IRON DEPOSIT NEAR ATLANTIC CITY, WYOMING

by Ralph H. King
Consulting Geologist

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ABSTRACT

A hill of siliceous iron ore about 4½ miles north of Atlantic City, in Section 26, T. 30 N., R. 100 W., Fremont County, Wyoming, is estimated to contain 73,000,000 tons of rock averaging 35.18% Fe. The deposit lies near the southeast end of the Wind River Mountains at an altitude of 8100 - 8600 feet and is one-half mile from the Lander-Rock Springs highway and 28 miles from Lander.

The iron-bearing rock is a metamorphosed sediment dipping in general about 85° east. It is cut by several dikes of diorite and related igneous rocks, and parts of the deposit have been displaced with respect to each other by faulting.

The topography and structure favor open-pit mining at some future date. At present the cost of beneficiation and of transportation to distant markets seems prohibitive.

INTRODUCTION

An iron deposit near Atlantic City, Wyoming, was studied to determine the structure and the grade and amount of reserves. An area approximately one-half mile by three-fourths mile, situated in Section 26, T. 30 N., R. 100 W., was mapped by plane table on a scale of 1:2400. Chip samples numbered 1 to 25 were collected at 2-foot or 3½-foot intervals over a total of 1938 feet. Glen L. Faulkner assisted in the work of mapping and sampling, which was begun July 5 and completed August 13, 1949. The illustrations were prepared and the report written in September and October 1949.

Aerial photographs of the area on a scale of 1:48000, were examined in the Lander office of the U. S. Geological Survey. H. G. Fisk, Director of the University of Wyoming Natural Resources Research Institute, visited the area and made the photographs, and also supervised the analytical work.

*Consulting Geologist

GENERAL GEOLOGY

Physiography

The iron ore constitutes the backbone of an elongate hill or short ridge 500 feet high trending generally north between two permanent streams, Rock Creek on the west and Beaver Creek on the east. Rock Creek flows southward into Sweetwater River, which flows eastward around the south end of the Wind River Mountains, whereas Beaver Creek flows southeast, east, and finally northeast into the Popo Agie-Wind-Big Horn River system.

The surrounding area is characterized by high but rounded hills of metamorphic rocks. These contrast with the higher angular granite peaks farther northwest and with the elongate hogbacks of sedimentary rocks farther east, which dip 15^{o} to 20^{o} northeastward.

The newly completed Rock Springs-Lander highway passes through Section 26, in which the mapped area is located, and a trail passable by automobile runs from this highway northwestward across the deposit.

Much of the surface is covered by slump and rocky soil, which supports a fair stand of grass and sage and a few trees, chiefly small pine and aspen.

Stratigraphy

Seemingly no names have been applied to the pre-Cambrian rocks exposed in the southeastern part of the Wind River Mountains, and the present project was too restricted to justify any attempt to establish stratigraphic units. The rocks have been folded, faulted, and metamorphosed to such an extent that considerable detailed mapping would be prerequisite to stratigraphic classification.

In the field a prominent quartzite 30 to 50 feet thick was regarded as the metamorphosed basal sandstone member of the stratigraphic sequence that includes the iron schist. It is overlain by a few hundred feet of shales that have been metamorphosed to schists of various kinds, chiefly chloritic, micaceous, and amphibolite schists. The thickness and character of these rocks are difficult to determine, because of lack of exposures and complexity of structure. These sediments are overlain by 35 to 50 feet of interbedded iron schist and non-iron schist, chiefly chloritic. The chloritic schists are progressively thinner and farther apart toward the top of this unit, as the iron schists are thicker and closer together. These alternating beds are a transition from non-iron schist to iron schist. The iron schist is at least 350 feet thick and consists of iron oxide and silica, so might be termed a quartzite schist. Thickness of individual layers of ferruginous and non-ferruginous silica ranges from paper thin to about one inch, but is mostly about one-sixteenth inch. Locally the thickness of the iron schist beds is increased by folding in tight pleats. Additional details are included in the discussion of the iron ore. Overlying the iron schist is an unknown thickness of non-iron schist, seemingly micaceous schist and some cloritic schist.

Igneous Rocks

The granite core of the Wind River range lies northwest of the area studied, and is of indirect significance, inasmuch as the metamorphism and distortion of the iron schist and associated rocks resulted from, or at least were intensified by, the intrusion of the granite.

