

No ore shows at the surface on the Iron Mountain claim (5). A shaft sunk on the contact reached a wedge of ore at a depth of 18 feet, and this had widened to 5 feet at the bottom of the shaft, 3 feet farther down. The ore is fine-grained specular hematite, somewhat rusty.

The highest point of the ore body on Woodhurst Mountain is on the Lookout claim (7). A 37-foot shaft disclosed ore at a depth of 33 feet and followed the top of the ore 12 feet across the ore body

from the porphyry. The ore is red granular hematite, stained with limonite. The adjoining limestone is cream-white and finely crystalline.

A cut at the southwest end of the Le Roi claim (8) shows no ore. To the east ore is reported at a depth of 25 feet.

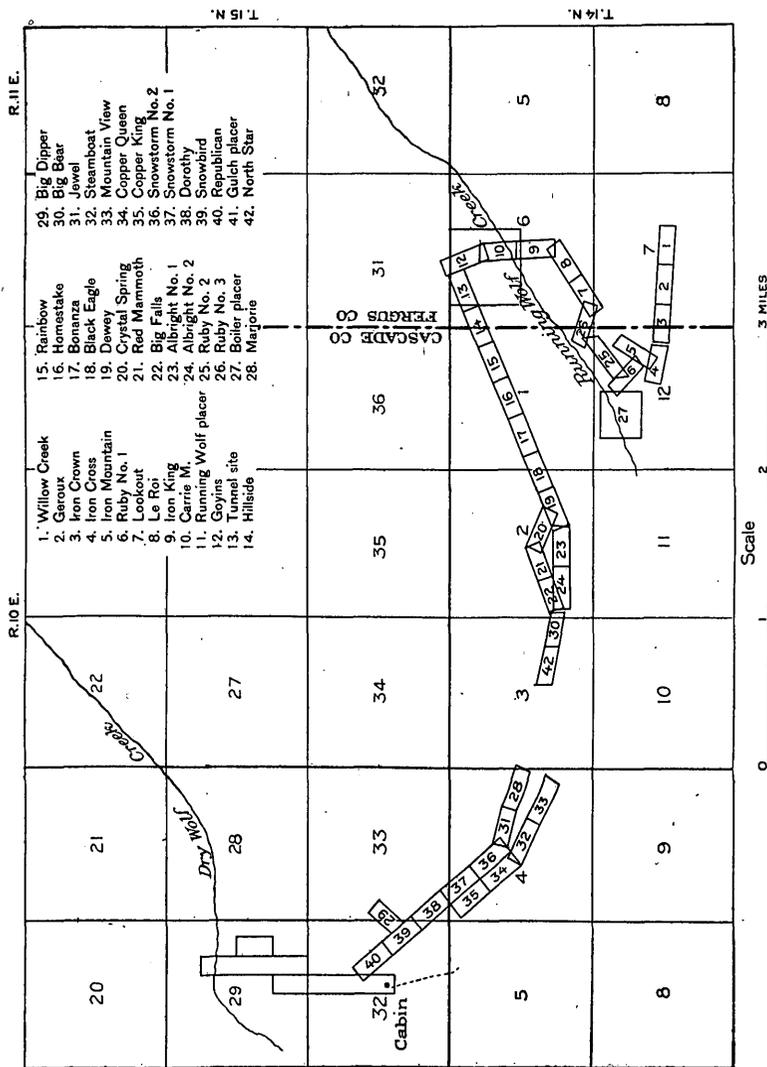


FIGURE 10.—Map showing claims on the hematite deposits near Stanford, Mont.

From the Iron Mountain (5) to the Iron King (9) through the Lookout (7) and Le Roi (8) claims little ore shows. On the Iron King claim the contact between porphyry on the north and limestone on the south trends N. 70° W. The limestone shows a strike of N. 60° E. and a dip of 30° NW. and so is cut across by the porphyry and likewise by the hematite body, which is here 50 feet wide. At one prospect the contact of ore and limestone is fairly

sharp, rather even, and nearly vertical. The ore, where in contact with limestone, shows a banding parallel to the bedding of the limestone, indicating clearly that the ore is a replacement deposit in the limestone. A very little ore runs out beyond the general contact between limestone and ore along bedding planes into the limestone. A second prospect 50 feet lower shows at the surface some interbedded lean ore or "rock," which is reported to disappear in depth, giving place to solid ore. The ore at these openings is in part fine-grained hematite, in part medium-coarse crystalline hematite. (See analysis 20, p. 91.)

