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COBALT-BEARING MANGANESE DEPOSITS OF ALABAMA, GEORGIA, AND TENNESSEE

BY
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COBALT-BEARING MANGANESE DEPOSITS OF ALABAMA, GEORGIA, AND TENNESSEE

By W. G. Pierce

ABSTRACT

Although it has been known for many years that some of the Appalachian deposits of manganese ore contain cobalt, little attention has been given until recently to the possibility of utilizing these deposits as a source of cobalt. The war, however, has caused a sharp increase in the demand for cobalt, which is used in making a special alloy steel. An endeavor to increase our supply of cobalt from domestic sources therefore becomes a logical part of the strategic-mineral investigations which are being carried on by the Geological Survey. This report deals with the possibilities of obtaining cobalt from the manganese deposits of Alabama, Georgia, and Tennessee.

The manganese deposits with appreciable cobalt content are mostly of low grade insofar as manganese is concerned. The cobalt is associated with near-surface or surficial rocks or with bedrock near the surface, and it decreases with depth. It was carried by ground water and deposited either with or on so-called manganese "oxides," commonly lithiophorite or hollandite, which are the only cobaltiferous minerals. These minerals usually have a layered botryoidal form and a dark blue color.

Analyses of 84 samples from Alabama, Georgia, South Carolina, Tennessee, and Virginia are arranged in tabular form by States. Of these, 73 were made recently in the Geological Survey laboratory in aid of the present investigation.

Of the 101 manganese mines and prospects that were examined for appraisal of their cobalt possibilities, only a few were found to contain appreciable quantities of cobalt. Some of these cobaltiferous deposits are described in detail. It is estimated that the deposits examined contain, altogether, 7,900 tons of manganese oxides containing 3/4 to 1 1/2 percent cobalt, or about 165,000 pounds of cobalt. Other deposits, in which the manganese oxides contain 0.2 to 0.3 percent cobalt, might supply 25,000 tons of manganese oxides containing about 140,000 pounds of cobalt.

The main cobaltiferous manganese deposits are in (1) the Weisner quartzite (Lower Cambrian), (2) the residual clay of the Shady dolomite (Lower Cambrian), (3) the Knox dolomite (Ordovician and Cambrian), and (4) the Fort Payne chert (Mississippian). Cobalt-bearing manganese "oxide" is commonly associated with sandstone, chert, or other siliceous rocks;

some of it partly replaces these rocks and some forms botryoidal incrustations and fracture fillings. It also occurs in nodules and masses in some residual clay deposits and as small manganiferous pellets in clay.

INTRODUCTION

The principal source of cobalt in recent years has been the Belgian Congo copper ores. At one time, however, most of the world's production came from deposits in New Caledonia, where the cobalt occurs in a mixture of manganese and cobalt oxides known as asbolite. Cobalt has been used for many years in the ceramic industry for the production of blue glass and pigments, but recently it has come into increased industrial use because of certain qualities it imparts to alloy steels.

The presence of cobalt in some of the Appalachian manganese ores has been known for many years. Little was known regarding the cobalt, however, except that, in the course of numerous laboratory analyses, tests for various minor elements would occasionally show the presence of a little cobalt. This investigation was therefore undertaken, at the suggestion of H. D. Miser and T. A. Hendricks, for the purpose of determining the reserves of cobaltiferous manganese ores and the quantity of the cobalt contained therein.

Field work on the project began with a reconnaissance of manganese deposits in Alabama, Tennessee, and Virginia, particularly at those deposits where cobalt had already been reported. This examination was made in company with H. D. Miser and H. S. Ladd of the Geological Survey, and to them the author is indebted for valuable information on the occurrence and character of various Appalachian manganese deposits. Detailed field work was first done in the Rock Run area of northeastern Alabama, whose deposits have the highest cobalt content. This was followed by an examination of other deposits in Alabama, Georgia, Tennessee, North Carolina, and South Carolina (see pl. 48). The author was ably assisted in the field by A. E. Engel, to whom he is indebted for his keen observations and his interest in pursuing the several problems involved in the work. The chemists of the Geological Survey laboratory made 73 cobalt analyses, and a number of manganese analyses and X-ray determinations, especially for this project. D. M. Coulter of the Bureau of Mines extended cordial cooperation, and supplied manganese analyses and specimens that were used for preliminary evaluation of several Alabama deposits. Captain Garland Peyton, Director of the Georgia Division of Mines, Mining and Geology, made available unpublished analyses of specimens containing cobalt and also unpublished data of the WPA Mineral Resources Survey, which was made in cooperation with the State. Captain W. F. Pond, State Geologist of Tennessee, facilitated the investigation of the Coble, Tenn., area through a joint examination with G. R. Gwinn of the Tennessee Geological Survey; and Dr. G. I. Whitlatch kindly supplied two unpublished analyses made by the State Geological Survey. Ed Emerson and W. P. Cowan supplied data on the deposits in the vicinity of Piedmont, Ala., with which they were familiar. Oscar Pope spent several days as field guide in locating many of the old prospects and mines in the Rock Run, Ala., area. H. D. Miser, W. T. Schaller, D. F. Hewett, and F. C. Calkins made valuable criticisms of the report.

GEOLOGY

Cobalt-bearing manganese oxide is commonly associated with some variety of siliceous rock, such as sandstone, quartzite, or chert, or with a fine-grained crystalline quartz which Kesler 1/ has identified as jasperoid. The cobalt-bearing manganese oxide occurs as incrustations and fracture fillings, and some of it partly replaces quartz (see pls. 49 and 50).

The stratified rocks known to contain cobaltiferous manganese deposits range in age from Carboniferous to Lower Cambrian and perhaps pre-Cambrian (see pl. 48). The more important deposits are in the Weisner quartzite (Cambrian), in the residual clay of the Shady dolomite (Cambrian), in the Knox dolomite (Cambrian-Ordovician), and the Fort Payne chert (Carboniferous). Other deposits occur in the Talladega slate (pre-Cambrian), in the Rome formation (Cambrian), in the residual clay of the Tonoloway limestone (Silurian), and in the Floyd shale (Carboniferous).

Cobalt-bearing manganese ore, of a type that is known as pellet or gravel ore, also occurs in colluvium, which is commonly a red clay. The pellet deposits are shallower than the manganese deposits in residual clay, most of them being less than 25 feet thick. The smallest individual pellets are as small as sand grains, while the largest are half an inch or more in diameter. The pellets may have a high iron content.

Cobalt has been reported 2/ to occur in the halloysite deposits of Taylor Ridge, 5 miles north of Gore, Chattooga County, Ga. The cobalt seems to be associated with the black streaks, lenses, and impregnations of manganese in the halloysite, rather than with the white halloysite itself. Here the halloysite is overlain by typical Fort Payne chert. Cobalt also occurs in tripoli in the Fort Payne chert in Perry County, Tenn., and here too the cobalt is in manganese oxides which form tiny spherules, the size of a pinhead and smaller, partly disseminated through the tripoli and partly concentrated in ribbons and lenses.

ORE DEPOSITS

Character and localization

In all of the known cobalt-bearing manganese deposits in the southeastern States, the cobalt occurs in black manganese minerals, which are referred to as manganese "oxides." This usage will be continued, although some of these so-called oxides are known to be either salts or compounds. The deposits are divisible into two general types.

In one type, the manganese oxides occur as fracture fillings and incrustations in siliceous rocks, such as quartzite, chert, or jasperoid, and they not uncommonly replace some of the siliceous rock. (See pls. 49 and 50.) The deposits in the Weisner quartzite in the Rock Run area of northeastern Alabama are characteristic of this type.

1/ Kesler, T. L., Structure and ore deposition at Cartersville, Ga.: Am. Inst. Min. Met. Eng. Tech. Pub. 1226, p. 2, 1941.

2/ Shearer, H. K., A report on the bauxite and fuller's earth of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 31, pp. 331-332, 1917.

In the deposits of the other type, such as that on Penland Hill near Etna, Ga., the manganese oxide forms fragments and rounded concretionary pellets in colluvial clay, which is commonly red. The clay deposits are mostly 10 to 15 feet thick, but locally they attain a thickness of 20 to 25 feet. The cobalt content of this type of deposit is much lower than that of the first type.

An unusual variety of the pellet type of deposit was found in Goshen Valley, about 4 miles north of Piedmont, Ala., in the NW¼ sec. 20, T. 12 S., R. 10 E. Here the pellets occur from the surface to depths of 2 to 4 feet, in an area from 600 to 800 feet wide and half a mile long. The amounts of both cobalt and manganese in the pellets appear to be too small for commercial recovery, but the deposit is noteworthy because the cobalt content is unusually high as compared with the manganese content. A partial analysis of one sample showed 0.26 percent cobalt, 7.41 percent manganese, and 21.55 percent iron. Another sample contained 0.23 percent cobalt, 3.93 percent manganese, and 19.00 percent iron.

In general it seems unlikely that the cobalt-bearing manganese deposits of this region could be worked commercially for their manganese content alone. On the other hand most of the high-grade, workable, manganese deposits contain little or no cobalt.

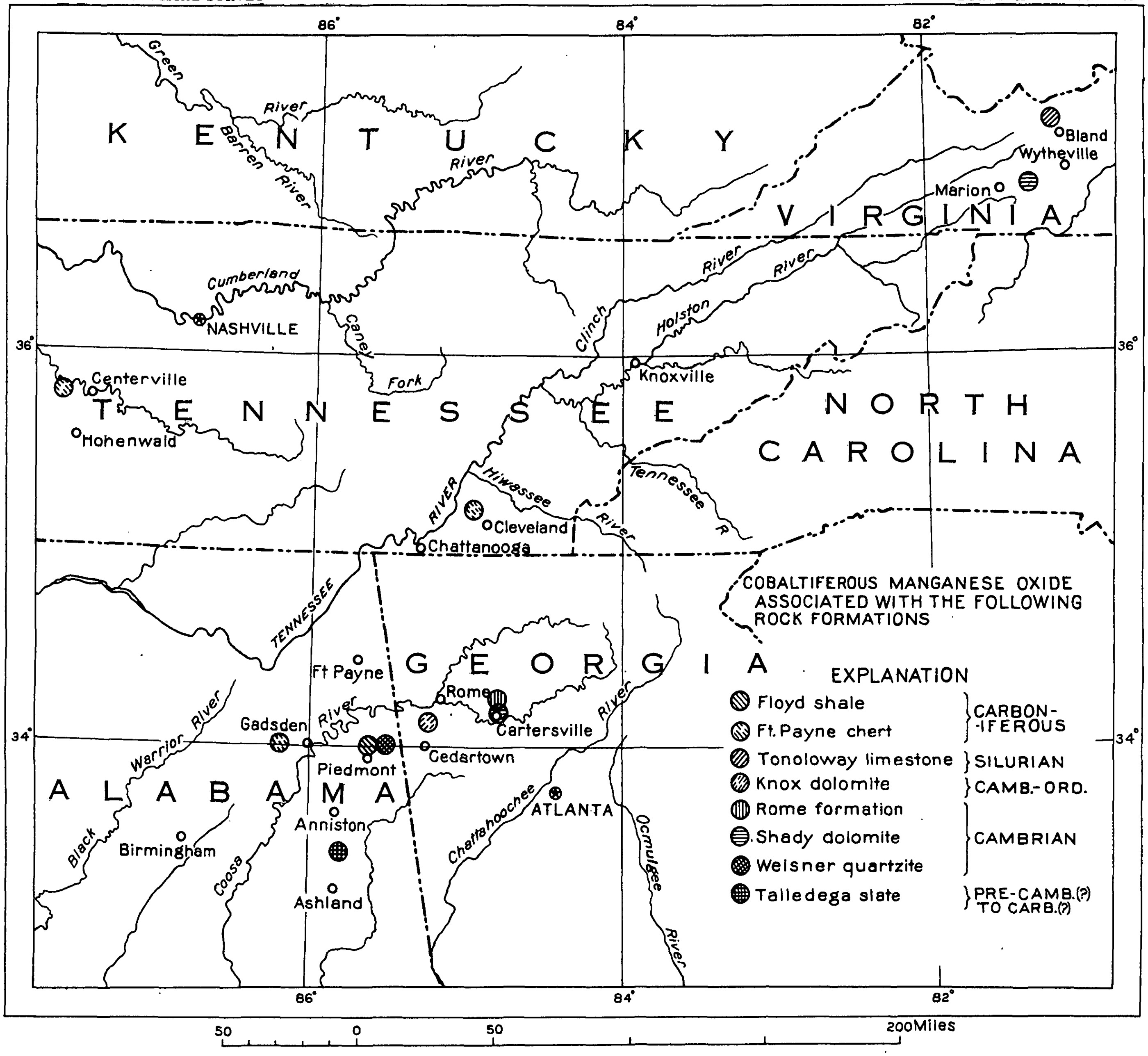
The cobalt-bearing manganese is found in fractures in rocks near the surface or is associated with surficial material, such as colluvial red clay and other material of the oxidized zone. There is no obvious topographic control for the location of the deposits. Several occur at or near the tops of hills, but others are on the hillsides. The deposits occur at altitudes ranging from 800 to 1,300 feet. Their general features indicate that the cobalt has been deposited by ground water. Cobalt occurs with the manganese "oxides" only; no more than a trace has been found in any of the several manganese-silicate deposits examined, or in the manganese carbonate at the East Fork mine near Sevierville, Tenn. The cobalt content seems to be highest in the near-surface parts of the manganese deposits.

