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**ORISKANY BROWN ORES OF WEST-CENTRAL VIRGINIA**

by

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**Newark, New Jersey**

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# ORISKANY BROWN ORES OF WEST-CENTRAL VIRGINIA<sup>1</sup>.

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## ABSTRACT

A small area in Alleghany, Botetourt, and Craig counties, Virginia, has been responsible for the bulk of the iron ore which has been mined from Devonian horizons in Virginia. Although no mines of either iron or manganese are now active in the region, there is a considerable supply of available ore, chiefly of iron, which forms an important economic reserve for the future. The following descriptions constitute an inventory of the Oriskany iron and manganese deposits of west-central Virginia.

## GENERAL STATEMENT

During the period from 1880 to 1912, Virginia was an important iron-producing state. Many of its mines were located in a small region centering around Clifton Forge and Covington, Alleghany County, where the ore was mined from Lower Devonian rocks. Adjacent portions of Botetourt and Craig counties, Virginia, and Monroe County, West Virginia, also belonged to the mining district, which is situated about 30 miles north of Roanoke and 15 miles west of Lexington. <sup>(Figure 1).</sup> The area lies along James River in the belt of folded mountains belonging to the Appalachian Valley and Ridge physiographic province; it is crossed by the Chesapeake and Ohio Railway.

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1. Published with the permission of the State Geologist of Virginia, and based upon field surveys of portions of Alleghany, Botetourt, and Craig counties undertaken between 1927 and 1932 for the Virginia Geological Survey.
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At the beginning of the 19th century iron ores were known to occur in this district, and as early as 1830 a number of small charcoal furnaces were utilizing ores from the more promising prospects. Most of the projects were extremely local, and in the period from 1845 to 1860 many were shut down or abandoned. During the War between the States some of the furnaces were rebuilt and put into use by the Confederate Government. Most of them, however, were idle in the period immediately following the War, when some prospecting, but very little serious mining, was attempted. About 1880, the development of coke furnaces and an increased demand for iron and steel gave a considerable impetus to metal mining in this part of the state, and in the period from 1880 to 1905 many new mines were opened and furnaces blown in.

Before the rapid development of the Lake Superior mines in 1892-1893, the Virginia iron workings were flourishing and had every prospect of continued profitable operation. The Lake ores, however, quickly became established on the market as a cheaper and more accessible source of iron, and the Virginia companies gradually found themselves unable to meet this strong competition. As a result, the larger companies, one by one, began to abandon their Virginia operations, and the first to close down was the Longdale Iron Company, which shut its furnaces in 1911. It had been the earliest and one of the largest of the Virginia companies to operate in this region.

With the beginning of the World War in 1914, the price of pig iron was advanced and freight rates became relatively low, so that the Virginia companies still in operation were able to

work full blast, and to earn profits which began to offset the lean years of the two preceding decades. With the close of the World War, however, pig iron dropped in value, freight transportation became relatively more costly, and active iron operations came to a halt in this part of Virginia.

During the period from 1916 to 1920 the search for American supplies of manganese stimulated local prospecting and some mining, but since 1920 even the demand for this material has been insufficient to continue mining operations. The final close came in 1924, when most of the mining companies ceased active work. At the present time, with high assessments, idle and deteriorating equipment, and no good market for the ore - even where it occurs in workable quantities - the iron properties of the State are losing investments for nearly all private holders.

The story of Virginia iron-mining can be readily summarized in the following table, which lists the total amount (in long tons) of iron mined during the years listed. The contribution of Oriskany brown ores to these totals ranges from 70 to 85 per cent.

<u>Year</u>	<u>Total Iron-Ore Mined</u> (long tons)
1870	- 47,168 (short tons)
1880	- 162,791
1885	- 350,000 (estimated)
1890	- 543,583
1895	- 600,562
1900	- 921,821
1905	- 752,045
1910	- 903,377
1915	- 348,042
1920	- 320,109
1925	- 96,272
1930	-
1935	-

## STRATIGRAPHIC RELATIONS

The Oriskany brown iron and manganese ores of west-central Virginia are associated with five stratigraphic horizons that range downward from the "Romney" shales of Middle Devonian age through the Healing Springs sandstone of Helderberg (New Scotland) age. The ore zone derives its name from the Oriskany sandstone with which it commonly occurs. Locally, however, it is found with either the Onondaga horizon, the Becraft limestone, or a Helderberg sandstone. The source of the iron is probably the black "Romney" shale.

