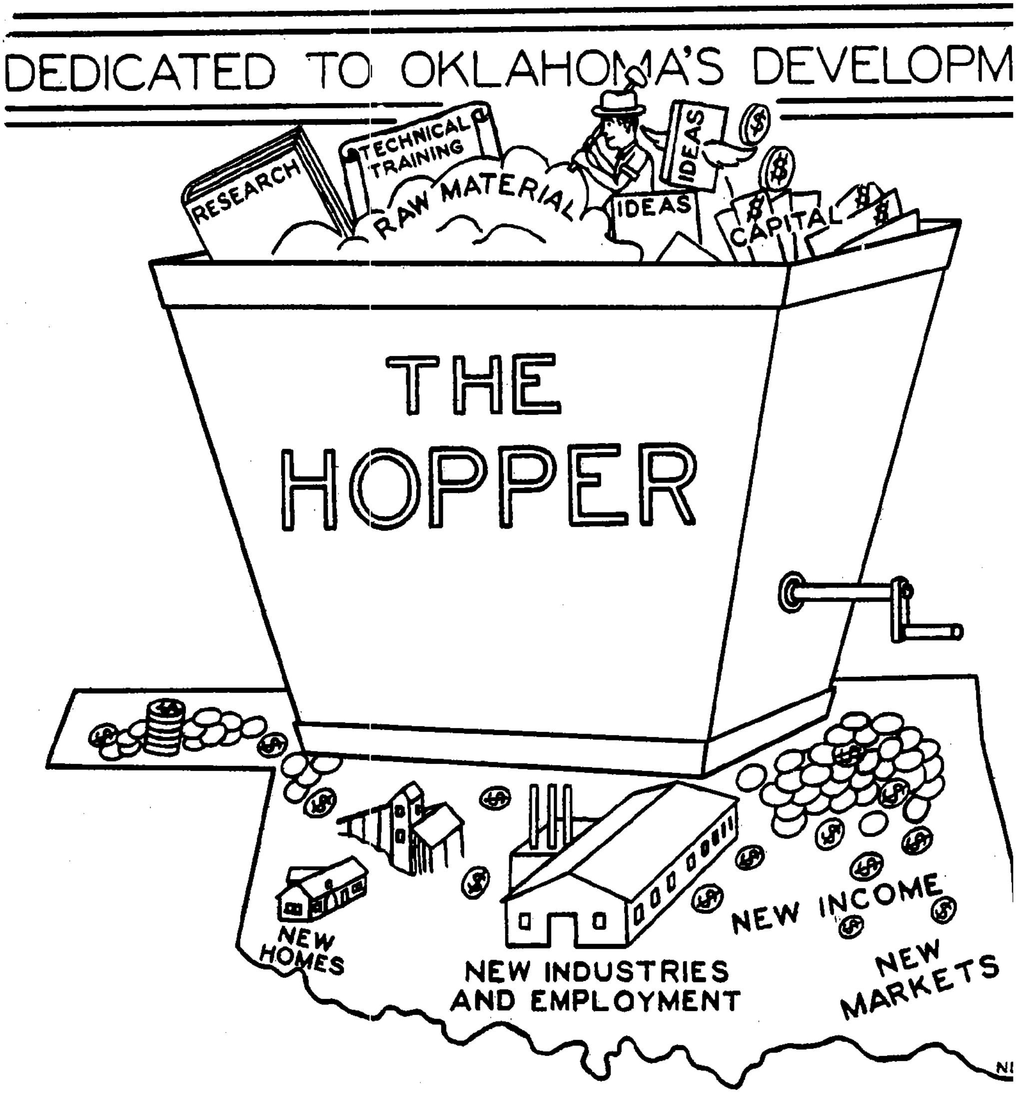

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TITANIFEROUS MAGNETITE IN BASIC ROCKS OF THE WICHITA MOUNTAINS, OKLAHOMA

by

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The occurrence of black sands in the Wichita Mountains has been known since Captain Marcy[1] first reported their presence in 1854. Little interest was shown in these sands until 1939, when Merritt[2] reported on the work done by the W.P.A. in the Wichita Mountains and described the presence of titaniferous magnetite in the basic rocks of the area.

With the increase in demand for titanium dioxide, ilmenite in the titaniferous magnetite has become a potential source of this oxide. With this fact in mind, the Oklahoma Geological Survey began a systematic study of the basic rocks of the Wichita Mountains and their association with titaniferous magnetite.

<u>Location</u>. The Wichita Mountain system in southwestern Oklahoma covers parts of Comanche, Kiowa, and Greer Counties. These mountains have a northwest trend that extends from Lawton in Comanche County, northwestward 65 miles to a short distance west of the city of Granite, in Greer County.