Mineralogy

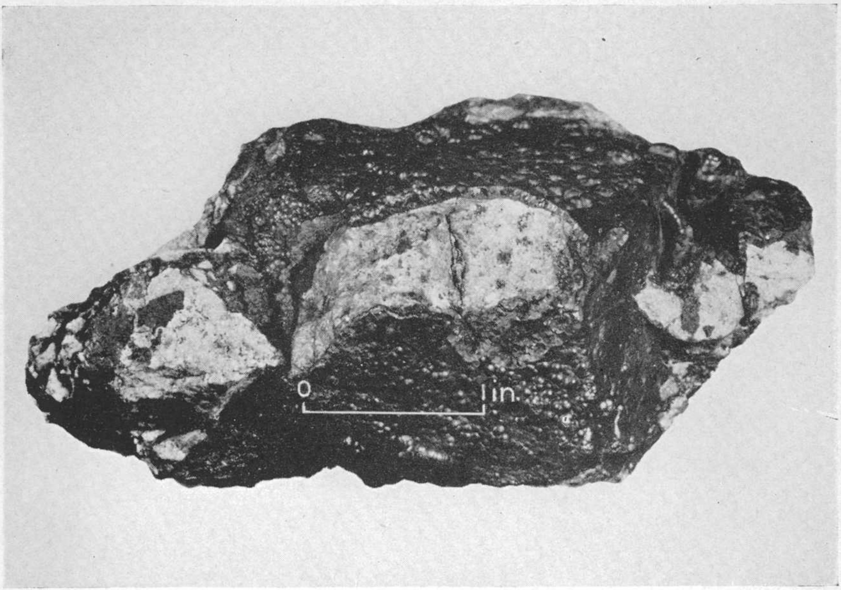
The cobalt seems to be either adsorbed on the manganese minerals as a cobalt oxide or to be a constituent of several manganese-"oxide" minerals. In describing a specimen of lithium-bearing manganese dioxide from the vicinity of the proposed Appalachian Park in eastern Tennessee, Wherry 3/ states that it belongs to a variety approaching lithiophorite. He discusses ways in which the oxides of lithium, sodium, potassium, cobalt, and nickel might occur, and, after eliminating several other hypotheses, he suggests that they may occur as gels, united by adsorption to the MnO_2 gel which makes up the bulk of the material. C. A. Hansen, from studies on electrolytic zinc practice, is reported 4/ to have obtained evidence that cobalt oxide is adsorbed on hydrated manganese dioxide, and that the cobalt can be removed by means of a reducing solution, such as ferrous sulfate, without greatly affecting the

3/ Wherry, E. T., Notes on alunite, psilomelanite, and titanite: U. S. Nat. Mus. Proc., vol. 51, pp. 84-86, 1917.

4/ Ralston, O. C., Manganese in electrolytic zinc practice: Eng. and Min. Jour., vol. 130, no. 12, p. 607, 1930.

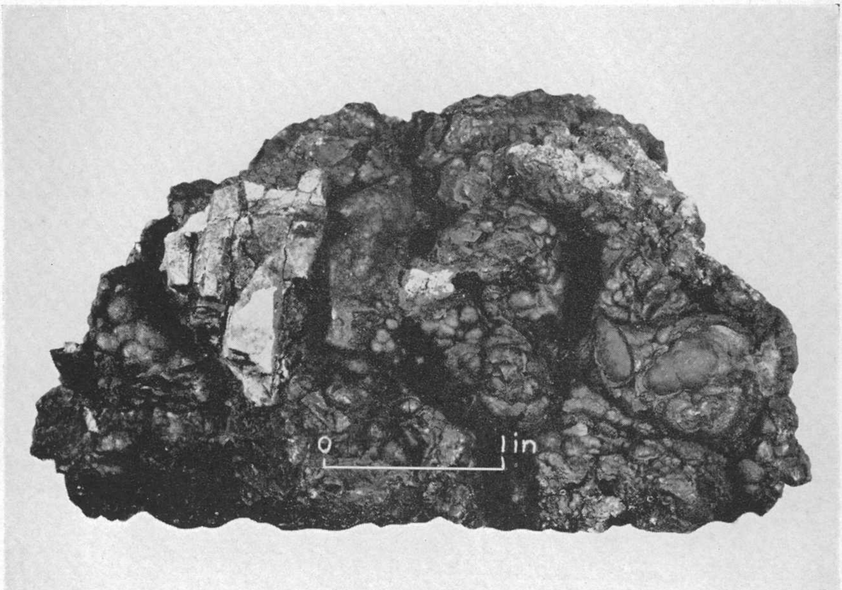


MAP SHOWING PRINCIPAL AREAS OF COBALT-BEARING MANGANESE OXIDE AND THE ROCK FORMATIONS WITH WHICH THEY ARE ASSOCIATED



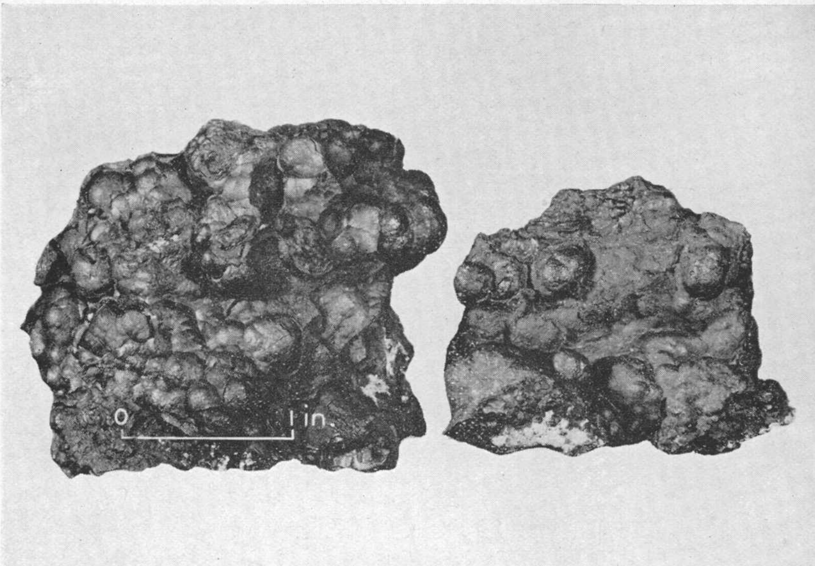
A. COBALT-BEARING MANGANESE OXIDE IN BRECCIATED WEISNER QUARTZITE.

Cobalt-bearing manganese oxide (lithiophorite), incrusting and filling fractures in brecciated Weisner quartzite. Specimen is from the W. C. Pope prospect, in Cherokee County, Ala. Scale in inches.



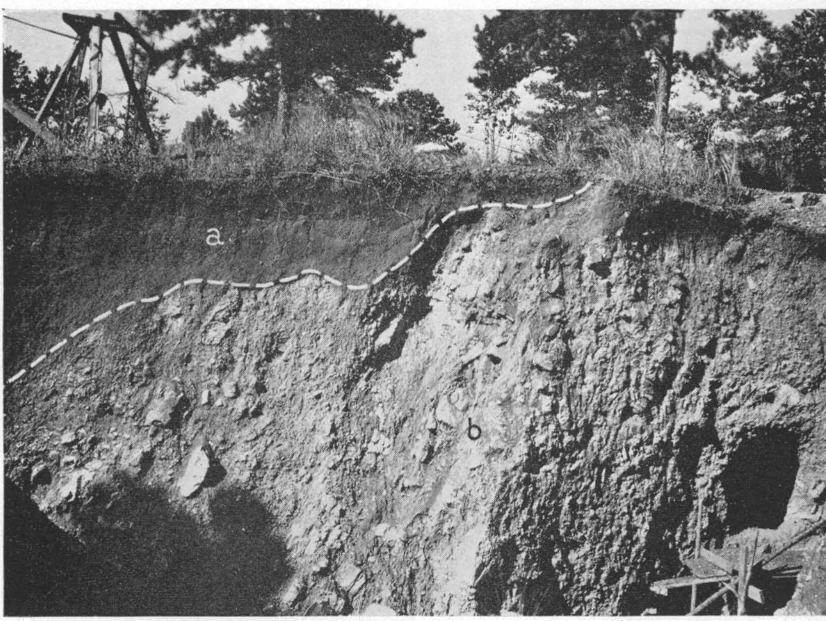
B. COBALT-BEARING MANGANESE OXIDE IN FORT PAYNE CHERT.

Cobalt-bearing manganese oxide (lithiophorite), incrusting and filling fractures in the Fort Payne chert. Specimen is from White Oak Mountain, Bradley County, Tenn.



A. COBALT-BEARING MANGANESE OXIDES FROM THE GEMES MINE NEAR CARTERSVILLE, GA.

Cobalt-bearing manganese oxides (lithiophorite and hollandite), incrusting and filling fractures in a friable crystalline quartz rock. Specimen is from the Gemes mine near Cartersville, Ga.



B. VIEW OF PELLET-BEARING CLAY OVERLYING MANGANIFEROUS CHERT OF THE KNOX DOLOMITE.

View of open cut at the Gibson mine, Floyd County, Ga., showing steeply inclined chert beds of Knox dolomite containing irregular masses of manganese, overlain by red clay with manganiferous pellets. *a*, pellet-bearing clay; *b*, manganese in chert.

manganese dioxide. Recent work by Fleischer and Richmond 5/ in the Geological Survey chemical laboratory has shown that cobalt commonly occurs in at least four manganese minerals; namely, lithiophorite (a hydrous lithium-manganese aluminate), psilomelane (which contains essential barium), cryptomelane (which contains essential potassium), and hollandite (which contains essential barium). In the last three the percentages of cobalt range from 0 to 2. All the samples of lithiophorite examined contain appreciable quantities of cobalt, the maximum percentage being 4.84. As shown by the X-ray determinations of the manganese minerals in 12 of the high-cobalt samples listed in the following table, the high-cobalt manganese mineral is commonly either lithiophorite or a mixture of lithiophorite and hollandite. However, X-ray mineral determinations, supplemented by qualitative chemical tests for barium and potassium, of cobaltiferous manganese ores from localities in Virginia, show that there the manganese mineral is cryptomelane.