Within the mapped area the igneous rocks consist of numerous parallel dikes, 2 to 20 feet thick, composed of diorite or related rocks which weather to angular blocks. Their color on fresh fractures ranges from medium dark green to greenish black, although weathered surfaces are almost black. In general, dikes only two or three feet thick are fine grained and thicker dikes are somewhat coarser, grain size approaching one-quarter inch. A few nodules of incompletely assimilated country rock were noted in the mass south of C' (see map). The igneous rocks cut the bedding of the iron schist, hence are intrusive rather than extrusive. A sub-schistose texture was noted in some places, implying that the dikes were intruded prior to the final stage of metamorphism, so they may be related to the granitic intrusion farther northwest.

Structure

Folds - If the stratigraphic sequence is correctly interpreted, the major structure of the area mapped is a broad shallow syncline dipping about 80° slightly south of east. This attitude is markedly inconsistent with the general regional pattern of tight east-west folds characteristic of the metamorphic rocks exposed in the area, but the structure is shown clearly by the iron schist, and confirmed by the quartzite farther northwestward, which was not mapped.

Minor folds in the iron schist north of the access road at the north edge of the map were not studied in detail, but they indicate that the area to the north is more complexly folded. There is a definite evidence of overturning of beds, but because of inability to distinguish the top and bottom of beds, no overturning was indicated by map symbol. There is a minor drag fold just north of F, near the southwest corner of the map. In the area between D and F much of the iron schist is wrinkled into tightly pleated folds several times higher than wide and only a few feet in maximum height.

Folding in the non-iron schist was not studied, as bedding planes are no longer discernable. The map symbols indicating dip and strike of schistosity in these beds suggest some minor folding, but it could not be verified in the time available.

Faults - Some evidence of faulting was noted in the field and additional indications were observed on the aerial photographs. Faults thus known to exist are shown by solid lines on the map. In addition, some anomalous relationships seem to be explainable only on the assumption that there are unexposed faults. These inferred faults are shown by dashed lines on the map. The underground position and attitude of all the faults are inferred, so they are indicated by dashed lines on the structure sections.

The faults trending northeast from the southwest part of the map are roughly parallel to each other and to the dikes, suggesting that a system of joints now unrecognizable governed the flow of the intrusive rock and also the movement of the solid rock. In fact, there seems to have been both intrusion and movement along one such plane just north of E. Movement along these faults may therefore have preceded or accompanied the metamorphic action that obliterated the joint pattern, prior to Cambrian time.

The curving trace shown between C-C' and D-D' is believed to represent a thrust fault. The movement may have been as recent as the post-Cretaceous uplift of the Wind River Mountains.

The southeast-trending fault shown at the north edge of the map was observed on the aerial photographs. It was traceable for several hundred yards in a straight line across Tertiary sediments as well as pre-Cambrian metamorphic rocks. It is therefore a relatively recent fault or an old fault recently reactivated.

IRON ORE

Occurrence and Distribution

The iron occurs as iron oxide disseminated in a siliceous sediment that has been metamorphosed to a schist. The ore body is regarded as a sedimentary rock. As such it constitutes one member of an extensive sequence of sediments deposited in pre-Cambrian time, then cut by intrusive rocks, metamorphosed, and complexly folded and faulted. These rocks were subsequently covered by Cambrian and younger sediments, and have been only partly exposed by erosion since the uplifting of the Wind River Mountains. The iron ore is exposed only near the northeast tip of the present outcrop.

The ore body seems to thin to a feather edge within a half mile west of Rock Creek, southwest of the mapped area. Northeastward it continues in dense timber from the mapped area to the valley of Beaver Creek, a distance of perhaps a half mile. East of Beaver Creek valley the metamorphic rocks are covered by Cambrian and younger sediments.

Lithology

The iron-bearing rock is composed of silica impregnated with iron oxide. It is thin bedded to laminated, the thickest beds being about one inch thick. The color contrast between adjacent beds implies an appreciable variation in the iron content of the beds or laminae. The iron oxide and silica are intimately intermixed, as is indicated by the fact that ordinary fine grinding is inadequate preparation of a sample for analysis. For satisfactory results the sample to be analyzed must be ground to an impalpable powder.

Some of the silica shows evidence, in the form of incompletely fused grains, that it was originally a fine sand or coarse silt.

Origin

The siliceous rock that contains the iron was deposited as alternating laminae or thin beds of silt and fine sand, then metamorphosed to a quartzitic, schistose rock. That the iron oxide was deposited contemporaneously with the silica seems probable, as other similar sediments are known. It is possible that the iron oxide was introduced after deposition, possibly contemporaneously with the intrusion of the dike rocks or of the nearby granite, and if so, it would enter the more permeable silt and sand rather than the adjacent shales. Under this hypothesis, however, the lack of iron in the quartzite farther west is inexplicable.

