JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE
Volume 39, Number 3, July, 1964

IRON, ZINC, AND BARITE DEPOSITS BETWEEN MORRISTOWN AND ETOWAH, TENNESSEE

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INTRODUCTION

Iron ores have been mined in southeastern Tennessee since the entry of white settlers into the region. In the last decade a revival in iron mining has resulted in the shipment of more than 80,000 tons of marketable ore from several mines. Production in this period has been chiefly from bodies of brown ore in residual clays overlying the Kingsport Formation of the Knox Group in the strike belt just northeast of the Dumplin Valley fault. However, one mine produced hematite from a zone of oolitic, fossiliferous ore in the lower Athens Shale. These mines and numerous related prospects extend from south of Morristown, Hamblen County, southwest to Etowah, McMinn County, a strike distance in excess of 80 miles.

Recent investigations of these ores have been made by R. L. Wilson (1958) under Division of Geology auspices and by L. Riseman for the University of Tennessee. The earliest known mention of these ores is by Lesley (1859), who lists a bloomery forge using these ores in 1823 (noted by B. C. Moneymaker). Safford (1869, pp. 254, 450) discusses the deposits and clearly recognized the occurrence of hematite in the Athens Shale. Safford does not explicitly describe the brown ore deposits in this district, but in his discussion of such deposits in other areas (pp. 222-223) he states that this class of iron ore results from the oxidation of primary sulfides in the Knox Group. Willis (1886) and Keith (1895) described this mode of formation and assigned to it deposits in the area under discussion. Neuman and Wilson (1960) and Riseman (personal communication) believe possibly the ores were formed under conditions obtaining from the development of physiographic terraces.

Investigation of an excavation for a bridge foundation at Maryville revealed a deposit of sphalerite. Subsequently, additional zinc mineralization was discovered in the strike belt. Barite has been mined near Madisonville in the same strike belt.

Two iron mines opened in 1958-59 showed features that were not clearly visible before. These exposures, taken in conjunction with earlier observations, establish the nature of the mineralization and guides for future prospecting.

BROWN ORE MINES

The mines described below are those examined by Division geologists.

The Linderman mine, 4 miles east of Madisonville, was opened in late 1950. From its opening until March 1954, 56,500 tons of concentrates averaging 42 percent iron were shipped. Of this, approximately 20,000 tons consisted of direct shipping ore. The mine consisted of two open pits, crudely oval in plan (370 by 300 feet) and about 40 feet deep.

The ore is "limonite," which both R. A. Laurence and Josiah Bridge (personal communications) report resulted from the oxidation of sulfides. The upper part of the ore-bearing ground in the eastern pit was a deep-red chert-free clay, but the lower part was a cherty yellow clay. A pinnacle of the subjacent Knox Dolomite exposed in mining contains veinlets of iron oxides. The western ore body was cherty throughout.

The mine is stratigraphically in the upper Kingsport Formation. Wilson (personal communication) reports a pre-Middle Ordovician sink in the Mascot Formation updip from the mine.

The Wilson mine, which is 2.8 miles southwest along the strike from the Linderman mine, is estimated to have produced 20,000 tons of brown ore. The geologic and stratigraphic features duplicate those described for the Linderman, except that the ore zone was cherty. Pre-Middle Ordovician sinks are located above the mineralized ground.

The Big Flag Springs mine is in Blount County about 10 miles southwest of Maryville and 0.7 mile southwest of Mint. The deposit was opened in the spring of 1957, idled in 1958, and reopened in 1959. Production is estimated at 6,000 tons of 52-percent concentrates.

The deposit consists of brown iron oxides in cherty clays overlying the Kingsport Formation. Similar to ore masses at the Wilson mine, some of the ore here shows boxwork structure and unoxidized sulfides. Bedrock exposed by mining is locally brecciated and veined by iron minerals.