All of the samples shown in the accompanying table except that from the McCollum prospect contain some nickel. A little copper occurs in the McCollum prospect and also in the White Oak Mountain deposit.

So far as observed in the southern Appalachians, pyrolusite nowhere contains as much as ½ percent of cobalt. None of the manganese-silicate veins in crystalline rocks that have been examined thus far contain more than a trace of cobalt.

Manganese minerals found in the cobaltiferous manganese deposits

Locality	Percent cobalt 1/	Manganese minerals 2/
Cartersville, Ga., district:		
Gemes mine; manganese oxide in jasperoid.	1.01	Lithiophorite and hollandite.
Gemes mine; manganese pellets in clay.	.77	Hollandite and lithiophorite (?).
Ward mine..................	1.60	Hollandite and lithiophorite.
White Oak Mountain, Bradley County, Tenn.	2.28	Lithiophorite.
Rock Run area, Ala. and Ga.:		
W. C. Pope No. 1 cut.......	4.84	Lithiophorite.
R. Stockdale prospect......	1.59	Lithiophorite and hollandite.
Hughes prospect............	1.66	Hollandite.
Daughdrill prospect........	1.96	Hollandite and a little lithiophorite.
McCollum prospect..........	1.14	Hollandite and lithiophorite.
Burke Estate prospect, 10 miles southwest of Piedmont, Ala.	1.26	Lithiophorite.
Dulin mine, Clay County, Ala...	.97	Lithiophorite and a little hollandite.
Coble, Hickman County, Tenn....	.64	Lithiophorite.

1/ The cobalt content is only approximate, for the chemical analysis was made on a sample consisting of several pieces, whereas the X-ray determination was made on a single specimen of homogeneous material.

2/ Geological Survey laboratory X-ray determinations by J. M. Axelrod except fo. specimens from White Oak Mountain and Coble, Tenn., which were examined by W. E. Richmond.

5/ Fleischer, Michael, and Richmond, W. E., The manganese-oxide minerals, a preliminary report: Econ. Geology, vol. 38, no. 4, pp. 269-286, 1943.

Distribution of cobalt content

One of the first problems encountered in the study of cobalt-bearing manganese deposits was the seemingly very irregular distribution of the cobalt within them. Field tests of the distribution of cobalt in the manganese oxides were made in the main cut at the Stockdale prospect, and the amount of cobalt was found to be fairly uniform, both in various parts of the pit and in masses of manganese oxides that differed from each other in appearance. At the Gemes mine, near Cartersville, Ga., five samples collected from an area of 200 by 300 feet contained 0.75, 0.77, 0.90, 1.01, and 1.30 percent cobalt (see pl. 51). At White Oak Mountain, Tenn., three samples taken at intervals of about 25 feet contained 0.82, 1.05, and 0.88 percent cobalt, but for a larger area of thinly disseminated and discontinuous manganese oxide the cobalt content ranged from 0.37 to 1.19 percent (see pl. 52). At Greasy Cove, Ala., however, rough chemical field tests on different manganese lenses in a 3-foot zone indicated 0.1 to 1 percent cobalt.

Identification of cobaltiferous manganese oxides

Manganese oxides that contain 1 percent or more of cobalt can usually be recognized by their appearance. In color they are dark blue or bluish black, rather than light blue or steel gray. They are only moderately hard; in a mortar they crush to a soft rather than a gritty powder. Little or no cobalt was found, however, in soft pyrolusite. Many samples of iron oxide were tested, but none of them contained cobalt, although cobalt was found with manganese oxide that was associated with iron deposits.

CHEMICAL ANALYSES FOR COBALT CONTENT

The results of the 73 chemical analyses for cobalt content made in the chemical laboratory of the Geological Survey for this investigation, together with other available cobalt determinations on material from the region investigated, are given in the table on pages 272-275.

RESERVES

Ten small deposits in northeastern Alabama are estimated to contain, in all, 900 tons of manganese oxides that contain from 1 to 1½ percent cobalt, or 25,000 pounds of cobalt. The Gemes, McCollum, and Ward properties in northwestern Georgia, and the White Oak Mountain property in southeastern Tennessee, are estimated to contain 7,000 tons of manganese oxides with from 3/4 to 1¼ percent cobalt, or about 140,000 pounds of cobalt. The Gibson, Penland Hill, Berkstresser, and Callahan deposits in Floyd and Polk Counties, Ga., the Thompson property near Piedmont, Ala., and the Arms mine on Flat Top Mountain in southwestern Virginia, contain an estimated aggregate of 25,000 tons of low-grade manganese oxides with from 0.2 to 0.3 percent of cobalt, or about 140,000 pounds of cobalt.

MINES AND PROSPECTS

During this investigation 101 manganese mines and prospects were examined—50 in northeastern Alabama, 25 in Georgia, 14 in Tennessee, 6 in Virginia, 4 in North Carolina, and 2 in South Carolina.

Cartersville district, Georgia

Several of the manganese mines in the Cartersville district were examined in company with T. L. Kesler of the Geological Survey. Because of his intimate knowledge of the district, it was possible to make a preliminary evaluation of the cobalt possibilities of many more of the mines than could otherwise have been done in the short time available. It was not feasible, however, to make a careful examination of the entire district, so that there may well be other cobalt-bearing manganese deposits in the district than the two here described.

Gemes mine.—The Gemes mine, owned by Tom V. Gemes of Cartersville, is located about a mile northeast of Cartersville (see pl. 51). When the mine was operated by Gemes and Dodd some years ago, about 35 carloads of manganese ore were taken out, but for the past 15 years it has been worked only on a small scale. The cobalt-bearing manganese ore was poor in manganese and hence very little of it has been mined. In 1942 an attempt was made to concentrate low-grade manganese ore obtained from the red clay on the east side of the hill shown in plate 51, but after a few months the operation was discontinued.

According to Kesler,6/ who has recently completed detailed studies of the district, the property is underlain by red residual clay derived from the Shady dolomite. The manganese minerals occur both in the clay and in a weathered, crumbly, quartz rock known as jasperoid. Part of the manganese ore in the clay is in a colluvial surface layer. The ore consists partly of fragments, partly of small round pellets with outer concretionary layers of manganese oxides. This kind of material could easily be concentrated by washing alone. Of the ore in the jasperoid, some partly replaces the rock and some forms incrustations, fracture fillings, and cement. All this jasperoid ore would have to be crushed and jigged after it was washed.

Seven analyzed samples of manganese minerals were found to contain from 0.5 to 1.3 percent of cobalt. As shown in plate 51, the manganese-bearing area on the east of the hill is not only the largest of the three cobaltiferous areas, but the highest in average cobalt content, which is 0.94 for the samples analyzed. An X-ray determination of the manganese minerals showed that they are lithiophorite and hollandite.

Ward mine.—The Ward mine is about 6 miles north-northeast of Cartersville (see pl. 51). According to Kesler,7/ it is a brecciated silicified zone in the lower part of the Rome formation. It has been developed by means of a single open cut. Exposures on the west side of the cut show silicified and brecciated dolomite, the fractures in which are filled with manganese oxide. Not only is the ratio of manganese oxide to chert low, but the two are so intermixed that crushing and jigging would be necessary. Some of the manganese oxide contains small irregular pieces of soft white halloysite.

6/ Kesler, T. L., personal communication. 7/ Idem.

Cobalt content of samples from manganese mineral localities

Property or mine	Location	Kind of sample* and analyst†	Percent cobalt
Alabama			
Augusta mine	E. line NE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 33, T. 12 S., R. 11 E.	3,N	1.37
Do	500 ft. W. and 1,500 ft. S. of NE. cor. sec. 33, T. 12 S., R. 11 E.	3,C	.53
North of Bluffton	SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 2, T. 12 S., R. 11 E.	1,C	.56
Burke Estate, near Davis mine	SW. end Dugger Mountain, 9 miles SW. of Piedmont.	3,S	1.26
Daughdrill prospect	SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 3, T. 12 S., R. 11 E.	1,C	1.96
Dulin mine	W$\frac{1}{2}$ sec. 14, T. 18 S., R. 8 E.	1,C	.97
Gorman prospect	W$\frac{1}{2}$NE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 1, T. 12 S., R. 11 E.	1,C	.61
Thompson property, Goshen Valley	NW$\frac{1}{4}$ sec. 20, T. 12 S., R. 10 E.	2,C	.23
Do	Do	2,C	.26
Do	Do	2,C	.10
Harbour property, Goshen Valley	SW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 18, T. 12 S., R. 10 E.	3$\frac{1}{2}$,D	.85
Goshen Valley	SW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 20, T. 12 S., R. 10 E.	3$\frac{1}{2}$,D	.14
Greasy Cove	SE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 11, T. 12 S., R. 4 E.	3,W	.96
Hughes prospect pit	SW$\frac{1}{4}$ sec. 20, T. 12 S., R. 11 E.	1,G	1.66
W. C. Pope, No. 1 cut	SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 9, T. 12 S., R. 11 E.	1,N	4.84
W. C. Pope prospect pit	300 ft. ENE. of No. 1 cut	3,C	.70
Do	400 ft. ENE. of No. 1 cut	3,N	.41
Pope-Hughes prospect pit	NE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 20, T. 12 S., R. 11 E.	1,C	.88
Stockdale mine	Center W$\frac{1}{2}$ sec. 28, T. 12 S., R. 11 E.	1,G	1.59
W. L. Moore prospect, No. 1 cut	NE$\frac{1}{4}$ sec. 31, T. 12 S., R. 11 E.	1,G	4.83
Georgia			
Bearden and Mosteller mine	11 miles north of Cartersville	4,G	.26
H. L. Berkstresser	4 3/4 miles east of Cave Spring, Floyd County.	2,C	.48
Callahan property	2$\frac{1}{2}$ miles south-southeast of Cave Spring, Polk County.	5,S	.30
Gemes mine, east ore body	1 mile northeast of Cartersville	1,S	.90
Do	Do	1,S	1.01
Do	Do	2,S	.77

Gemes mine, east ore body	1 mile northeast of Cartersville	2,S	1.30
Do	Do	2,S	.75
Gemes mine, northwest ore body	Do	1,S	.68
Gemes mine, southwest ore body	Do	2,S	.50
Halloysite mine	5 miles north of Gore, Chattooga County	3,S	.52
McCollum property, west side	5 miles southwest of Cave Spring, Polk County.	3,S	1.14
McCollum property, east side	Do	3,S	.65
McCollum property, west side	Do	2,D	.24
Penland Hill	1¼ miles south of Etna, Polk County	1,C	.29
Penland Hill, pit No. 4	Do	2,E	.19
Penland Hill, pit No. 17	Do	2,D	.10
Potts Hill, pit No. 27	1 mile east of Etna, Polk County	2,E	.02
Ward mine	6 miles north-northeast of Cartersville	1,E	1.60
Gibson mine	6½ miles east of Cave Spring, Floyd County	2,C	.30
Do	Do	3,D	.64
South Carolina			
McCormick mine	McCormick	1,E	Trace
Silver Bluff	2 miles southwest of Kathwood, Aiken County.	6	24
Tennessee			
Blue Spring mine	Stony Creek Valley, Carter County	3,C	.42
Embree Iron Co., West Baptist Hollow	Bumpus Cove district, Unicoi County	1,W	.09
Embree Iron Co	Do	3,G	.14
East Fork mine, north cut	10 miles southeast of Sevierville	1,W	.004
East Fork mine, south cut	Do	1,W	.004
White Oak Mountain, middle prospect area.	8 miles northwest of Cleveland, Bradley County.	1,N	.92
White Oak Mountain, north prospect area	Do	1,N	1.19
Do	Do	1,N	.82
Do	Do	1,C	1.05

* Kind of sample: 1, Average sample of manganese "oxide" in single exposure or prospect; 2, washed concentrate of pellets or fragments from clay; 3, single specimen; 3½, sample of surface concentration of pellets; 4, mill concentrates; 5, old mill tailings; 6, published analysis; 7, analysis by Tennessee Geological Survey, 1942.