The small particles, the thinness of the bedding, and the thickness of the member as a whole suggest slow deposition in deep still water. It follows that the original deposit was fairly extensive. Therefore the deposit is not likely to pinch out underground, although it may be considerably displaced by faulting.

Method of Sampling

All samples were collected from surface exposures. Where the strata were undistorted, chips of approximately equal size (about the size of a walnut) were collected at intervals of 2 feet along a line perpendicular to the strike of the beds. If the rock at a sampling point was covered with soil or slump a sample was collected as near the line as possible and from the same bed, as well as could be determined. If the rock was concealed for an appreciable distance, the samples were collected from the nearest exposure, and along a line parallel to the original line of sample. Where the strata were distorted, chips were collected at 3½ foot intervals along a line perpendicular to the general trend of the exposure.

A possible defect in the method is obvious. Where exposures are poor and discontinuous there is a tendency to sample the most resistant part of each bed, which may not be representative of the ore in that bed. For this particular deposit, however, this possible source of error is not believed to be important, because the variation along bedding is insignificant in comparison with the variation from one bed to another,

Chemical Analyses

Each sample was ground and thoroughly mixed. The portion to be analysed was then powdered, before fusion and analysis, to insure complete separation of the iron oxide from the silica.

The lines along which the samples were collected are shown on the map by dashed lines, accompanied by the sample number. Results of the analyses follow:

Table I. Chemical analyses of samples of iron ore collected in Sec. 26, T. 30N., R. 100 W., Fremont County, Wyoming, about 4½ miles north of Atlantic City.

Sample No.	Thickness Sampled, ft.	Sampling Interval, ft.	Iron Content % Fe
1	54	2	39.74
2	121	2	39.45
3	45	2	31.80
4	91	2	32.75
5	55	2	33.90
6	9	1	27.60
7	212	2	35.45
8	36	2	38.00
9	70	2	36.30
10	70	2	37.68
11	96	2	35.55
12	102	3½	37.52
13	138	3½	33.40
14	50	2	40.60
15	36	2	29.65
16	32	2	30.95
17	86	2	34.30
18	178	2	24.50
19	71	2	37.20
20	58	2	34.10
21	104	2	31.05
22	67	3½	34.50
23	36	2	36.65
24	71	2	31.85
25	50	2	27.60
	Total 1938	Weighted average	33.99
		Omitting Block F, Nos. 15 - 18	35.18

Reserves

Indicated reserves are computed on the basis of 8 cubic feet per ton, which may be somewhat low, considering the grade of the ore, but the chance for error because of uncertainties as to the grade at depth and the underground extent of the ore body far outweighs any error in the tonnage factor. No allowance has been made for the small amounts of dike rock.

Separate estimates are presented for blocks defined as follows:

Block B - Limited by the boundary of the iron schist on the northwest and southeast, by the assumed fault south of Section B-B', and by the known and assumed faults northeast of Section B-B'. All these faults are assumed to be vertical.

Block C - Limited by the boundary of the iron schist on the northwest and southeast, by the assumed fault northeast of Section C-C', and by the vertical projection of the curving surface trace of the inclined fault south of section C-C'.

Block D - Limited by the boundary of t he iron schist on the west and east sides, by the vertical projection of the curving surface trace of the inclined fault north of Section D-D' and by the presumably vertical fault that cuts section F-F' about 100 feet southeast of F and section E-E' about 200 feet east southeast of its intersection with section A-A'.

Block E - Limited by the boundary of the iron schist on the west and east sides, by the presumably vertical fault southeast of the diorite mass around D', and by the slightly inclined fault that cuts section E-E' at E'.

Block F - Not fully defined; cut by numerous dikes; ore of low grade; most of the block lies below the 8360-foot contour along section F-F'. Partly limited by the slightly inclined fault that cuts section F-F' at its intersection with section A-A' and by the presumably vertical fault that cuts section F-F' at F'.

Reserves are computed for that part of each block lying above an altitude of 8300 feet and separately for each additionat 100 feet of depth. These estimates are presented in the following table:

Table II. Estimate of reserves of iron ore in part of Sec. 26, T. 30 N., R. 100 W., Fremont County, Wyoming, about 4½ miles north of Atlantic City.

Block	Sample Nos.	Weighted Average Grade, % Fe	Ore Above 8300' elev., 2000-lb.Tons	Additional Per 100' Depth Below 8300',2000-lb. Tons
B	19,20	35.81	7,500,000	3,000,000
C	1,2,3,4, 5,6,21	34.81	12,500,000	4,500,000
D	7,8,9,10,11, 12,22,23,24, 25	35.28	12,500,000	6,000,000
E	13,14	35.31	4,500,000	4,500,000
F	15,16,17,18	28.22	1,500,000*	2,500,000
Total above 8100 ft. elevation, excluding F				73,000,000

*Above 8200 ft. elevation.