The thick mass of black fissile shale which invariably overlies the ore zones is tentatively identified with the Romney shale of West Virginia, which it lithologically resembles. It contains fossils that indicate the presence of Marcellus, Hamilton, Genesee, and, possibly, Portage horizons; and its inability to resist erosion has been responsible for a series of valley lowlands along its outcrop. The Oriskany mines and prospects are located along the sides of these valleys at points where anticlinal or synclinal structures expose the base of the formation. "Romney" soil is poor and sterile; hence, most of the mines adjoin ground that is agriculturally unproductive. The formation is considerably contorted and contains many minor folds. Its thickness must approach 1,000 feet.

The horizon of the Onondaga limestone of New York occurs immediately below the "Romney" shale, and is occupied, throughout the region under consideration, by yellow, or buff, shales

ranging from 10 to 100 feet in thickness. Little or no limestone is present. Occasionally, however, the ore zones occur immediately below the "Romney" in the absence of any known Onondaga representatives, a fact which suggests that the ore may replace thin limestones of Onondaga age. The Onondaga horizon can be readily identified by characteristic fossils as a distinct unit, but its soft representatives are commonly grouped with the overlying shales in descriptions of the Oriskany mines.

The true Oriskany sandstone has given its name to the ore zones, but not infrequently it is absent in this region. Where present, it is a rusty-brown, saccharoidal sandstone, varying from 1 to 30 feet in thickness. It may be identified by the presence of characteristic fossils, such as Rennselaeria ovoides and Spirifer arenosus, but it is less common in exposed sections than formerly supposed. Indeed, in many of the outcrops near Oriskany mines the arenaceous beds associated with the ores are sandy zones of either the Becraft or Healing Springs formations. The Oriskany sandstone appears to be the exact equivalent of the Ridgeley sandstone of West Virginia, but fails to carry the prominent chert zones which are characteristic of the latter. Together with the other rocks of the ore zones, the Oriskany sandstone is commonly inclined at high angles.

The Becraft limestone, which lies unconformably beneath the Oriskany, is a common site of ore accumulation and is the usual foot-wall of Oriskany brown iron mines. The formation has a local thickness of from 50 to 200 feet and is a massive, gray, fossiliferous limestone. Its middle portion is commonly

cherty and supplies much of the chert associated with the irregular masses of ore. The upper portion is somewhat arenaceous and, where thoroughly weathered, takes on the appearance of a porous sandstone. Both calcareous and arenaceous horizons are commonly enriched with ore minerals, and fragments of the rock form the chief impurities of the ore. In a few workings, especially those near the Lowmoor furnace, the entire series of ore-bearing rocks stands vertically, or, indeed, is actually overturned, and some mining operations have made use of the Becraft as a hanging wall. A large underground quarry, or mine, in the Becraft limestone is located near Lowmoor, where rock was formerly extracted for flux by the Lowmoor Iron Company.

A highly arenaceous limestone, occupying the horizon of the New Scotland shale of New York, commonly underlies the Becraft limestone in west-central Virginia. This limestone grades laterally into a sandy bed known as the Healing Springs sandstone.<sup>1</sup> It has a thickness of from 20 to 40 feet, and,

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1. Schwartz, F. M.; The Helderberg group of parts of West Virginia and Virginia; U. S. Geol. Survey, Prof. Paper 158-C, 1929, p. 41

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because of its arenaceous character, has been confused with the Oriskany sandstone. It rests upon the Coeymans and Keyser limestones, neither of which, however, appears to be involved in the ore deposition.

## NATURE AND OCCURRENCE OF ORISKANY ORES

The Oriskany ore minerals consist of a series of hydrated iron and manganese oxides. The most common mineral is limonite, which occurs in a brown amorphous form that is commonly porous and generally admixed with various impurities. Occasionally hematite occurs with the limonite. The chief manganese ore mineral is psilomelane, which is likewise amorphous. It is dusky black in color, and occurs either alone or mixed with limonite or other manganese oxides. Among the latter are manganite, pyrolusite, and wad. The iron and manganese oxides occur in intimate association, so that the ores vary from a pure iron ore, through an intermediate iron and manganese ore, into a relatively pure manganese ore.