† Analyst: C, Cyrus Feldman; D, N. Davidson; E, M. D. Foster; F, Michael Fleischer; G, F. S. Grimaldi; J, J. G. Fairchild; N, Victor North; S, W. G. Schlecht; W, R. C. Wells.

Cobalt content of samples from manganese mineral localities—Continued

Property or mine	Location	Kind of sample* and analyst†	Percent cobalt
Tennessee—Continued			
White Oak Mountain, north prospect area	8 miles northwest of Cleveland, Bradley County.	1,C	0.88
Do	Do	1,C	.37
Do	Do	3,N	2.28
Nunnelly prospect	2 miles southwest of Coble, Hickman County	6	.64
Do	Do	7	.81
Chessor mine	4 miles south of Coble, on Hurricane Creek	7	.13
Virginia			
Buckhorn Mountain, Harrison prospect	Bland County	3,C	.46
North side Iron Mountain	Between St. Clair and Grosses Creeks, Smyth County.	1,W	.02
Crimora mine	$2\frac{1}{2}$ miles east of Crimora, Augusta County	3,F	.53
Do	Do	6	.28
Arms mine, Flat Top Mountain	Old Stange mine, Bland and Giles Counties	4,C	.39
Do	Mine cut in red clay on side of hill	1,G	.11
Do	Do	1,G	.30
Do	Mine cut in sandstone on top of hill	1,G	.25
Do	Do	6	.53
Glade Mountain	3 miles west-northwest of Cedar Springs	3,W	.63
Fisher mine, Lick Mountain	Wythe County	3,C	.27
Lick Mountain Sand Co., Lick Mountain	No. 5 opening	3,G	.11
Pocahontas mine	2 miles south of Tiptop, Tazewell County	3,C	.42
Suiter mine, Round Mountain	$1\frac{1}{2}$ miles northwest of Suiter, Bland County	4,N	.12
Do	Do	3,F	2.24
Prospect pit, Round Mountain	Along ridge to east of Suiter mine	3,N	.29
Do	Northeast end of mountain	3,N	.90
Williams, Spruce Run Mountain, et al.	Giles County	3,C	.63
Boyd Stephenson prospect	$4\frac{1}{2}$ miles north-northeast of Warm Springs, Bath County.	3,N	.21
Church Mountain mine	Elkton	6	2.48
Compton mine	Compton	3,F	.83

Hogpen Hollow	Vesuvius, Rockbridge County	3,J	0.40
Little Piney Mountain prospect	2 miles southeast of Warm Springs, Bath County.	6	2.96
Midvale mine	3/4 mile east of Midvale, Rockbridge County.	6	.79
Mine Bank mine	5 miles east of Vesuvius, Augusta County	3,F	.94
Mt. Torrey mine	Stuarts Draft, Augusta County	3,N	.36

* Kind of sample: 1, Average sample of manganese "oxide" in single exposure or prospect; 2, washed concentrate of pellets or fragments from clay; 3, single specimen; 3½, sample of surface concentration of pellets; 4, mill concentrates; 5, old mill tailings; 6, published analysis; 7, analysis by Tennessee Geological Survey, 1942.

† Analyst: C, Cyrus Feldman; D, N. Davidson; E, M. D. Foster; F, Michael Fleischer; G, F. S. Grimaldi; J, J. G. Fairchild; N, Victor North; S, W. C. Schlecht; W, R. C. Wells.

Specimens were collected at many places on the west face of the cut to make a composite sample that would represent the average composition of the exposed manganese minerals. This sample was found to contain 1.6 percent of cobalt. The manganese minerals present were determined by X-ray to be hollandite and lithiophorite.

White Oak Mountain, Tennessee

The White Oak Mountain manganese property, which belongs to Mrs. M. M. Artz of Cleveland, Tenn., lies 8 miles northwest of Cleveland, in Bradley County, Tenn. It is on one of the several northeast-trending ridges which form White Oak Mountain. The deposit was described by Nelson 8/ in 1911, by Stose and Schrader 9/ in 1918 and 1923, and by Reichert 10/ in 1942. Some prospecting for kaolin as well as manganese has been done three-quarters of a mile to a mile south-southwest of the area shown in plate 52, but the principal manganese deposits are in what are designated on the map as the middle and north prospect areas. Most of the prospecting work was done between 1911 and 1918. The openings comprise many surface cuts and pits, a two-compartment shaft 75 feet deep, and two smaller shafts. In 1941 seven trenches having a uniform depth of about 3 feet were dug, one at the north end of the middle prospect area and six in the north prospect area. There is ore on the dumps of some of the openings, but none has been shipped.

The manganese minerals occur in the Fort Payne chert, filling cracks and joints and partially replacing the rock. The ore is high in silica and would require crushing and jigging. The ratio of manganese to chert is so low that it would be necessary to mine and mill a large amount of chert in order to recover a relatively small amount of manganese concentrates. In the middle prospect area, manganese minerals are most abundant at

8/ Nelson, W. A., A new manganese deposit in Tennessee: Tennessee Geol. Survey, The resources of Tennessee, vol. 1, no. 6, pp. 220-228, 1911.

9/ Stose, G. W., and Schrader, F. C., Manganese deposits of east Tennessee: Tennessee Geol. Survey, The resources of Tennessee, vol. 7, nos. 3 and 4, pp. 189-190, p. 323, 1911; Manganese deposits of east Tennessee: U. S. Geol. Survey Bull. 737, pp. 139-142, 1923.

10/ Reichert, S. O., Manganese resources of east Tennessee: Tennessee Geol. Survey Bull. 50, pp. 189-193, 1942.

the west end of the southernmost cut or trench. The large shaft to the east is said 11/ to be 75 feet deep, with the lower 22 feet in black shale. The large open cut at the north end of this area seems to have encountered manganiferous iron oxide. The shaft to the south is about 50 feet deep, but it did not strike any manganese ore. In the north prospect area, the principal workings consist of an open cut, measuring roughly 50 by 75 feet, and a narrow cut about 100 feet long just to the north of it. The best showings in the north prospect area are in these cuts, but even here the ratio of manganese to chert is very low.

The manganese minerals at the White Oak Mountain prospects are generally known as oxides. An X-ray determination of the oxide in one specimen showed it to be lithiophorite. The cobalt content of the seven samples analyzed ranged from 0.37 to 2.28 percent and averaged about 1 percent. As indicated in the cross sections on plate 52, the manganese oxides are believed to be most abundant near the surface and to extend only to shallow depths.

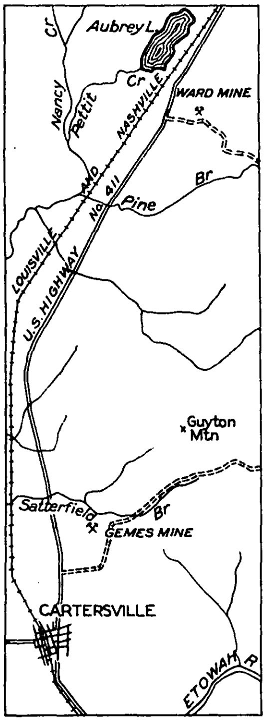
Rock Run area, Alabama and Georgia

The Rock Run area comprises a belt about 11 miles long, which lies mostly in Cherokee County, Ala., but includes a part of Cleburne County, Ala., and a little of Polk County, Ga. (see pl. 53). It has aroused interest because it has been found to contain manganese ore containing several percent of cobalt. Although cobaltiferous manganese oxides are rather widespread in the area, the deposits are all of such low grade with respect to manganese that they cannot be worked profitably for their manganese content alone. So far as known, moreover, their tonnage is insufficient to warrant plans for concentrating the manganese materials and recovering the contained cobalt.

Of the ten deposits included in the Rock Run area, eight are in the Weisner quartzite and two in clay residual from the Knox dolomite. In all of the deposits the manganese oxides have about the same appearance, and all that have been analyzed consist of lithiophorite or hollandite or both. The manganese minerals occur as fracture fillings and incrustations, and they partially replace quartzite, sandstone, and chert. Brief descriptions of the cobaltiferous manganese-oxide properties in the Rock Run area are given below.

W. C. Pope prospect.—The W. C. Pope prospect is located in the SE¼SE¼ sec. 9, T. 12 S., R. 11 E. According to Mr. Pope, the first prospecting was done in 1918, when two tons of ore was shipped to Niagara Falls. In 1929 the property was leased by Mr. Blood, and some further prospecting was done. In 1931 the Harshaw Chemical Co. took an option on the property and mined and shipped about 18 tons of ore, and in the following year they did some churn drilling and sampling. As shown in plate 54, many surface pits and cuts have been made in search for additional ore. Tyler 12/ reports that about a carload of manganese ore, containing 4 percent cobalt, was taken out, some of which was shipped for making ferromanganese.

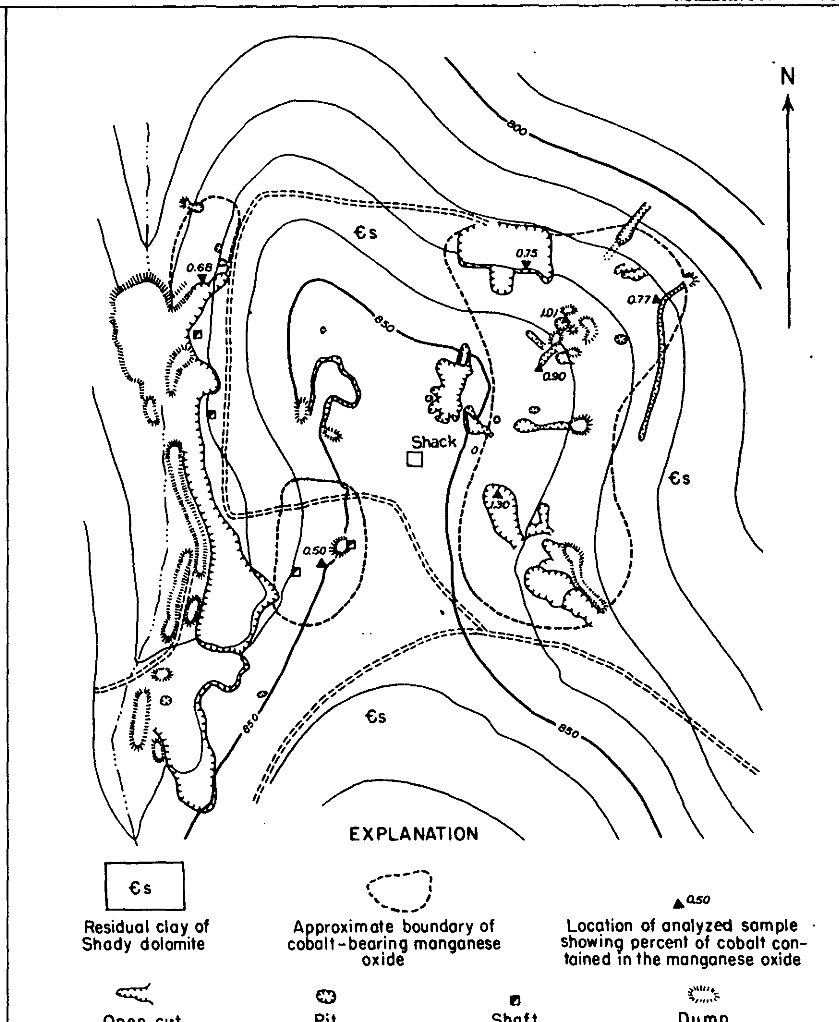
11/ Stose, G. W., and Schrader, F. C., op. cit., p. 141, 1923.
12/ Tyler, P. M., Cobalt: U. S. Bur. Mines Inf. Circ. 6331, p. 8, 1930.