The area described in this paper is in Kiowa and Comanche Counties and is confined to the basic igneous rocks in T. 4 N. and parts of Tps. 3 N. and 5 N., Rs. 16, 17, 18, and part of 15 W.

Topography. The basic rocks occur as a long narrow chain of low, rounded hills surrounded on all but their east side by a flat red-bed plain. These hills disappear westward beneath a cover of red-bed sediments and eastward beneath a range of granite hills. The hills have an average height of 250 feet above the plain and reach their maximum height of 700 to 800 feet in sec. 10, T. 4 N., R. 17 W.

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Rock Types

The basic rocks within this area consist of the following: anorthosite, diallage gabbro, olivine diallage gabbro, troctolite, basic pegmatites, and microdiorite dikes.

Divisions used in the field mapping are as follows: anorthosite 0 to 10 percent mafic minerals, and gabbro 10 to 95 percent mafic minerals determined by the Rosiwal method. The Johannsen classification for naming the subdivision of the gabbro family was followed wherever possible. The composition of plagioclase and mafic minerals was determined in powders using the oil immersion method.

Anorthosite. The anorthosite comprises all the major hills in the area and forms 90 percent of the exposed basic rocks.

The anorthosite ranges from black through gray to nearly white in color and is generally stained light brown by the presence of hematite. The rock is medium-grained with the plagioclase crystals averaging 1.5 mm in length and having a maximum length of 4 cm. In a few places near the base of the hills, the anorthosite is foliated, with linear flow structure being absent or so poorly developed as to be questionable.

Diallage Gabbro. Most of the diallage gabbro exposures are topographically low in relation to the anorthosite and occur in valleys. The gabbro grades into the anorthosite and a zone of foliation, in a few places, marks the gradational phases between the two. In secs. 7, 8, 17, and 18, T. 4 N., R. 15 W., the gabbro is topographically high in relation to the anorthosite of this local area. The gabbro forms the lower part of Mount Baker and is overlain by granite.

In numerous places, the diallage gabbro grades into small irregular bodies of pyroxenite and is usually found in valleys cut in the gabbro.

The gabbro is black in color and has a coarse texture, with the plagioclase feldspar crystals ranging in length from 7 mm to 5 cm. The diallage is black to deep green in color and averages 6 mm in length with a maximum length of 3 cm.

The magnetite and ilmenite are interstitial to the pyroxene and form a maximum of 15 percent of the rock.

Olivine Diallage Gabbro. This gabbro occurs in only two known exposures, one of which is a dike and the other an irregular body that has intruded the anorthosite and diallage gabbro. This gabbro is host to a small dike-like body of magnetite rich in olivine.

This gabbro is dark gray to black and is stained brown from the presence of hematite and goethite. This rock weathers easily and generally the exposures consist of fragments of pyroxene crystals surrounding spheroidal boulder remnants of the original rock.

The brown hornblende occurs in close association with the magnetite as a zone around the magnetite or between the magnetite and labradorite crystals. The magnetite comprises 2 to 14 percent of the rock, increasing downward toward the massive magnetite phase near the base of the gabbro exposure in sec. 14, T. 4 N., R. 17 W.

<u>Troctolite</u>. Gabbro occurs as low hills separated from the main gabbro anorthosite range by flat plains and in only one area is the relationship between troctolite and the other basic rocks clear. This is in secs. 29 and 33, T. 4 N., R. 16 W. where both the olivine diallage gabbro and troctolite cut the diallage gabbro and anorthosite as long, narrow, dike-like bodies.

The troctolite grades from dark to light gray with weathered olivine giving the gray background of the rock a pink spotted appearance. In a few places the rock is foliated and fine-grained. Titanferous magnetite occurs as a zone of numerous, narrow, irregular dikes within the troctolite. At the contact the gabbro is coarse-textured, and grades into country rock of medium-grained texture.

The magnetite and ilmenite occur throughout the gabbro as anhedral crystals some of which appear to have crystallized before the silicates, though a portion of the oxides followed the silicates in crystallization.

<u>Basic Pegmatites</u>. These occur throughout the area as long narrow zones that cut the diallage gabbro, diallage olivine gabbro and anorthosite. These zones are composed almost entirely of huge euhedral crystals of diallage and magnetite.

The crude euhedral magnetite crystals have an average diameter of 1 cm and reach a maximum of 4 cm. Ilmenite is intergrown with the magnetite along the octahedral planes, and these oxides crystallized before or contemporaneously with the diallage.