Mining Conditions

The structure and topography of the deposit seem to favor open-pit mining, starting on top of the ridge, preferably in Block C. For several years of operation the overburden would be negligable, although ultimately the barren rock at the sides of the pit would have to be cut back for safety. There is relatively little waste rock on the west slope,and it dips toward the ore, so might stand, but the east side would require considerable waste removal. In the long run, it might be burdensome. Possibly the final total cost of an underground operation by block caving would be less, although initial cost would be greater.

The dike rocks seem to be sufficiently uniform and sufficiently distinct from the iron-bearing rock to permit mining them separately for removal to the waste pile. The cost of this procedure is believed to be much less than the cost of crushing and processing this barren material.

The faulting of the iron schist is not likely to have any serious effect on open-pit operations, but might cause trouble in underground operations.

Variation in the grade of the ore is insufficient to warrant any attempt at selective mining, except that Block F may be excluded. There is some suggestion that the grade is somewhat better in the western part of the deposit, but the difference is slight, and far from consistent.

Access to the deposit is provided by the newly completed Lander-Rock Springs (or Farson) highway, which passes within a half mile, and a trail that would require very little work to make it passable for trucks. Another trail, not shown on the map, follows the valley of Rock Creek almost to Block F, and could be extended at small cost if needed. The haul of 28 miles to the railroad at Lander is mostly down grade, the elevation at Lander being about 5350 feet, in comparison with 8100-8600 feet at the deposit.

Both Rock Creek and Beaver Creek are permanent streams, but whether any water rights remain unappropriated is not known.

The deposit lies within the Shoshone National Forest. Present status of old mining claims should be investigated.

COMMENTS CONCERNING "IRON DEPOSIT NEAR ATLANTIC CITY, WYOMING"

page 2. Physiography. The sentences are too long and complex. This makes the author's meaning obscure. This is particularly true of the sentence describing the drainage of Rock Creek and Beaver Creek.

page 3. "Locally the thickness ......is increased by folding into tight pleats." I am not sure just what the author means by this term.

line 12."... seemingly micaceous schist,.." A schist is either a mica schist, or it isn't.

para. 3 No statement is made cncerning the mineralogy of the dike rocks.
para. 4 "...the major structure of the area mapped is a broad shallow syncline dipping about 80° ..." I do not know what the dip of a syncline might be. Does the author mean "plunge"? If so, why is a fold plunging 80° slightly south of east inconsistent with a regional pattern of east-west folds?

page 4.
line 4. "There is a definite evidence of overturning of beds..." What is the evidence?

para. 3 "Some evidence of faulting was noted..." What evidence?

page 5. "The iron occurs as iron oxide...." Nowhere does the author state what iron mineral or minerals are present in the ore. This is an important feature from the standpoints of geology and ore treatment. It is a serious ommission.

Much of the material in the first paragraph belongs in the introduction to the paper.
para. 4. "fused grains". The meaning is not clear to me.
para. 5. "...as other similar sediments are known." Location of these sediments should be stated.

page 6.
para. 1. "It follows that the original deposit was fairly extensive. Therefore the deposit is not likely to pinch out underground...." This is true, provided the assumption that the iron was deposited in a sedimentary environment is correct. However, the possiblity that the ore was introduced or concentrated after deposition should not be overlooked. In this case the ore would be controlled by structural features and might not be so extensive.

The illistrations need captions and explanation. The map is not included with the report.

In view of the facts outlined above, I do not recommend publication by the Wyoming Geological Survey, unless the paper is carefully edited and partially rewritten. Many statments need more scientific evidence to support them, and as pointed out above many important facts have been ommitted. The paper has value in presenting data concerning the composition, location, and tonnage of ore.

Frank H. Ostwald

CONCLUSIONS

The ore requires extremely fine grinding and beneficiation, the cost of which, together with the cost of transportation to present distant markets, probably renders operation of the deposit uneconomical. At some future time, however, continued increase in demand for steel in the western states, coupled with the continuation of the trend toward dispersal of industry and advances in the technology of treating taconite ores, may result in establishment of a small market near enough to the deposit and in beneficiation procedures efficient enough to permit profitable exploitation.

Reference

Spencer, A. C. - U.S.G.S. Bulletin 626, "The Atlantic Gold District and the North Laramie Mountains", 1916.