Base from Geological Survey topographic map of Cartersville mining district, Ga.

INDEX MAP
SHOWING LOCATION OF
GEMES AND WARD MINES

0 2 Miles

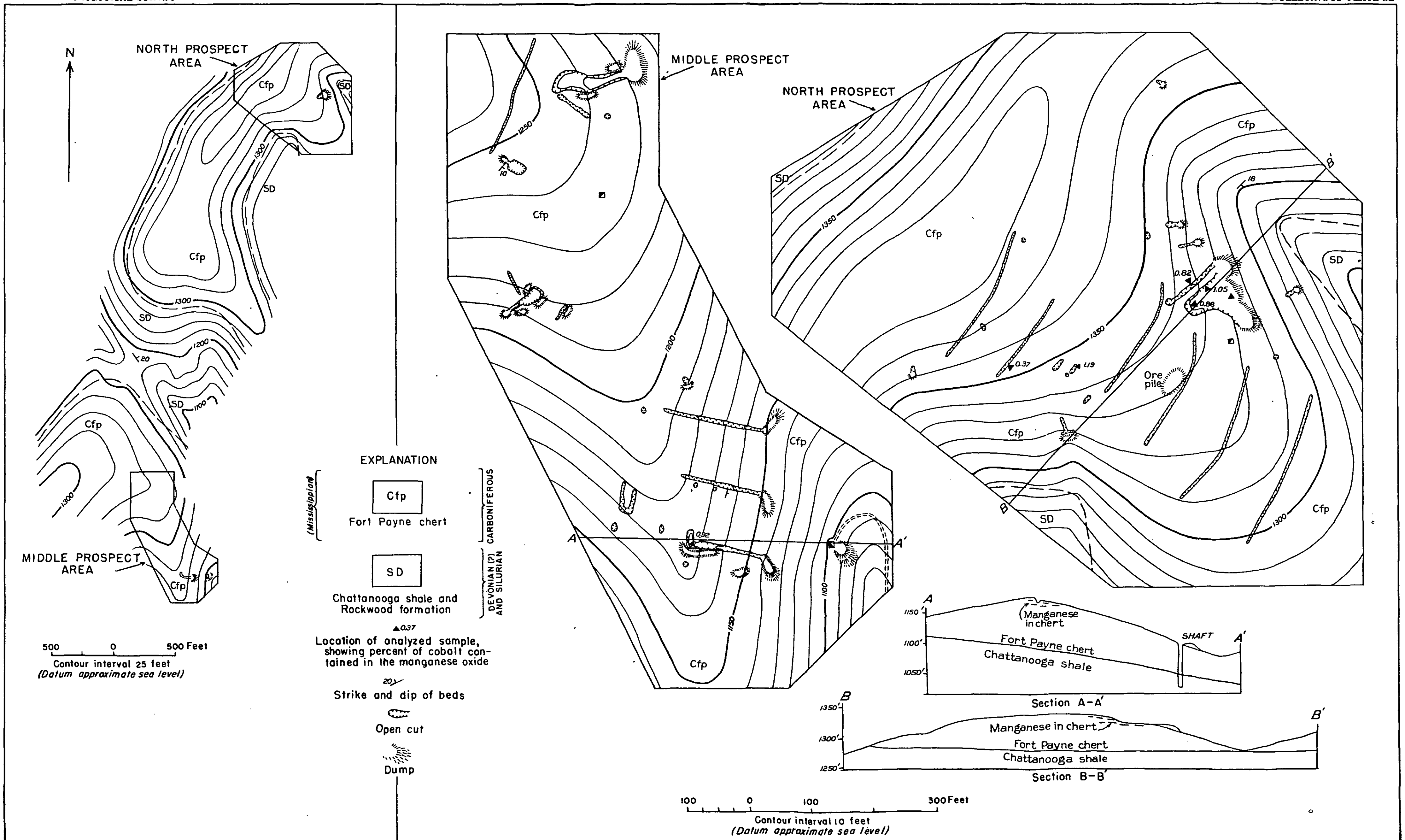


W. G. Pierce and A. E. Engel
Nov. 1942

MAP OF THE GEMES MINE, CARTERSVILLE DISTRICT, GA.

100 0 100 400 feet

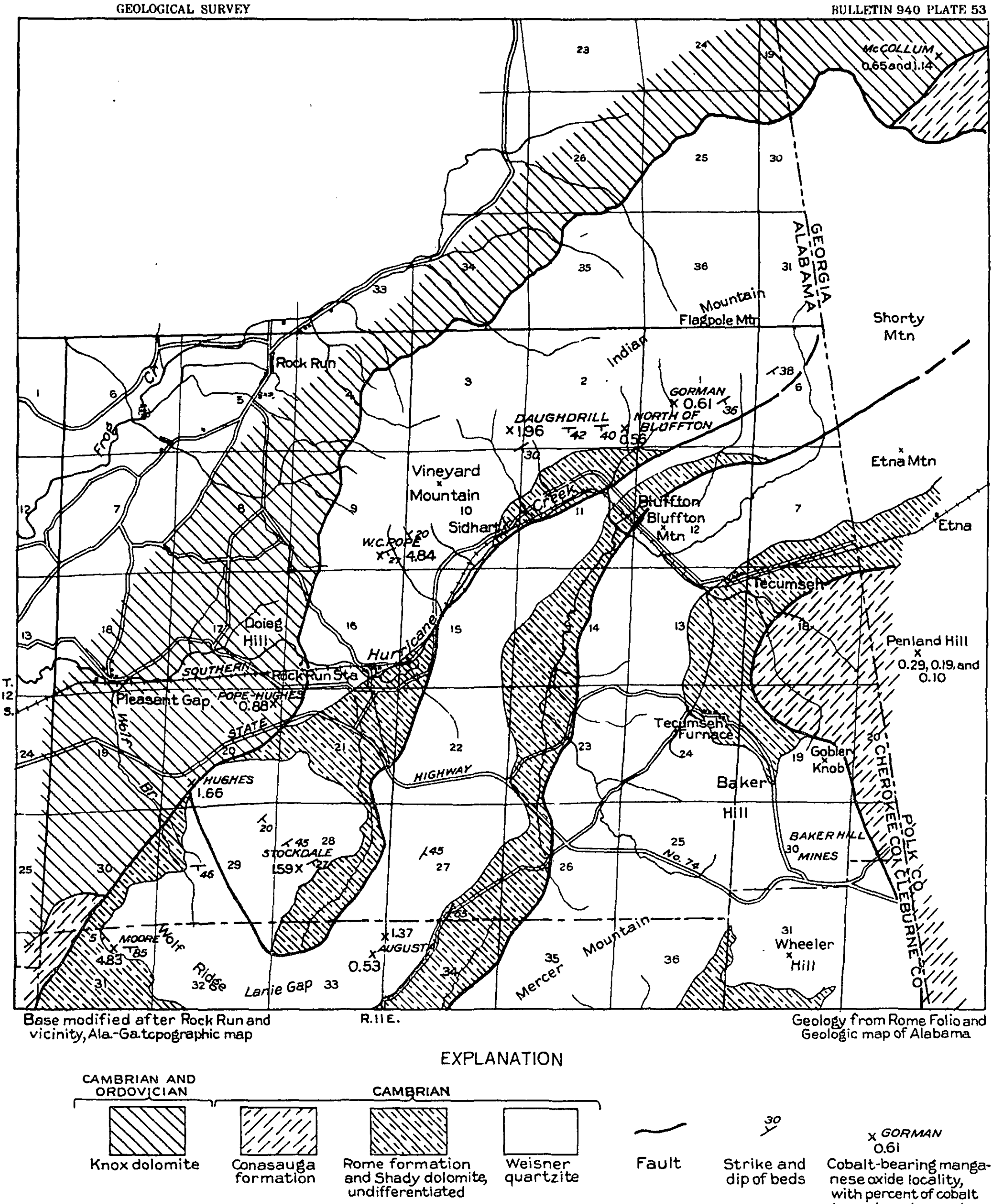
Contour interval 10 feet
Datum approximate sea level



MAP OF WHITE OAK MOUNTAIN MANGANESE AREA, BRADLEY COUNTY, TENN.

W.G. Pierce and A.E. Engel
Nov. 1942

582081 O - 44 (Face p. 276)



GEOLOGIC MAP OF THE ROCK RUN AREA, ALABAMA

0 2 Miles

The only manganese ore now exposed in the prospect pits is in the No. 1 cut. Manganese oxide is sparingly present on the east side of the cut as fracture fillings and incrustations on the quartzite, and a very little can be seen on the west side. On the northeast face of the cut there is much iron oxide, occurring in the same manner as the manganese oxide, but it contains no cobalt. The most northeasterly cut shown on the map is reported to have encountered some manganese oxide, but none of it is now exposed.

A composite sample made up of many pieces of manganese oxide collected by the writer from a small ore dump of the No. 1 cut was found on analysis to contain 4.84 percent cobalt. A piece of manganese oxide obtained from the dump of a small prospect pit about 300 feet east-northeast of the No. 1 cut contained 0.70 percent cobalt, and a manganese-oxide specimen from the dump of the most northeasterly cut contained 0.41 percent cobalt.

R. Stockdale prospect.—The Stockdale prospect is near the center of the W½ sec. 28, T. 12 S., R. 11 E. It has been worked by Ralph Stockdale, Bud Glover, Ross Clay, and Ed Emerson. It was last worked about 1934 by Emerson, who estimates that all told about 500 tons of ore has been mined. The workings (see pl. 54) consist of a roughly circular open cut about 50 feet in diameter and 20 feet deep, a smaller cut to the north, and several shallow pits and trenches.

In the main cut, manganese oxide occurs as fracture fillings and incrustations in brecciated Weisner quartzite. Some large masses of brecciated chert, which may not be in place, lie about 100 feet to the north-northwest. The manganese oxide in the chert is harder and more siliceous than that in the quartzite and does not have botryoidal forms.

An analysis of a composite sample of manganese oxides from several parts of the main pit showed 1.59 percent cobalt.

W. L. Moore prospect.—Most of the prospecting by Mr. W. L. Moore has been done on property in the NE¼ sec. 31, T. 12 S., R. 11 E., belonging to Norris C. Webb of Spring Garden, but some work has been done in the adjoining SE¼ of sec. 30. The largest cut, designated in plate 54 as No. 1 cut, was made in 1937. About 750 feet to the northwest is No. 2 cut, and 250 feet farther northwest, beyond the limits of the detailed map, is a small shallow trench. In sec. 30 there are two prospect pits, about 6 feet long, 3 feet wide, and 3 feet deep, and two shallow open cuts.

In No. 1 cut and at scattered localities to the northwest, cobaltiferous manganese oxides occur as fracture fillings and stringers and replace brecciated ferruginous Weisner quartzite. At No. 2 cut there are a few nodules of manganese oxide. The stringers of manganese oxide, the thickest of which are about 1½ inches thick, are sparingly distributed through a zone 5 feet in maximum thickness. This mineralized zone is nearly vertical, being parallel to the bedding of the rocks. The prospect pits to the north and west of No. 2 cut contain clay and chert as well as quartzite, and may be in the weathered residuum of the Shady dolomite. One of these pits was worked for brown iron ore.

A sample of manganese oxide collected by the writer from the beds exposed in the face of No. 1 cut was found on analysis to contain 4.83 percent cobalt; the manganese oxides in No. 2 cut and in the prospects to the north contain much less.

Hughes prospect.—The Hughes prospect is located in the SW¼ sec. 20, T. 12 S., R. 11 E. It was prospected about 1930 by digging two small pits 3 to 4 feet deep, one about 4 by 10 feet in horizontal dimensions and the other about 5 feet in diameter.