Microdiorite. Microdiorite dikes cut all the basic rocks in the area and extend unbroken for distances up to 3 miles. They have an average width of 25 feet and strike east-west. In places where the dikes and sills of microdiorite are cut by a granite, hybrid rocks and intrusion breccias occur.

Age Relationships of the Basic Rocks

The age relationships of the basic igneous rocks are summarized as follows:

Younger series:	Microdiorite: Dikes cutting all the gabbroic rocks.
	Magnetite - oliving - pyroxene pegmatites: Cut oliving-diallage gabbro and rock, of the older series.
	Oliving-diallage gabbro: Irregular intrusive bodies and dikes cutting the older series.
	Troctolite: Intrusive bodies cutting the older series.
Older series:	Anorthosite: Stratiform body overlying the diallage gabbro.
	Diallage pyroxenite: Irregular segregation bodies in the diallage gabbro.
	Diallage gabbro: Cut by oliving-bearing rocks and microdiorite.

Occurence of Titaniferous Magnetite

Titaniferous magnetite occurs as dikes and irregular bodies in the gabbro and as large crude euhedral crystals in the basic pegmatites. A small amount of anhedral magnetite crystals also occur in the foliated zones of the gabbro.

Small amounts of black sands are found in the sediments surrounding the gabbro-anorthosite hills. These black sands are derived from the weathered gabbro and occur in scattered concentrations containing 2 percent ilmenite. These concentrations are too small to offer commercial possibilities. The only areas in which these sands may be of significance are in Cut Throat Gap at the foot of Mount Baker and the sedimentary plain south of Iron Mountain.

The basic pegmatites have not been studied in detail but a reconnaissance survey with dip needle over these zones showed no indication of magnetite concentration.

The only titaniferous magnetite found mappable with a dip needle was the magnetite dike near Iron Mountain, Mountain Glenn, and the area west of Mount Baker.

Iron Mountain

In the plain to the east and south of Iron Mountain, numerous zones of titaniferous magnetite dikes cut the troctolite and in two places these zones are 1000 feet in length and 200 feet in width. The major part of these dikes is covered by sediments prohibiting detailed studies of their relationship with the gabbro, but in the NE$\frac{1}{4}$, SW$\frac{1}{4}$ of sec. 7, T. 4 N., R. 16 W., a gravel pit was opened on a weathered outcrop of the troctolite exposing the magnetite as irregular dikes that range in thickness from a few inches to 4 feet. These dikes thin and swell throughout their exposed length and connect with each other by small cross-cutting dikes. This zone of dikes strikes east-west with a north dip of 30 degrees.

In the vicinity of the pit, the country rock is cut by granite and microdiorite dikes, and when the original exposure was first visited, the considerable alteration of the dikes and country rock suggested hydrothermal activity associated with the intrusions. However, as the pit was deepened, the gabbro and the dikes were found to be fresh and unaltered, leading to the conclusion that alteration had resulted from weathering rather than hydrothermal action.

The magnetite crystals are subhedral to euhedral and range from 1 to 6 cm in width. The chromite in the ore occurs as vein-like replacements cutting the magnetite crystals indiscriminately. The ilmenite occurs (1) as regular to irregular tabular plates parallel to the octahedral planes of the magnetite; (2) as irregular zones between the magnetite crystals; and (3) as veins cutting both the magnetite crystals and the chromite.

Studies made of the titaniferous magnetite from the two largest zones of dikes show that the magnetite in the ore from the zone in the SW$\frac{1}{4}$ of sec. 7, T. 4 N., R. 16 W. is altered to hematite, and that from the NW$\frac{1}{4}$, sec. 18, T. 4 N., R. 16 W. is altered to maghemite.

Mountain Glenn

A small exposure of magnetite rich in olivine is located in the SE$\frac{1}{4}$, NE$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 14, T. 4 N., R. 17 W. near the south end of Mountain Glenn and forming a part of the west bank of Glenn creek. This body of magnetite is exposed over a distance of 100 feet and has a sharp upper and lower contact with the diallage olivine gabbro in which it occurs. On the north end of the ore body, magnetite grades into gabbro and loses its identity. The contact of the ore body with the gabbro has a strike N 50° E and a dip to the northwest of 25°. The body has a calculated thickness of 27 feet.

Mount Baker

A small exposure of troctolite occurs west of Mount Baker in the NW$\frac{1}{4}$, sec. 19, T. 4 N., R. 15 W. and has an exposed area of 50 square feet. The major portion of the gabbro is soil-covered and the relationship between the magnetite and gabbro is not known. Corrected dip needle readings made over the area range from +20 to +30 and suggest a long narrow dike-like body with a width of 75 to 100 feet.