At the east end of the Albright No. 1 claim (23) the top of the ore body is 18 feet below the surface and is 12 feet wide. About 300 feet farther west 26 feet of ore is reported next to the porphyry, which at the surface is soft and weathered. The ore is a fine-grained gray and red hematite, with considerable disseminated calcite.

A trench on the Albright No. 2 claim (24) shows a width of 50 to 60 feet of ore with cream-white limestone on the south and porphyry on the north. The contacts of the ore and the adjacent rock do not show. The ravines down the slope to the north are reported to contain boulders of fine-grained black hematite.

The work done on the east-west line of claims west of the point where the vein crosses Running Wolf Creek has been sufficient to show the continuity of the porphyry westward to the end of this series of claims, but ore appears only at intervals. On the Bonanza claim (17) ore occurs 350 feet north of the main body, probably on a second parallel porphyry dike. Ore is shown also in a shaft on the Dewey claim (19).

Near the west end of the claims they form a double series. Claims 28, 31, 36, 37, and 38 follow the main ore body. Claims 32, 33, 34, and 35 follow a body at the contact with a second porphyry dike to the south, which joins the main ore body in the Dorothy claim (38).

Ore 4 feet wide is shown on the Snowstorm No. 2 claim (36). The contact between the porphyry and the ore and limestone is sharp and not uneven, but there is a more gradual transition and an interfingering between the ore and the limestone, and hematite occurs irregularly in the limestone.

The ore body is 27 feet wide on the Dorothy claim (38).

On the Copper King claim (35) the ore is banded with rock at the surface but is reported to pass into solid hematite at a depth of 15 feet. This is a parallel ore body and dike to that on Snowstorm No. 2. Boulders of ore are found uphill to the south, so that still another body exists in that direction.

Two shafts, 50 and 30 feet deep, are in ore to the bottom on the Snowbird claim (39). The main ore body is shown in figure 11.

The ore body at the surface is 26 feet wide; at a depth of 50 feet it is 32 feet wide. At a second locality 130 feet lower, to the northwest, a shaft went down 37 feet in ore.

A tunnel at the lower end of the Snowbird claim cuts the main ore body at a distance of 125 feet below the surface. It was inaccessible at the time of visit, but the ore is reported to have a width at this depth of 16 feet. The ore on the dump, which probably came from the main vein, is a dense, fine-grained gray hematite, with small irregular cavities due to the removal of materials by solution. The hematite contains enough disseminated magnetite to be attracted by the magnet, and some specimens show small crystals of magnetite. Other specimens show small irregular masses of pyrite in the hematite, and blocks stained by malachite can be found.

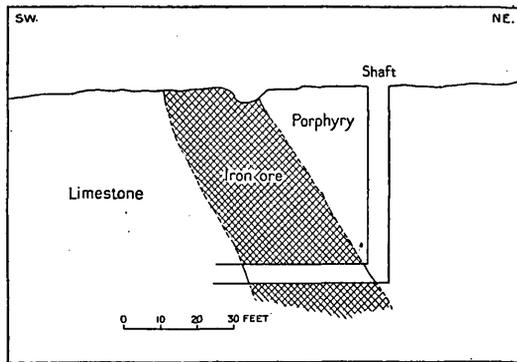


FIGURE 11.—Section of the ore body on the Snowbird claim, near Stanford, Mont.

There is no ore at the surface in the Republican claim (40), but ore is reached at a depth of about 25 feet.

FEATURES OF THE ORE BODY.

The main facts of the occurrence and character of the ore and the associated rocks are as follows:

1. The iron ore occurs in tabular bodies at the contact of the porphyry and the Madison limestone. The ore bodies range in width from 5 to 60 feet and average about 20 feet.
2. The ore is the result of the replacement of the limestone, as shown by its much more uneven contact surface against the limestone and by the retention here and there in the ore body of the banding of the limestone and of parts of the limestone itself.
3. Where the contact is inclined the hematite is more commonly found where the limestone is the footwall.
4. The ore is a compact gray or reddish-gray hematite. It contains in places enough magnetite to make it react to the magnet. It

is not to any large degree limonitic at the surface. At the one point where any considerable depth has been reached (125 feet, on the Snowbird claim) the ore contains a little pyrite and chalcopyrite.

The limestone at the contact with the porphyry is usually altered to a yellowish, finely crystalline marble. No contact silicates were seen except a small amount of wollastonite in the rock taken from the tunnel on the Snowbird claim.