The ore minerals are commonly mixed with sandy material as well as with cherty fragments which are derived from the underlying rocks. The masses of limonite occur as continuous accumulations in clay, sandstone, or porous limestone, and assume a wide variety of irregular forms. Occasionally pockets and stringers of clay, sand, or limestone occur in the ore bodies, and veinlets of pure ore run through the containing rocks. Many of the minerals have a concretionary or botryoidal structure, and the ore bodies themselves are somewhat tabular.

The outcrop of Oriskany ores occurs along mountain slopes some distance above the level of present drainage. The strike of the ore is identical with that of the containing rocks, and the ore is remarkably persistent around the Devonian shale valleys. Commonly the ore minerals are found in several

zones, some of which maintain a uniform thickness, ranging from 5 to 30 feet, over a distance of 3,000 feet. At some localities several ore bodies occur; at other points only a few pockets or nodules of ore minerals indicate horizons that elsewhere contain commercial values. Most of the rocks associated with the ores have been thoroughly disintegrated and are stained with dark-brown or red colors resulting from the weathering of the ores.

The thickest ore bodies commonly occur near the surface or at moderate depths. As the ore is followed to depths of 200 to 300 feet, however, the thicknesses are found to be less than those near the surface; and, although few workings have reached depths of more than 500 feet, it is probable that the ore bodies pinch out at, or about, this depth, giving way to solid rock.

In stratigraphic position the ores persistently occur immediately below the Devonian shales of the Onondaga and "Romey" formations. <sup>(Figure 2.)</sup> This association of the ore beds and the shales is more common than the occurrence of the ore with the true Oriskany sandstone. As has been previously mentioned, the latter is not always present throughout this region and, indeed, has been confused with the analogous sandstones and arenaceous limestones of the Helderberg group. The ores are found either (1) above or within the Oriskany sandstone, (2) upon or within the Becraft limestone, or (3) within one of the other members of the Helderberg group below the Becraft. As reported by Weld<sup>1</sup> who tabulated the logs of some 420 wells

1. Weld, C. M.; The Oriskany iron ores of Virginia, Econ. Geology, Vol. 10, page 411, 1915.

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drilled through Oriskany ore zones, the ore bodies directly underlie the Devonian shales in 75 per cent. of the drill holes and rest upon either sandstone or cherty limestone. In about 15 per cent. of the well records examined by Weld, the ores occur between a hanging wall of sandstone and a footwall of cherty limestone. In the remaining 15 per cent. of the wells, the position of the ore varies considerably.

The beds carrying the brown ore are commonly deformed and have been folded into the anticlines and synclines which characterize the structure of Appalachian Virginia. In general, however, there are few faults in the vicinity of the ore workings. There is a distinct tendency for the folds to be somewhat unsymmetrical, with the higher or overturned dips occurring on their northwestern flanks. The general strike of the rocks varies from N130°E. to N.40°E. Dips on the southeastern sides of the folds seldom exceed 35°; those on the northwestern flanks range from 50° to a vertical, or even overturned, position. This asymmetry of structure has been reflected in the occurrence of the ore bodies, for a majority of the workings occur on the southeastern flanks of the folds or, correspondingly, upon the southeastern slopes of the anticlinal ridges. Apparently, lower dips of the bed-rock have permitted greater concentrations of ore minerals than the steep or overturned dips. In a few mines, notably the Callie and Wilton mines in Botetourt County, the ore concentration has proceeded in overturned strata, but such occurrences are relatively rare.

The outcrops of the Oriskany ores occur along the lower slopes of the Appalachian ridges, from 200 to 500 feet above the

base level of present drainage. The richer outcrops of ore are definitely associated with benches or terraces along the mountain flanks where they accumulated during the production of erosional levels. Comparison of the elevations of the many mines in this region indicates that the ore horizons have been worked most commonly at levels between 1,600 and 1,950 feet above sealevel. <sup>(Figure 3).</sup> A few mines, near James River, occur between 1,400 and 1,600 feet above sealevel, and a small group along the higher ridges occurs about 2,100 feet above sealevel. These levels coincide with the elevations of the Valley-floor (Harrisburg) peneplane, which was developed in Tertiary time. A very few deposits occur at much higher levels, possibly at the horizon of the Upland, or Cretaceous (Kittatiny), peneplane.