The Goodsprings-Bethel mine, the most southwesterly of this group of mines, is 2.7 miles southwest of Etowah, McMinn County. The mine is an open pit 150 by 100 feet with a maximum depth of 60 feet. The ore consists of brown oxides in cherty residual clay above the Kingsport Formation. Nodules of sulfides encrusted by oxides are common. In the pit is a pinnacle of gray fine-grained brecciated dolomite, which contains veinlets of iron oxides and sulfides.

This mine was operated in 1959-1960 as is reported to have shipped some 5,000 tons of 50-percent concentrates.

ASSAYS

All of these brown ore mines produced ores containing more than 50 percent iron; and small amounts of phosphorus, manganese, and other metals. Those tested contain traces of zinc or copper in both the oxides and sulfides (Table 1).

Table 1

Representative Assays of Brown and Red Ores (in percent)

Brown Ores Mine	Fe	Mn	Insol.	P	Cu	Zn	Moist.
Wilson[1]	52.92	0.13	11.99	0.068	0.015	(2)	8.31
Linderman[1]	53.17	0.10	13.16	0.048	0.015	(2)	8.24
Big Flag[1]	55.80	0.13	8.26	0.034	(2)	(2)	8.00
Goodsprings[3]	—	—	—	—	0.01	0.016	—
Wilson bank[4]	53.54	Tr.	6.70	0.143	(2)	0.36	—
Red Ore							
Nonaburg[5]	54.72	0.057[6]	7.80	0.83	(2)	(2)	
Al_2O_3	9.22						
CaO	0.80						
MgO	0.40						

[1] Carload lot. Tenn. Prod. and Chem. Corp. assay. Brown ore.
[2] Not determined.
[3] Iron sulfide. Nichols Laboratory.
[4] Willis (1886, p. 335). Also contained 0.1 percent NiS. Not same as Wilson mine.
[5] TVA; courtesy B. C. Moneymaker.
[6] Oxide.

Red Ore Mines

The Nonaburg mine is 2 miles south of Englewood, McMinn County. The mine operated in 1959. Production records are not available, but the amount is known to have been more than 10,000 tons.

The ore is hematite in a bed as thick as 2 feet, approximately 100 feet stratigraphically above the base of the Athens Shale. The ore zone consists of oolitic, fossiliferous hematite, quartz sand, encrinal limestone, and interbedded shale.

Workings consist of an open cut some 2,000 feet along the strike and 30 feet or more down the dip. The ore zone appears to have been of irregular width, and along the strike to the northeast it is entirely absent.[1]

The Blockhouse prospect is identical to the Nonaburg mine lithologically, but stratigraphically it is at the base of the Athens. This prospect is more than 30 miles northeast of Nonaburg in the same strike belt, at Blockhouse, 4 miles southeast of Maryville, Blount County. No ore has been produced here, but some prospecting was done in 1951.

Iron Deposits of the Terraces

Many prospect pits have been sunk in this area on the strength of iron oxide pebbles associated with alluvial terrace materials. Such deposits are widespread in the region and have suggested to some workers that the ore controls were related to the erosional history.

So far as the writer knows, none of the terrace bodies has ever produced sufficient ore to be commercially significant. Observed pits sunk in the terraces showed the ore-bearing zone to be too thin and too lean to permit successful mining.

Zinc Deposits

The best known zinc deposit in this strike belt is the Felknor or White Pine prospect near White Pine, Jefferson County (Secrist, 1924, pp. 147-151; Walthier, unpub.). This deposit is notable in that the ore minerals include considerable galena; the mineralization is more intense than disseminated, and is almost certainly localized by a small fault. The host rocks are the Mascot Formation of early Ordovician age.

Another zinc deposit was discovered by R. L. Wilson in 1958 (Maher, 1959; Neuman and Wilson, 1960) in Maryville, Blount County. This deposit is similar to the well-known Mascot-Jefferson City district deposits in being lead-free and in its occurrence in brecciated host rocks of the Kingsport Formation.

Prospecting by Frank Dakin of Knoxville and investigations by the writer and C. P. Finlayson have resulted in the discovery of additional occurrences of sphalerite in the vicinity of Maryville and Wildwood, Blount County. These deposits are mineralogically analogous to the Maryville occurrence but occupy a wider stratigraphic interval.