Analyses of hematite ores from deposits near Stanford, Mont.

Analysis No.	Claim and map No.	Iron.	Phosphorus.	Silica.	Sulphur.	Lime.
1	Iron Crown (3) and Iron Cross (4).....	66.05	0.015	1.90	.....	.....
2		65.01	.014	3.90	.....	.....
3		64.00	.0028	6.50	.....	.....
4		65.50	.0028	4.20	.....	.....
5		64.30	.005	5.90	.....	.....
6		65.30	.006	5.53	.....	.....
7		64.00	.014	6.10	.....	.....
8	Snowbird (39).....	67.90	.0028	2.80	.....	.....
9	do.....	65.60	.0	2.50	.....	.....
10	do.....	66.20	Trace.	2.20	.....	.....
11	Iron Mountain (5).....	64.20	Trace.	4.20	.....	.....
12	Iron King (9).....	66.90	Trace.	2.00	.....	.....
13	Crystal Spring (20).....	63.20	Trace.	5.40	.....	.....
14	Snowbird (39) and Dewey (19).....	64.00	.014	6.10	.....	.....
15	Snowbird (39).....	67.00	.010	4.50	None.	.....
16	do.....	61.50	.010	5.70	None.	.....
17	Geroux (2).....	63.69	.020	6.18	.....	.....
18	Iron Crown (3).....	56.52	.025	5.07	.....	.....
19	Iron Cross (4).....	37.41	.107	3.17	.....	8.87
20	Iron King (9).....	56.51	.021	4.10	.....	.....
21	Carrie M. (10).....	56.00	.019	12.95	.....	.....
22	Dewey (19).....	63.09	.035	5.71	.....	.....
23	Iron King (9).....	53.44	.022	4.55	.....	.....
24	Snowstorm No. 1 (37).....	34.88	.021	3.90	.....	High.
25	Snowbird (39).....	50.14	.026	6.60	.....	.....
26	do.....	58.03	.020	7.86	.....	.....

1-7, 14-16 by Colorado Fuel & Iron Co.; 8-13 by Anaconda Copper Mining Co.; 17-26 by Dwight E. Woodbridge, Duluth, Minn.

Analyses 1 to 16 seem to have been made on selected specimens of better ore. Nos. 17 to 26 were made on samples taken by Mr. Woodbridge and are probably more nearly average analyses of the ore. Nos. 19 and 24 were made on samples taken near the limestone and show a large amount of lime and less iron. The phosphorus content is small, in many samples unusually small, and in nearly all of them well below the phosphorus limit for Bessemer ores. No sulphides were seen in the ores, and, except in Nos. 15 and 16, no tests for sulphur were made. Mineralogically the ores are entirely satisfactory for steel manufacture.

QUANTITY OF ORE.

Development work has not gone far enough to make possible any estimate of the quantity of ore that can be mined. At the surface the ore body is of varying width, reaching a maximum of 50 feet. As it is a contact deposit in limestone, it will vary in dimensions from place to place according to the character and course of the solutions

at work. It is more likely to show a series of lenses than a single continuous vein. The depth to which the ore extends below the surface is unknown. The greatest depth shown in any opening is 125 feet, on the Snowbird claim. Here a little pyrite is present. Whether the hematite is succeeded in depth by sulphides, and if so, at what depth, is unknown. Exploration has been made almost wholly by shallow surface trenches and pits and by shafts put down only far enough to prove the presence of ore. Further development, possibly by diamond drilling, is necessary in order to show how much ore is present.

The best showing for thickness and apparent continuity is at the east end of the property, on claims 2 to 5. Here for a length of 3,000 feet a good body of ore occurs. The average thickness at the surface is 25 feet. With an assumed depth of 100 feet, there would be approximately 1,000,000 gross tons of ore on claims 2 to 5.

Ore is exposed at points along the middle of the belt, but no estimate of tonnage can be attempted here.

At the west end showings are better. Ore appears at intervals through a distance of nearly a mile, and the average of the thickness of the ore body in the different openings is 20 feet. On the assumptions of a continuous body (which may not be present), a depth of 100 feet, and a distance of 5,000 feet, there would be approximately 1,340,000 gross tons of ore in the western group of claims.

These estimates are suggestive only. Development may well reveal ore in much larger amounts.

The present availability of this ore depends on several factors which can not be considered in this paper, such as the cost of transportation to central and eastern manufacturing points and the possibility of economic production of iron in the near-by Rocky Mountain region.