Many theories have been invoked to explain the origin of the Oriskany ores, but it is now generally thought that the overlying black Devonian shales were the chief source of the metallic elements. It is probable that the iron and manganese were leached from higher levels by descending surface waters and were deposited at the lower limit of weathering on the floors of the benches or local peneplanes. The "Romney" black shales are fairly rich in iron and contain from 4 to 5 per cent. of metallic iron. The formation of the deposits was probably contemporaneous with the last stages of Valley-floor peneplanation, and the ore bodies initially developed near the water-table on the peneplane. Subsequent uplift of the entire region has enabled the streams to entrench themselves into the peneplane, and simultaneously to lower the general level of the water-table. It is probable that ore deposition followed the water-table downward as the latter became lowered, but proceeded at increasingly slower speeds. Few

deposits are known to occur below the present water-table. Hence, the present height of the surface outcrops of the ore bodies above the valley floors appears to determine the approximate depth to which the ores can be expected to reach.

The entrenchment of the present streams has dissected the Tertiary peneplane, and its remnants now stand several hundred feet above the present valley-floors, where they form the benches, or terraces, along which the Oriskany ore deposits occur. It is possible that many deposits of ore minerals were entirely destroyed during Quaternary erosion and that the existing ore bodies escaped removal only because they were located along the edges of the valley floors at points which were distant from the actively degrading streams.

Probably the ores have been additionally enriched since their initial formation. Indeed, it is easy to imagine that, as the water table became lowered, deposits previously formed would be partially leached by descending meteoric waters and that metallic oxides deposited during one stage of the weathering process would be subject to solution and re-deposition at a lower level during the next epoch. The texturally porous Oriskany and Helderberg sandstones, as well as the structurally porous and soluble Becraft limestone, served as ideal sites for the deposition of the metallic oxides, which not only fill cavities and interstices within the bed rock but also replace considerable masses of solid rock.

The iron content of the Oriskany ores varies considerably, for the ore beds grade into sandstones or limestones. In the workable beds, however, between 30 and 50 per cent. of iron may occur. The content of phosphorus ranges from .06 to 0.5 per cent.; of silica from 10 to 20 per cent.; and of manganese

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(Figure 4).

from 0.5 to 40.0 per cent., but generally less than 5 per cent. ^  
Although the ores are not high in iron, they are easily smelted and make good foundry iron. With negligible exceptions, no Oriskany brown iron ore occurs in workable quantities outside of Virginia and adjacent portions of West Virginia.

#### DEVELOPMENTS

The following pages briefly describe the history, general geology, ore bodies, and nature of mining operations for the more important mines and prospects of the region. ^ (Figure 5). — NOT AVAILABLE

In the light of actual trends in iron production and in quantity of ore available, only a few of the workings herein described have been of commercial value or hold promise of future development. It was, of course, impossible to foresee the future for these ores in the days when the first surveys and descriptions of the iron properties were made. For that reason, the Oriskany ores have commonly been described with somewhat more optimism than discretion, and the early accounts of some of the properties were written with a lavish hand. It has not seemed desirable to make an entirely new suite of analyses for certain of the ores, and some of the analyses here included are those which accompanied the early reports. They may somewhat exaggerate the actual average iron content, for it is probable that some of them were made from selected samples and not from the run of the mine.

In the course of the present survey, most of the described workings were visited between 1927 and 1932, but many of them, long abandoned, have so completely slumped in, or become grown over with brush, that detailed examination of the actual ore

zones was impossible. For these mines, it has been necessary to rely upon descriptions previously made when operations were in progress.

### Alleghany County

#### Longdale Mines:

The workings known as the Longdale mines are located near the headwaters of Simpson Creek between North and Brushy mountains, about 12 miles northeast of Clifton Forge in the extreme eastern portion of Alleghany County. The mines are situated along the southeastern slope of Brushy Mountain, and are about 11 miles above Long Dale Station of the Chesapeake and Ohio Railway, with which they are connected by a narrow-gauge track. The mines are 4 miles northeast of Longdale Furnace, at an elevation of about 2,150 feet above sealevel.