The first occurrence examined is in the uppermost Copper Ridge Formation exposed on a bluff above Little River; map reference 147-SW (Maryville quadrangle), Tennessee Coordinates 522,000N., 2,627,000E. The visible mineralization is associated with brecciated dolomite sealed by coarsely crystalline white gangue dolomite and pale-yellow sphalerite. The zinc-bearing zone observed is approximately 6 feet thick. Similar zinc-bearing breccias occur at Tennessee Coordinates 519,970N., 2,627,700E. and 516,900N., 2,621,500E., Maryville quadrangle. Another occurrence is at Tennessee Coordinates 522,300N., 2,620,400E., 147-SE (Wildwood quadrangle). An exposure of a pyrite-bearing breccia was noted on the Wildwood quadrangle at coordinates 534,100N., 2,634,600E., stratigraphically near the contact of the Chepultepec and Longview formations as mapped by Neuman (1960).

Numerous bodies of breccia cemented by white gangue dolomite occur in the strike belt but do not contain sulfides on the exposed surfaces. A particularly notable example is exposed along an unnamed tributary to Nails Creek approximately 2,000 feet northeast of Little River on the Maryville quadrangle. The outcropping units of the Knox in the valley of this northwest-flowing stream are continuously brecciated and faulted from the Copper Ridge Formation into the Newala Formation of Cattermole (1962) and Neuman

[1] This mine appears to be geologically and stratigraphically analogous to the "Deaton ore series" near Rockmart, Georgia (Spencer, 1893, pp. 169-170).

Table 2

Summary of Mines and Prospects Discussed

Mine	Reference	Map	Tennessee Coordinate (10,000 ft.) location	Remarks
Goodsprings	Tenn. Div. Geology	125–SE	337,000N., 2,427,000E.	Pyrite in Kingsport breccia visible.
	Willis (1886, p. 332)	132–NW	Possibly: 367,500N., 2,449,400E.	2 mines, 1 mile apart, on Chestnut Ridge. Pyrite.
Wilson (Rocky Springs)	Tenn. Div. Geology	132–NE	406,500N., 2,495,100E.	Shipped 20 000 tons. Pyrite.
Linderman	Tenn. Div. Geology. U. S. Geol. Survey	132–SE	415,700N., 2,507,000E.	Shipped 56,500 tons. 2 pits. Pyrite visible.
Big Flag Springs (Mint)	Tenn. Div. Geology Willis (1886, p. 335)	139–NE	459,200N., 2,579,500E. and 460,400N., 2,583,800E.	One or both may be "Kerr bank" of Willis. Kingsport breccia.
	Tenn. Div. Geology	139–NE	486,700N., 2,593,500E.	Iron-manganese prospect.
Carpenter bank	Willis (1886, p. 335) Keith (1895)	148–NW	Approximately 474,600N., 2,599,100E.	Willis reports mined out after 1 year.
Wilson bank	Willis (1886, p. 335) Keith (1895)	147–SW	Approximately 507,000N., 2,614,000E.	Willis' assay shows 0.5% Zns and 0.1% NiS.
Seaton bank	Willis (1886, p. 335) Keith (1895)	147–SW	Approximately 514,700N., 2,624,600E.	Willis' and Keith's locations combined by Maher.
	Keith (1895)	156–NW	Approximately 561,300N., 2,683,500E. and 557,500N., 2,671,000E.	2 pits, about 1 mile apart. Described as oxidized pyrite.
Williams bank	Willis (1886, p. 336)	163–NE	2 miles west of Witt Foundry; Witt of modern maps 660,700N., 2,789,800E.	Pinnacles still exposed. Brecciated dolomite; no sulfides.
Vinyard bank	Willis (1886, p. 336)	163–NE	655,700N., 2,805,700E. 1 mile north of Witt	
	Tenn. Div. Geology	163–SW	612,700N., 2,764,000E.	Reported by G. D. Swingle as magnetic.
Hematite Deposits in Athens Shale				
Nonaburg	Safford (1869, p. 254) Willis (1886, p. 332) Tenn. Div. Geology	132–NW	369,400N., 2,253,500E.	Mined 1959. Probably Hills bank of Safford and Willis.
Blockhouse prospect	Tenn. Div. Geology Neuman and Wilson (in press)	148–NW	484,000N., 2,613,200E.	Prospected 1951; no mining.
Barite Deposits				
Kodak		156–NE	588,200N., 2,730,600E.	
Notchy Creek	Tenn. Div. Geology	132–NE	397,800N., 2,487,000E.	