Summary

1. The basic rocks are composed of two types, those rich in olivine and those olivine-free.

2. Diallage is common to all the basic rocks and forms the major portion of the basic pegmatites.

3. The presence of diallage gabbro as small segregations in the anorthosite suggest that the main diallage gabbro occurrences are phases of the anorthosite.

4. The magnetite rich in olivine contains the same olivine and plagioclase as the host rock. The ratio iron to titanium in this magnetite is the same as that in the ore found in the troctolite suggesting that the diallage olivine gabbro is a phase of the troctolite.

5. Brown hornblende is found only in the olivine-bearing rocks, and in them only if magnetite is present.

6. Magnetite is common to all the gabbro phases and is generally anhedral and subhedral to the silicate minerals.

7. The massive magnetite is associated with those gabbros rich in olivine and occurs primarily as dikes in troctolite.

8. The ratio iron to titanium ($\frac{83.52}{16.48}$) in the massive magnetite occurrences is a constant ratio, suggesting a common origin for the ore.

References

1. Marcy, R. B., "Exploration of the Red River of Louisiana in the Year 1852," U. S., 32nd Cong., 2nd Sess., S. Ex. Doc. 54, 1853; U. S., 33rd Cong., 1st Sess., H. Ex. Doc., 1854; U. S. 33rd Cong., 1st Sess., S. Ex. Doc., 1854.

2. Merritt, C. A., "The Iron Ores of the Wichita Mountains, Oklahoma," Econ. Geol., Vol 34, No. 3, P. 268, 286, 1939.

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Location of Samples given in Analyses on following page:

9893 massive magnetite from prospect pit in SE$\frac{1}{4}$, NW$\frac{1}{4}$, NE$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 7, T. 4 N., R. 16 W.

9894 Magnetite rich in olivine from ledge in SE$\frac{1}{4}$, NE$\frac{1}{4}$, NE$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 14, T. 4 N., R. 17 W.

9895 massive magnetite from dike in troctolite NW$\frac{1}{4}$, SE$\frac{1}{4}$, SE$\frac{1}{4}$, NE$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 7, T. 4 N., R. 16 W.

9896 massive magnetite from prospect pit in NE$\frac{1}{4}$, NW$\frac{1}{4}$, NW$\frac{1}{4}$, NW$\frac{1}{4}$, sec. 18, T. 4 N., R. 16 W.

10020 crude crystals of magnetite occuring in troctolite SE$\frac{1}{4}$, NW$\frac{1}{4}$, NE$\frac{1}{4}$, NE$\frac{1}{4}$, SE$\frac{1}{4}$, NE$\frac{1}{4}$, sec. 23, T. 4 N., R. 16 W.

10021 massive magnetite occuring in troctolite SE$\frac{1}{4}$, SE$\frac{1}{4}$, NW$\frac{1}{4}$, NW$\frac{1}{4}$, sec. 19, T. 4 N., R. 15 W.

Chemical Analyses of Titaniferous Ores

Lab Number	9893*	9894*	9895*	9896*
Total Iron as Fe_2O_3 not corrected	74.04	64.80	74.04	77.29
TiO_2 - not corrected	17.63	14.98	18.50	17.45

SiO_2	1.85	9.18	0.86	0.37
TiO_2	17.10	14.54	18.06	16.90
Al_2O_3	3.91	5.18	3.38	4.25
Fe_2O_3	65.34	35.57	64.36	51.16
FeO	7.67	25.18	8.60	23.36
MnO	0.30	0.35	0.18	0.27
MgO	1.68	6.57	1.43	3.19
CaO	0.99	0.67	0.42	0.56
P_2O_5	0.002			
S	0.012	0.014	0.013	0.004
Cr_2O_3	0.17	0.21	0.27	0.25
V_2O_3	0.33	0.24	0.23	0.32
NiO	0.04	0.04	0.03	0.03
Loss at 110° C. H_2O	0.175	0.495	0.15	0.04
Gain or loss above 110° C. - ign. at 1000° C.	Loss 0.57	Gain 2.15	Loss 1.02	Gain 1.83
TOTAL	100.14	97.10	99.00	98.88
Theoretical gain FeO - Fe_2O_3	0.85	2.92	0.96	2.60
TOTAL	100.99	100.02	99.96	101.48

Fe corrected	51.66	45.23	51.69	53.94
Ti corrected	10.25	8.72	10.83	10.13
Ratio Fe/Ti	$\frac{83.44}{16.56}$	$\frac{83.84}{16.16}$	$\frac{82.68}{17.32}$	$\frac{84.19}{15.91}$

* Locations from which these samples were collected are given on the preceding page.