One of the first attempts to develop Oriskany iron ores was made at this locality by the Jordans in 1827, and the ore was smelted at the Lucy Salina charcoal furnace built the same year. The early operations were continued on a small scale until the original furnace burned out in 1852. The Australia furnace was erected nearby in 1854, and it continued in operation during the War between the States. Shortly after the War, the property was taken over by the Longdale Iron Company which was incorporated in 1869. It is reported that the rectangular section of Alleghany County east of Brushy Mountain was allocated to Alleghany, rather than Rockbridge, County, solely to accommodate the owners of the property.

The Longdale Iron Company operated the mines from 1870 to 1911, and erected two blast furnaces which had a total capacity of 40,000 tons. The furnaces were in blast up to 1911, when the company closed them down. There have been no recent operations, and the mine equipment has largely deteriorated.

The original workings were open cuts along the southern slope of Brushy Mountain about 400 feet above the level of Simpson Creek. The operations extended for about a mile along the strike of the rocks, parallel to the axis of the mountain. Some of the cuts were over 100 feet deep, and all were located at about the 2,150-foot level. Some of the later workings went as far as 500 feet underground.

The ore, which is brown, earthy limonite, occurs near the base of the black Devonian shales that floor the valley of Simpson Creek. The valley is synclinal, and the ore beds dip at steep angles toward the southeast. The footwall beneath the ore is the cherty Becraft limestone, and the ore bodies are irregular accumulations and replacements near the upper contact of this limestone. The chief ore zone has a thickness of from 10 to 30 feet, and it is reported to hold this thickness throughout the entire area of operation. As a result of the deformation of the containing rocks, the ore zone is somewhat contorted, and at various places the rocks may be found to dip in almost any given direction.

The following analyses of ores from this mine have been reported:

	A.	B.	C.
Metallic iron. . . .	48.20 . . .	51.66 . . .	54.70
Insoluble residue. . .	3.82 . . .	. . .	. . .
Phosphorus . . . . .	0.42 . . .	0.463. . .	0.215
SiO <sub>2</sub> . . . . .	. . .	9.66 . . .	

- A. Ore from Longdale mine.<sup>1.</sup>  
 B. Ore from Longdale mine, F. A. Geesh, analyst.<sup>2.</sup>  
 C. Ore from Longdale mine, J. B. Britton, analyst.<sup>3.</sup>

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1. Holden, R. J.; Iron ores of Virginia; in Watson, T. L., Mineral Resources of Virginia; Lynchburg, 1907, p. 439.  
 2. Harder, E. C.; Iron ores of the Appalachian region in Virginia; U. S. Geol. Survey Bull. 380, 1909, p. 249.  
 3. The Virginias, Vol. II, 1881, p. 5.
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It has been reported that small quantities of zinc oxide accumulated in the furnaces where the ore was smelted, although there is no known zinc in the ores, coke, or limestone used. The latter was supplied from quarries in the Helderberg limestones, 2 miles from the furnace.

A smaller working, known as the Fancy Hill mine, was also operated about 2 miles due north of Longdale Furnace, on the southeastern slope of Mill Mountain above Brushy Run.

A large quantity of iron ore has been extracted at the Longdale Mines, and it was estimated that over 1,500,000 long tons of ore were taken out between 1869 and 1907.<sup>4.</sup> The

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4. Holden, R. J.; op cit., p. 439.

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available ore is by no means exhausted, but under present conditions the probabilities are against profitable operation. With the analogous deposits near Lignite, in Botetourt County, the Longdale ore bodies may be considered the most favorable iron reserves now known in Virginia.

Lewmoor Mines:

The Lewmoor Mines<sup>5.</sup> are located about 2 miles south of

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5. Lyman, B. S.; Geology of the Low Meer, Virginia, iron ores; Trans. Amer. Inst. Min. Eng., Vol. XIV, 1886, pp. 807-809.

Lowmoor, along the valley of Carne Creek between Rich Patch and Horse Mountains. The Lowmoor Iron Company was first organized in 1873 and began mining in 1875; its furnace at Lowmoor was blown in October 11, 1880. The mines produced steadily until 1905, giving a total production of over 1,000,000 tons; they were finally closed in 1924. The ore was mined upon a series of small folds between the two larger mountains. The general structure of the valley is synclinal, and the ore was mined on both sides of the basin at about the 1,400-foot level. The ore-bed is conformable to the adjacent rocks and was reported to be of good quality but to be variable in thickness. The ore is typical brown limonite, including both "soft" and "solid" ore, the former being loose and earthy. A broad-gauge railway connected the mine with the furnace at Lowmoor. The furnace, however, was demolished in 1930. The prospects were first mined by stripping the overburden from the outcrop of the ore, but later the mining was carried on by underground drifts.