Manganese minerals here occur as fracture fillings and partially replace chert. The chert suggests that the deposit is in the Knox dolomite, but if so it is probably near a fault contact between the Knox dolomite and the Weisner quartzite. The ratio of manganese oxide to chert seems to be higher here than at some other Rock Run localities, and if it is found that this type of material can be worked for cobalt and manganese, some further prospecting here to determine the extent and grade of the deposit might be worth while. A composite sample of manganese oxide collected by the writer from the dumps of the two pits contained 1.66 percent cobalt.

Pope-Hughes prospect.—The Pope-Hughes prospect is in the NE¼NE¼ sec. 20, T. 12 S., R. 11 E. About 1938, three shallow pits were dug here, 7 feet apart and each about 5 feet in diameter.

The manganese oxide is disseminated in chert, which is probably a part of the Knox dolomite. Fairly abundant manganese-oxide float was observed to extend for a distance of 250 feet west of the prospect pits. A composite sample of manganese oxide from the dumps of the prospect pits contains 0.88 percent cobalt.

Augusta mines.—The Augusta mines are principally old iron mines, first operated about 1890, but a manganese mine near the east line of the NE¼ sec. 33, T. 12 S., R. 11 E., was worked about 1918. The ore, about two carloads of which were shipped, is said to have been sacked, and hauled by mules to the railroad at Borden Springs. The workings consist of three open cuts and several smaller pits extending up the hillside for a distance of 200 feet.

Weisner quartzite is exposed at several places near the pits. Manganese oxide fills fractures, partially replaces sandstone, and occurs as nodules in clay which may have been derived from the Shady dolomite. An analysis of a specimen collected near these pits by T. G. Andrews showed 1.37 percent cobalt. Another specimen collected by Andrews from a locality 1,000 feet to the southwest contained 0.53 percent cobalt.

Daughdrill prospect.—The Daughdrill property, in the SE¼SE¼ sec. 3, T. 12 S., R. 11 E., has been prospected by W. E. and W. A. Daughdrill of Alabama City. A pit about 15 feet in diameter and originally 12 feet deep has been dug on the southwest side of a hill, and on the southeast side of the hill is a trench about 50 feet long and 5 to 7 feet deep (see pl. 54).

The manganese oxide in the circular pit occurs as veins in fractures and as thin incrustations on the Weisner quartzite. The ratio of manganese oxides to sandstone and quartzite is very low. The trench is in a mantle of yellow clay containing a little iron oxide, which is thinly coated with manganese oxide. A composite sample of manganese oxides obtained from the pit contained 1.96 percent cobalt, and qualitative tests on the manganese oxides from the trench indicate they also have an appreciable cobalt content.

North of Bluffton.—North of Bluffton, in the SE¼SE¼ sec. 2, T. 12 S., R. 11 E., there are thin stringers of manganese oxide in the Weisner quartzite. No prospecting for manganese ore has been done here, although a few shallow prospect pits have been made in looking for iron ore. Some unusually good exposures were noted that show manganese oxides filling fractures and crevices and replacing quartzite. At one place a 3-foot zone in the quartzite contains several manganese-oxide stringers ranging from an eighth of an inch to an inch wide. The combined thickness of the stringers, however, is only about 2 inches, so that the total quantity of manganese oxide is very small. A composite sample of manganese oxide obtained from the zone contains 0.56 percent cobalt.

Gorman prospects.—The Gorman prospects consist of several open cuts in the N½SW¼ sec. 1, T. 12 S., R. 11 E., which have been worked for iron and manganese ores. The property was worked about 1930, and some prospecting was done in 1942. It is reported that about a carload of manganese ore has been shipped.

On the east side of a small draw (see pl. 53) are several pits. The lowest pit is in clay and sandstone. The manganese ore on the dump is of low grade, containing much silica and iron. About 100 feet up the hill to the northeast, in Weisner quartzite, is a trench 40 feet long with a maximum depth of 15 feet. The trench follows a fault that strikes N. 9° W. and dips 80° E. Manganese oxide fills and partially replaces the quartzite, but the ratio of manganese oxide to quartzite is very low. A sample of the manganese oxide contained 0.61 percent cobalt.

The open cut on the west side of the small draw is also in brecciated sandstone. Here iron oxide is much more abundant than manganese oxide.

McCollum prospect.—The McCollum property is about 1¼ miles east of the Alabama-Georgia line and about the same distance south of the north line of Polk County (see pl. 53). Considerable prospecting was done in 1918,13/ but not much ore has been shipped. There are many prospect pits on the southeast slope of a northeast-trending ridge, in an area extending along the side of the ridge for about 800 feet and lying at an altitude of about 1,000 feet.

Manganese oxides occur as incrustations on the Knox dolomite, and some of them replace the rock. The ore is very siliceous, as shown by published analyses.14/ At the southwest end of the deposit there is some red clay containing pellets of manganese oxide, which is locally called gravel ore. A sample of manganese oxide concentrate washed from the clay was analyzed and found to contain 0.24 percent cobalt. The middle and northeastern parts of the deposit contain manganese oxide, which forms coatings and fracture fillings and partially replaces pieces of chert embedded in the clay. A sample of manganese oxide from the middle of the deposit contained 1.14 percent cobalt, and one from the eastern part contained 0.65 percent cobalt. A sample from the middle of the deposit was found by X-ray determination to consist of hollandite and lithiophorite.

13/ Hull, J. P. D., LaForge, Laurence, and Crane, W. R., Report on the manganese deposits of Georgia: Georgia Geol. Survey Bull. 35, pp. 160-162, 1919.

14/ Idem, p. 161.

Dulin mine, Alabama

The Dulin mine is located in the NE¼SW¼ sec. 14, T. 18 S., R. 8 E., in Clay County, Ala. It is described, as the Shadix property, by Prouty 15/ as follows: "At this place there is both a bed of bog manganese and a fairly wide (40 feet) zone of phyllite mineralized with stringers, veins, and lenses of psilomelane. This deposit was tested prior to 1917, and was worked some during 1917-18. One drawback to the ore is the difficulty of separating it from the phyllite with which it is associated. The pure ore analyzes from 52 to 58 percent manganese."

The workings consist of two circular pits 15 to 20 feet in diameter and about 20 feet deep. The pits are about 12 feet apart and are connected by a tunnel. They were half filled with water when visited, so that part of the old workings could not be examined. A drift, presumably short, could be seen to extend westward from the west pit, and an adit has been driven 10 feet eastward from the east pit. About 100 feet south of these pits are several shallow pits and a shaft.

The manganese mineralization at the Dulin mine is quite different from the manganese silicate type usually found in the crystalline rocks. No manganese silicates were found on the dump or in the accessible workings. The mineralization appears to be similar to that of the manganese deposits in the Weisner quartzite, the manganese oxide having been transported by ground water and deposited in fractures and open spaces in the country rock; the manganese content will therefore probably decrease with depth. A composite sample from several "veins" in the upper part of the west pit contained 0.97 percent cobalt. An X-ray determination showed that the sample consisted mostly of lithiophorite, with a little hollandite.

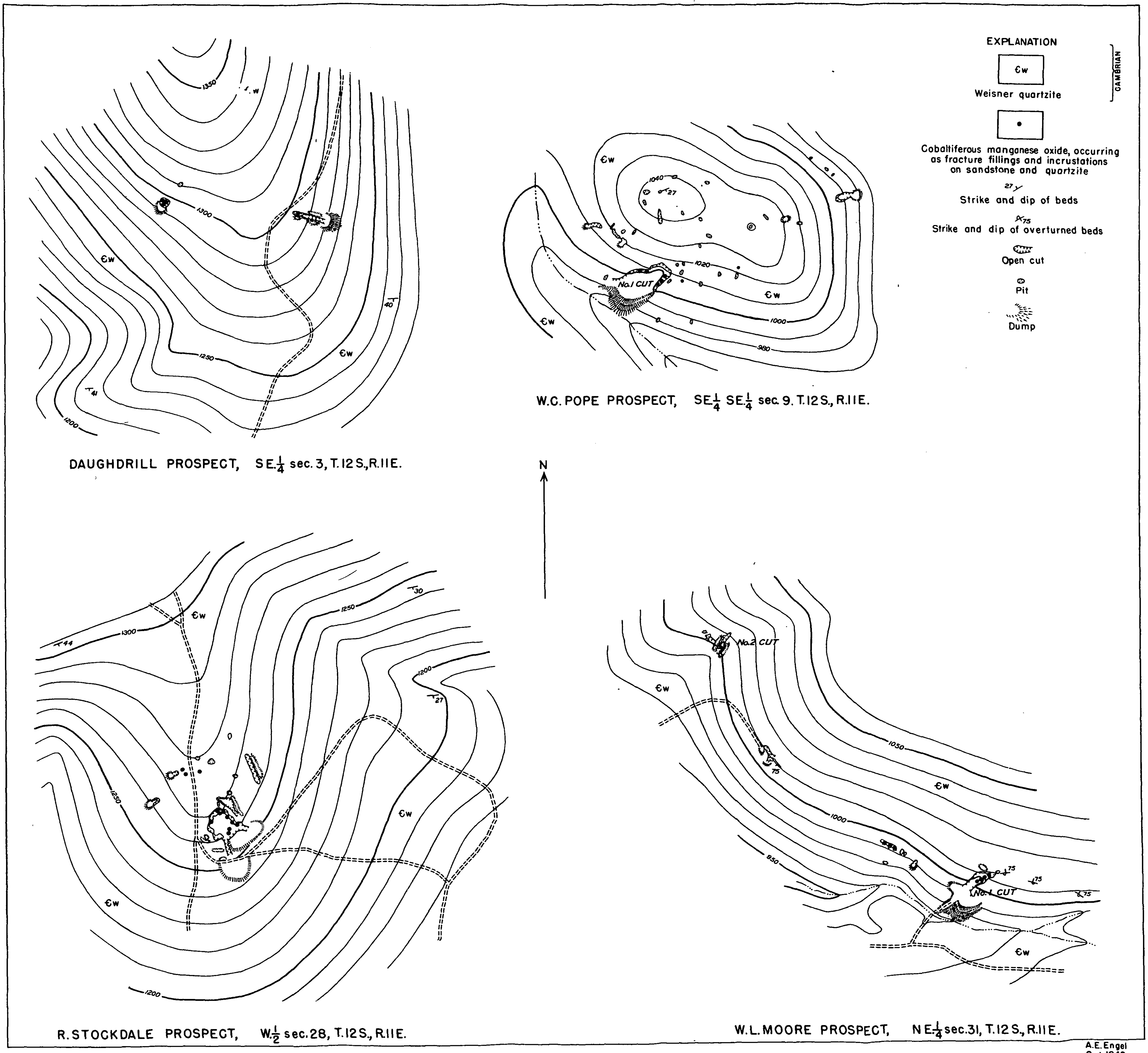
Greasy Cove, Alabama

The Greasy Cove deposit is on property owned by Mrs. Rogers of Attalla, Ala. It is located 6 miles southwest of Attalla, on the top of a hill having an altitude of 965 feet,16/ in the SE¼SW¼ sec. 12, T. 12 S., R. 4 E. It is reached by a trail leading from J. E. Blackmon's house in the NW¼NE¼ sec. 14, T. 12 S., R. 4 E. Mr. Blackmon reports that about 100 tons of ore has been taken out, and that the last mining was done about 10 years ago. There is an 18-foot shaft, now caved, near the middle of the deposit, and about 125 feet to the north-northeast is the portal of an inclined tunnel that pitches 17° southward. About 50 and 75 feet southwest of the shaft are the caved portals of two northeast-trending adits. In addition to these underground workings there are several small prospect pits.