(1960). The lower Newala breccias in these exposures are zinc-bearing.

An occurrence of sphalerite in the Mascot Formation near Douglas Dam in Sevier County has been reported recently by R. A. Laurence and Helmuth Wedow of the U. S. Geological Survey (personal communication). This deposit has not yet been examined in detail. It is at Tennessee Coordinates 580,000N., 2,730,500E., 156-NE (Kykers Ferry quadrangle). The exposures are in an old borrow pit.

Barite Deposits

Two barite deposits have been mined in the area discussed. Only minor amounts were produced and the deposits have long been idle. One is near Kodak in Sevier County at Tennessee Coordinates 588,200N., 2,730,600E., 156-NE (Kykers Ferry quadrangle); and the other is about 3 miles south of Madisonville, Monroe County, at Tennessee Coordinates 397,800N., 2,487,000E., 132-NE (Mount Vernon quadrangle). These deposits are in residual soils overlying upper Knox Group, probably Kingsport Formation, bedrock.

The proximity of the Kodak prospect to a deposit of sphalerite nearby is noteworthy.

Table 2 summarizes the mines and prospects discussed in the foregoing sections.

Conclusions

The descriptions of the deposits presented above indicate that the Knox formations in the strike belt discussed are extensively mineralized. The writer believes that the brown iron, zinc, and barite deposits are genetically related. These deposits appear to have resulted from the emplacement of mineralizing solutions in carbonate rocks, especially those of younger Knox age. The general resemblance of these deposits to the well-known Mascot-Jefferson City zinc district and Sweetwater barite district is striking.

Noteworthy exceptions are the Felknor lead-zinc prospect and the Nonaburg iron mine. The former appears to have been influenced by intense local structural control, and may well represent a different metallogenetic episode than other zinc deposits in the area. The Nonaburg iron deposit is clearly a sedimentary hematite of Ordovician age analogous to the better-known bedded hematites of Silurian age. Its occurrence in proximity to the brown iron ores is a geologic coincidence.

Degradation of the folded hematite beds, as that mined at Nonaburg, has supplied ferruginous rounded and polished pebbles to alluvial deposits in the area. Such iron-bearing deposits have led some workers to believe a genetic relationship exists between the iron deposits and the physiographic history of the region. In view of the evidence presented here this theory can not be sustained.

Future prospecting should be guided by stratigraphic controls analogous to those established in the Mascot-Jefferson and Sweetwater districts, especially near post-Mascot pre-Middle Ordovician collapse structures. The favorable areas for hematite are those underlain by the lower hundred feet or so of the Athens Shale, especially where the interval is sandy.

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NEWS OF TENNESSEE SCIENCE

(Continued from Page 102)

Dr. J. Gordon Carlson, Head of the Department of Zoology and Entomology at the University of Tennessee, is conducting research at the University of Heidelberg, Germany, under a special fellowship from the United States Public Health Service. He will study at the Cancer Research Laboratory and will continue his research concerning the effects of radiation on various kinds of cells and tissues. He will resume his duties at the University in January.

The University of Tennessee College of Medicine has been awarded training grants totaling $76,264 from the National Institutes of Neurological Diseases and Blindness of the United States Public Health Service. The funds will be used to support full-time faculty members in otology, laryngology and rhinology, neurological surgery, and ophthalmology to stimuate additional interest in the teaching and research programs in sensory diseases.