Analyses of ores from these mines are as follows:

	A.	B.	C.	D.	E.	F.
Metallic iron	46.52	43.84	51.68	53.13	50.58	48.09
Insoluble residue	17.60	.....	.....	.....	.....	.....
Silica	.....	22.87	.....	.....	.....	.....
Phosphorus	.....	0.636	0.19	0.53	0.29	0.48

A. 1.

B. F. A. Gooch, analyst. 2.

C. and D. Otto Wuth, analyst. 3.

E & F. C. E. Dwight, analyst. 4.

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1. Holden, R. J.; op. cit., p. 440.
  2. Harder, E. C.; op. cit., p. 249.
  3. The Virginias, Vol. I, 1880, p. 150.
  4. Peckin, E. C.; The Iron Development and Ore Resources of Virginia, Trans. Amer. Inst. Min. Eng., Vol. XIX, 1891, p. 1021.
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Rich Patch Mine:

This mine is located in the valley of Carne Creek, 6 miles southeast of Covington, between Rich Patch and Horse Mountains, about three miles southwest of the Lowmoor mine. It was opened by the Lowmoor Iron Company in 1895 and was a large producer in its day, furnishing 90,000 tons of ore in 1902. The ore was mined at an elevation of 2,300 feet above sealevel from a synclinal structure with prospects on both sides of the valley, and occurs between fossiliferous Becraft chert and granular Oriskany sandstone, upon which rest Onondaga and "Romney" shales. At the south end of the area the ore is reported to be 30 feet in thickness and to consist of a solid mass of laminated and jointed limonite. The ore contains much sand near the hanging wall (Oriskany) and much chert near the foot wall (Becraft). The former is a rusty sandstone, and the foot wall consists of a mass of irregularly bedded cherty limestone, 35 feet in thickness. The early mining was chiefly underground; later operations were made by steam-shovel cuts. A standard-gauge railway connected the mine with the company's furnaces at Lowmoor.

Analyses of ore from the Rich Patch mines report the following percentages:

	1	2
Metallic iron	42.90	53.75
Silica	25.60	10.31
Phosphorus	0.33	0.191
Manganese	0.78	0.57
Water	.....	10.48

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1. Holden, R. J.; op. cit., p. 440.
  2. Harder, E. C.; op. cit., p. 222.
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Prospects near Covington:

A group of small mines, or prospects, has been opened in the general vicinity of Covington, but none is of much commercial importance.

The Dolly Ann mines were developed 3 miles east of Covington, along the headwaters of Founding Mill Creek between Peters Ridge and Fore Mountain. Their elevation is about 1,900 feet above sealevel. The Iron Mountain mine is situated nearby. A broad-gauge track connected the mines with the Chesapeake and Ohio Railway, southeast of Covington. The mines were extensively operated for about 30 years after their opening in 1885, and are reported to have produced over 70,000 tons of ore in 1897. They were operated by the Lowmoor Iron Company, but have not been worked for over a generation. The ore occurs along both sides of the valley of Founding Mill Creek, which is a synclinal structure floored with Mack Devonian shales. Analyses of the ore are reported as follows:

	A.	B.	C.
Metallic iron	44.32	51.77	57.98
Insoluble residue	24.15	.....	.....
Phosphorus	.....	0.428	0.4188
Sulphur	.....	1.133	.....

- A. Ore from Dolly Ann mines. 1.
- B. Ore from Dolly Ann mines. 2.
- C. Ore from Dolly Ann mines. 3.

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1. Holden, R. J.; op. cit., p. 439.  
 2. Harder, E. C.; op. cit., p. 249.  
 3. The Virginias, Vol. IV, 1883, p. 168.