The manganese occurs in thin lenses and small irregular bodies of oxide in weathered chert and clay of the Fort Payne chert. As the deposit lies on the top of a small hill, its lateral extent is very limited. A specimen collected by E. F. Burchard was found to have a cobalt content of 0.96 percent.

15/ Prouty, W. F., Geology and mineral resources of Clay County: Alabama Geol. Survey County Report 1, p. 70, 1923.

16/ U. S. Geol. Survey, Greasy Cove, Ala., topographic map, advance sheet.



COBALTIFEROUS MANGANESE PROSPECTS IN THE ROCK RUN AREA, CHEROKEE COUNTY, ALA.

100 0 100 300 Feet

Contour interval 10 feet

(Datum approximate sea level)

Cedartown, Georgia, manganiferous pellet deposits

Low-grade manganese of the kind variously called gravel, shot, or pellet ore occurs at several localities in the Cedartown area. The pellets are in a red clay, from which they can readily be separated by washing. Several of the deposits contain a considerable quantity of manganese-oxide pellets, but the manganese content of the pellets is below normal market demands. The Gibson and Berkstresser deposits in Floyd County and the Penland Hill, Potts Hill, and Red Hill deposits in Polk County were examined and are estimated to contain a total of 16,000 tons of concentrates. Of this amount, 13,500 tons is in the Gibson, Penland Hill, and Berkstresser deposits, which are described below. The cobalt content of the pellets in these three deposits ranges between 0.2 and 0.5 percent.

Gibson mine.—The Gibson mine is 7 miles north of Cedartown and 6 miles east of Cave Spring, in Floyd County, Ga. It is said to be on lot 835, 3d district, 4th section, on property now owned by Glen York and R. L. Norton of Cedartown. The map (pl. 55) also shows part of the M. F. Mullinax property on lot 836, which adjoins lot 835 on the west. The Gibson mine contains one of the Reynolds Mountain deposits, described by Watson,17/ and it is part of the Wood and Reynolds property, described by Hull and others.18/

Here for some years Mr. Gibson obtained manganese-oxide ore from open cuts, mining, sorting, and cobbing the ore by hand. Early in 1942, York and Norton made the long cut in the red clay to the southeast of the old workings with a power shovel, and hauled a few truckloads to an iron-ore log washer for a trial test. In the spring of that year test pits were put down by the Work Projects Administration Mineral Resources Survey. Most of the pits were between 4 and 8 feet deep, but as they have been back-filled they could not be examined.

Two types of manganese ore occur here. In one type, manganese oxide replaces and fills voids in chert beds of the Knox dolomite. It is this type of ore that has been worked by hand methods. The other type, known locally as gravel ore, consisting of pellets, fragments, and concretionary nodules of manganese oxide in red clay, has not yet been mined, except for an experimental half carload which was washed in an iron-ore log washer.

The chert-manganese-oxide deposits contain some massive chert, but for the most part the chert is severely brecciated and mixed with clay. It is predominantly fresh, crisp, and hard, showing little evidence of leaching of silica. The manganese oxide occurs in irregular masses and in fracture fillings, and there are some pockets of clean high-grade ore. Stringers of wad and soft pyrolusite also occur in the clay and chert. The chert-manganese-oxide type of deposit underlies the pellet deposit. It is not exposed along the lower slopes of the hill, but lies a few feet below the surface along the hilltop. (See photograph, pl. 50, B).

The pellet-bearing clay is a roughly lens-shaped mass, thickest along the slope of the hill below the crest, where the

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17/ Watson, T. L., A preliminary report on the manganese deposits of Georgia: Georgia Geol. Survey Bull. 14, pp. 119-122, 1908.
18/ Hull, J. P. D., LaForge, Laurence, and Crane, W. R., op. cit., pp. 167-169.

thickness in two test pits is over 22 feet, and thinning out toward the crest of the hill and the bottom of the valley, as shown in the cross section, plate 55. Laterally along the hillside the abundance of the pellets varies, probably reflecting variable extent of manganese mineralization in the underlying chert.

It seems evident that the pellets of manganese oxide have been derived from manganese oxide formerly in the chert. The upper part of the manganiferous chert grades into the pellet-bearing clay. The transition zone is variable in thickness, with a maximum thickness of 6 feet, and is characterized by an increased concentration of the more insoluble oxides of iron and manganese. The chert is altered, in this zone, to soft tripoli-like masses, commonly coated and partially impregnated with manganese oxide.

The pellets range in diameter from 1 millimeter to 3 inches. Most of the large pellets and many of the small ones have cores of chert or crystalline quartz. Many of the small pellets are concentrically layered, which indicates that they have been built up by an accretionary process. The deep red color of the clay in which the pellets occur suggests a residual concentration of iron as well as manganese in this surficial material. Analyses of the pellets show that they contain about 7 percent of iron.

A small sample of clay from the face of the recent large cut was washed and found to contain roughly 8 percent of pellets by volume. A sample of the pellets was found to contain 24 percent manganese, 6.6 percent iron, and 0.3 percent cobalt. A similar sample from the upper 13 feet of a 22-foot test pit, 100 feet northeast of the mouth of the red clay cut, contained roughly 5 percent of pellets, which were 14 percent manganese and 7.5 percent iron. The half carload of pellet concentrates that was shipped is said by Glen York to have contained 26 percent manganese. A sample of manganese oxide from the chert was analyzed and found to contain 0.64 percent cobalt, but not all of the manganese oxide in the chert carries this much cobalt.

The main body of pellet-bearing material is southeast of the hilltop, as shown in plate 55. The deposit north of the hill is probably less rich, smaller in area, and not as deep. The small area northwest of the hill is very lean and is only a few feet deep.

Berkstresser property.—The H. L. Berkstresser property is 7 miles north of Cedartown and 1½ miles west of the Gibson mine. It is said to be on lots 840 and 841, 3d district, 4th section. Some prospect pits have been dug on the property but no mining has been done. A carload of manganese nodules is said, however, to have been picked up on the surface and shipped.

The deposit consists of manganese-oxide pellets in a residual red clay. It is presumably underlain by the Knox dolomite. Except for one prospect pit 5½ feet deep, the test pits now open are no more than 4 feet deep and most of them do not reach the base of the pellet-bearing clay. It is reported that 36 test holes from 10 to 35 feet deep were put down in 1924, and that in some of them the pellets extended to a depth of 20 feet. Present exposures in prospects are not sufficient to determine accurately the extent of the deposit; the approximate extent shown in plate 55 is largely inferred from the distribution of pellets on the surface. According to rough field estimates, the pellets make up from 4 to 8 percent of the clay. Of the few exposures available, the one showing the most abundant pellets was in the 4-foot pit just beyond the northwest corner of the cotton field. Near the top of the hill to the west of the deposit there is abundant float of high-grade manganese ore in a cultivated field.

A single analysis of pellets washed from a 4-foot section of clay near the middle of the deposit showed 23 percent manganese, 7.2 percent iron, and 0.48 percent cobalt.

Penland Hill.—The Penland Hill property of Charles H. Fite is 8 miles west of Cedartown and 1¼ miles south of Etna, in Polk County, Ga. It is said to be on lot 238, 17th district, 3d section, and its location is shown on the Rock Run map, plate 53. No mining has been done on it, but 38 test pits were put down in 1941 by the Work Projects Administration Minerals Survey, and these were still open at the time of the present examination. Four of them were from 10 to 23½ feet deep, and 34 were from 2 to 5 feet deep.

The pellets occur in a residual red clay, similar in appearance to the clay at the Gibson mine. The deposit is on the top of a gently rounded hill. Quartzite, apparently the Weisner quartzite, crops out on the south end of the hill, and also on the hill 1,200 feet to the west-northwest. It is therefore inferred that the pellet-bearing clay is derived from weathering of the Shady dolomite, which overlies the Weisner quartzite.

The location and depth of most of the prospect pits and the thickness of the pellet-bearing clay exposed in them are shown in plate 55. The horizontal extent of the pellet-bearing clay can be determined with a fair degree of accuracy, although the boundary between pellet-bearing clay and that without pellets is gradational. Since few of the pits were extended to the base of the pellet-bearing clay, the thickness of the deposit at most places is not known. In two of the holes, however, the deposit is seen to be over 23 feet thick.

Rough field estimates indicate that the concentration of pellets in the clay varies both laterally and vertically, ranging from 3 to 10 percent by volume. A composite sample, made up of the good-grade pellets from several pits, contained 28.2 percent manganese and 0.29 percent cobalt, which is thought to represent approximately the best grade of material that could be produced in any quantity by concentration. The manganese content of an average pellet concentrate, however, is considerably less. A pellet concentrate from pit No. 17 contained 16 percent manganese, 7.9 percent iron, and only 0.1 percent cobalt.

Coble, Hickman County, Tennessee

According to S. D. Harper, who lives near Coble, cobalt was first discovered in this region about 1905, in a manganese specimen sent to the Thomas A. Edison laboratory by H. C. Lewis. Mr. Edison then visited the area personally, and soon thereafter exploratory work, in which Mr. Harper was employed, was done on several properties near Coble to see if a body of cobalt ore could be found.

One of these, the Nunnelly property, is 2 miles by airline west-southwest of Coble. Having been described by Burchard,19/

19/ Burchard, E. F., The brown iron ores of the Western Highland Rim, Tenn.: Tennessee Geol. Survey Bull. 39, pp. 115-116, 1934.

it need not be described here, except to say that manganese oxide occurs in a small fracture and in a few vertical seams in weathered Fort Payne chert. Burchard gives an analysis of a sample of manganese oxide, showing 0.81 percent cobalt oxide and 1.48 percent nickel oxide. A sample of similar material recently analyzed by the Tennessee Geological Survey contained 0.81 percent metallic cobalt and 1.02 percent nickel.20/

Another deposit is on the Bates farm, 4½ miles by airline southwest of Coble. It is prospected by means of a side-hill cut 40 feet long, 20 feet wide, and 8 feet in maximum depth. Manganese oxide forms incrustations on Fort Payne chert; it is mostly confined to a horizontal layer from 6 inches to 1 foot thick. Some of the chert coated with manganese oxide has been mined but has not been shipped. A chemical test indicates that the manganese oxide contains much less cobalt than the Nunnelly samples.

At the old Chessor mine, which lies 5½ miles south of Coble and half a mile southwest of Coble Cemetery, manganese ore was mined many years ago for pottery use. Mr. Edison is reported to have had some exploration work done here at the time the other Coble deposits were prospected, and in 1940 a small prospect pit was dug by Omar Barber. An analysis of manganese oxide from the Barber pit by the Tennessee Geological Survey showed 0.13 percent cobalt and 0.53 percent nickel.21/ The manganese oxide seems to be mostly confined to the upper few feet of weathered Fort Payne chert and clay, and it is probably spotty and of very limited lateral extent.

Silver Bluff, South Carolina

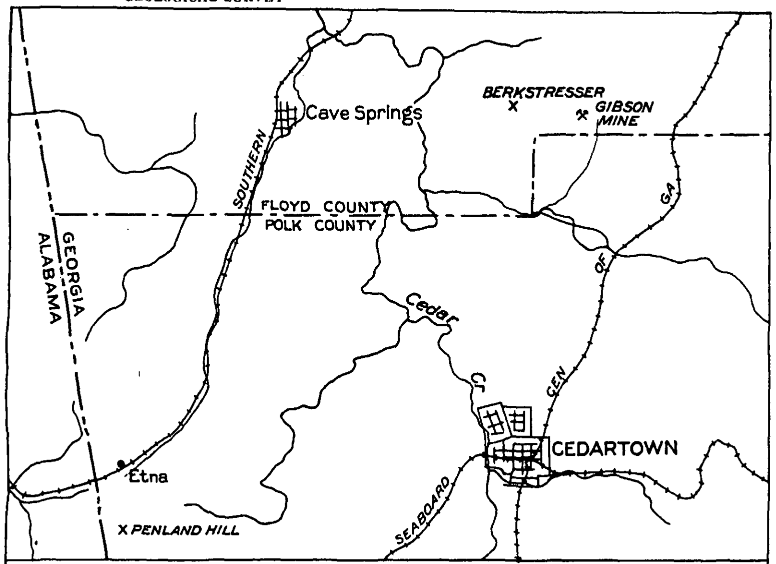
Asbolite or earthy cobalt oxide, with 24 percent cobalt oxide and 76 percent manganese oxide, is reported by Dana 22/ to occur near Silver Bluff, S. C. Silver Bluff is on the east bank of the Savannah River, 2 miles southwest of the post office of Hankinson (now Kathwood), shown on the Augusta quadrangle topographic map. A pottery concern of Liverpool, O., investigated the Silver Bluff occurrence 20 years ago or more and did some prospecting in the hope of finding asbolite or cobaltiferous manganese oxide on the old C. C. F. Hammond property, now owned by F. T. Starr of Philadelphia. They failed, however, to find a workable deposit of cobalt ore.

The rock exposures at Silver Bluff show about 15 feet of coarse sandstone and fine-grained angular conglomerate, underlain by 5 to 8 feet of blue clay which extends down to the water of the Savannah River. The only cobaltiferous material found by the writer consists of a few masses a few inches across in the sandstone, which have a dark manganiferous cementing material that contains a little cobalt.

Manganese-silicate veins of Alabama, Georgia, South Carolina, and North Carolina

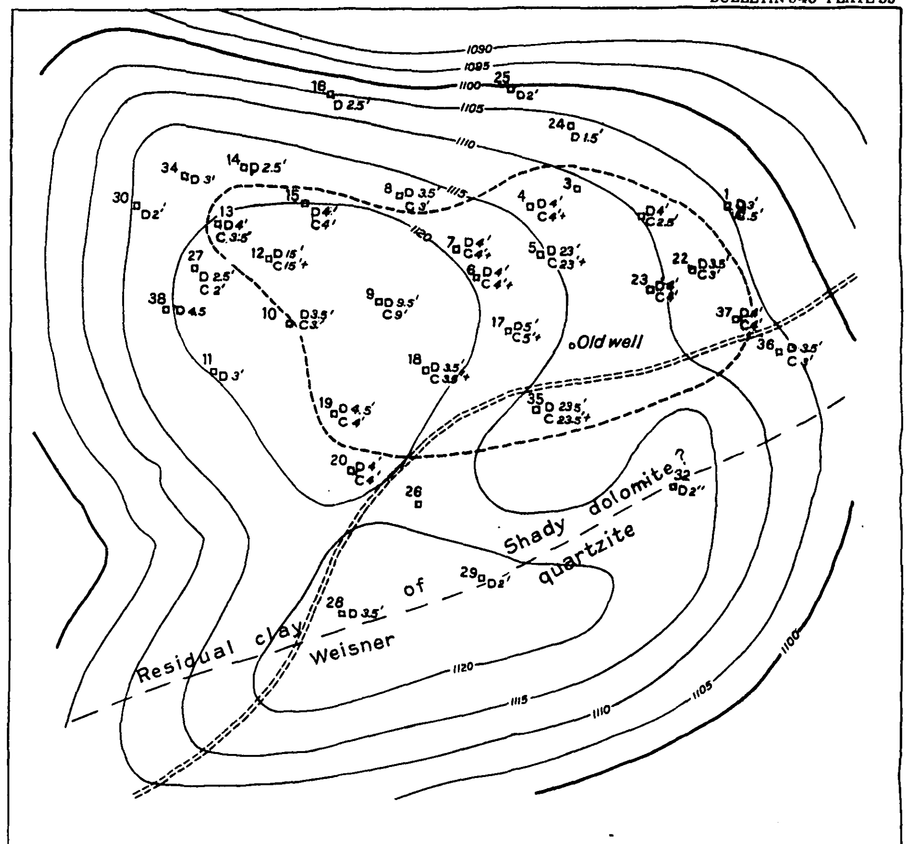
Seven deposits composed of veins of manganese silicates were examined to see whether they contained any cobalt. These

20/ Whitlatch, G. I., personal communication.
21/ Idem.
22/ Dana, E. S., System of mineralogy, 6th ed., p. 258, 1892.



INDEX MAP SHOWING LOCATION OF THE CEDARTOWN MANGANIFEROUS PELLET DEPOSITS

1 0 1 5 Miles



EXPLANATION

Approximate limit of manganiferous pellet deposit

27 D 2.5' C 2' W.P.A. prospect pit 27; total depth 2.5 feet thickness of pellet-bearing clay 2 feet

THE PENLAND HILL PROPERTY OF CHAS. H. FITE
POLK COUNTY, GEORGIA
Contour interval 5 feet
(Datum approximate sea level)

EXPLANATION

€ok Knox dolomite — CAMBRIAN AND ORDOVICIAN

5 W.P.A. prospect pit 5 (only 17 of a total of 42 pits are shown)

Approximate limit of manganiferous pellet deposit

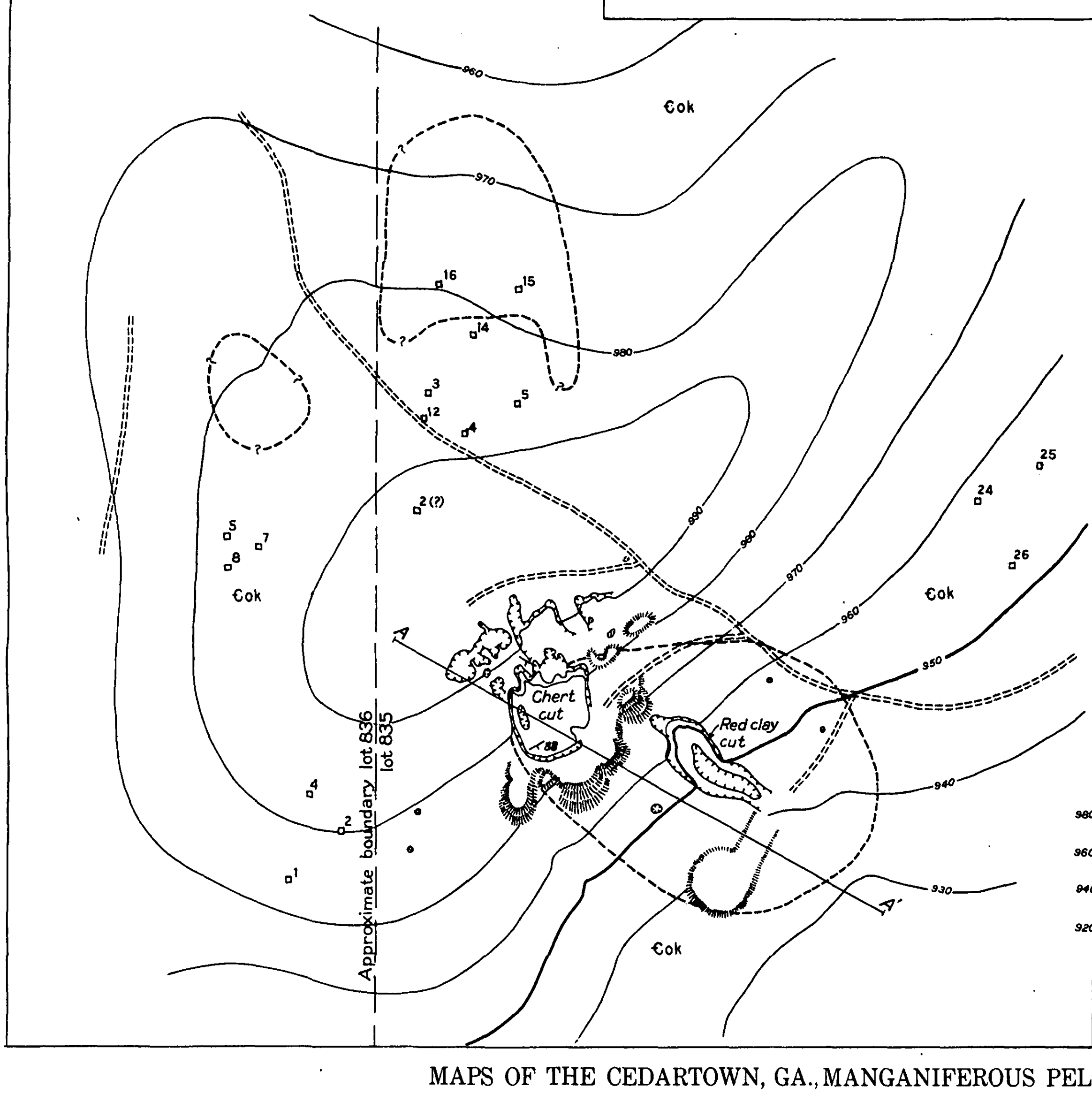
Open cut or prospect pit

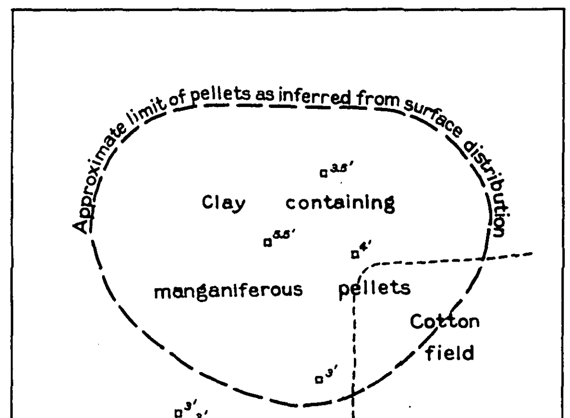
Strike and dip of beds

Mine dump

GIBSON MINE AND SECTION ON REYNOLDS MOUNTAIN
FLOYD COUNTY, GEORGIA
Contour interval 10 feet
(Datum approximate sea level)

N

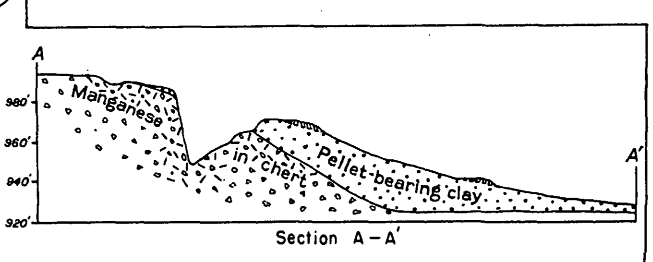




EXPLANATION

3' Prospect pit, showing depth in feet

SKETCH MAP OF
THE H.L. BERKSTRESSER PROPERTY,
FLOYD COUNTY, GEORGIA



Section A – A'

MAPS OF THE CEDARTOWN, GA., MANGANIFEROUS PELLET DEPOSITS

100 0 100 300 Feet

W.G. Pierce and A.E. Engel
Mapped in Oct. 1942

582081 O - 44 (Face p. 284)

deposits were: the Watts prospect, in the SW$\frac{1}{4}$ sec. 12, T. 20 S., R. 6 E., Clay County, Ala.; the Thos. Peoples prospect and the G. C. Miller prospect, both in sec. 16, T. 18 S., R. 9 E., Clay County, Ala.; the old Douglass prospects, now the Goldin property, 2 miles north of Draketown, Ga.; the Colley, Lincolnton, or Boykin mine, 3 miles east of Lincolnton, Ga.; the McCormick mine, on the northeast outskirts of McCormick, S. C.; and the old Freeman mine, now the Tar Heel Manganese Co. mine,23/ 12 miles west of Mt. Airy, N. C. None of the manganese minerals in these deposits were found to contain more than a trace of cobalt.

23/ Jones, A. I., Manganese-bearing veins in southwestern Virginia: Econ. Geology, vol. 37, no. 5, p. 412, 1942.