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About 3 miles south of the Dolly Ann mine, at the southern end of Fore Mountain, is the Vowles manganese mine which was worked before 1890, and, to a slight extent, in 1917 and 1918. The ore is largely amorphous limonite with a little psilomelane,

and occurs in several zones, or lenticular masses, in a residual clay derived from the weathering of the Becraft limestone. There are several tunnels at the 1,280-foot level, and side-drifts to the main ore-bed which is from 1 to 6 feet thick. It is reported that 400 tons of iron ore were shipped about 1890, and about 20 cars of manganese ore were taken out in 1917-1918. The ore is reported to carry about 36 per cent. of metallic iron, 11 per cent. of manganese, and 10 per cent. of silica.<sup>1</sup>

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1. Stose, G. W., and Miser, H. D.; Manganese deposits of western Virginia; Virginia Geol. Survey Bull. 23, 1922, p. 107.
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Manganese has also been prospected at several places along the northwestern slope of Sweet Springs Mountain between 4 and 6 miles northeast of Covington. The operations are small, and involve open cuts and small tunnels which at present are largely filled with debris. A small quantity of ferruginous oxides, together with lumps and nodules of manganese ore, attracted attention to the locality. The ore occurs near the contact of the "Romney" shale with the Oriskany sandstone and the underlying cherty Becraft limestone at elevations about 1,500 feet above sealevel. The deposits are too small to be of present economic importance.

Iron mining was formerly carried on along the northwest slope of Sweet Springs Mountain, 4 miles southwest of Callaghan, and 5 miles south of Mud Tunnel. The workings were known as the Stack Mine and were among the first in this region to be opened for shipment of ore. A narrow-gauge railway connected the mines with the Chesapeake and Ohio Railway at Backbone, and the ore was used by the Lowmoor Iron Company at their Lowmoor furnace. A

series of open cuts developed along the slope of the mountain on the strike of an ore-bed which occurs between "Romney" shales and the Helderberg limestone at the horizon of the Oriskany sandstone, 1,600 feet above sealevel. It is reported that the ore ran as follows:

	1	2
Metallic iron	45.67	43.71
Insoluble residue	19.72	.....
Phosphorus	.....	0.380

1. Ore from Stack mine.<sup>1.</sup>
2. Ore from Stack mine.<sup>2.</sup>

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1. Holden, R. J.; op. cit.; p. 440.
  2. Harder, E. C.; op. cit., p. 249.
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The Rumsey mine is located on the southeastern side of Sweet Springs Mountain at the head of Harmon Branch, about 4 miles northeast of the Stack Mine. It was originally connected by a broad-gauge railway to Covington. The workings are located along the mountain slope at an elevation of 1,700 feet above sea-level, and consist of a series of open cuts which extend through a distance of 4,000 feet.

Several other small prospects occur along Potts Creek Valley, between Sweet Springs Mountain and Mill Ridge, southwest of Arritts.

These include the Bess (elevation 1,600 feet A.T.), Double Ridge (elevation 2,190 feet A.T.), Potts Valley, Given (elevation 1,890 feet A.T.), and Robinson and Bennett prospects (elevation 2,039 feet A.T.), and adjoin a similar group of small prospects in the Potts Valley section of Craig County (q.v.).

Botetourt County

Oriskany and Adjacent Mines:

The Oriskany mines lie in the foot-hills of Rich Patch Mountain, about 14 miles due west of Eagle Rock, the main workings being just west of the mining camp, known as Lignite.

These mines were opened in the late 90's and were operated by the Alleghany Ore and Iron Company until 1924, at which time they were closed down. The ore was sent to the company's furnace at Buena Vista, but this was taken out of blast in December, 1924. In 1925-1926, the mine was again opened, and some 20,000 tons of ore were put on the stock-pile. From 1926-1930, the mines lay idle, but in 1930 a crew of 30 men was put to work shipping the ore from the stock-pile. During the summer of 1930, the company shipped about 120 tons (two cars) of ore from the stock-pile daily. This ore was sent to their furnace at Pulaski. The mines were closed because of high freight rates, and at present the equipment is rapidly deteriorating.

The largest workings are about 1.5 miles due west of Lignite, and connect with the camp and washer by means of a narrow-gauge railway, which meets the Craig Valley Branch of the Chesapeake and Ohio Railway at Oriskany, where the ore was transferred to the standard-gauge railroad by a steam conveyor. At these openings, which range between 1,550 and 1,650 feet above sealevel, several acres have been excavated by steam shovels. The ore consists of limonite replacing sandstone, together with both limonite and manganese oxides in botryoidal and mammillary masses. The prevailing dip is gentle, being about 30° to the southeast. The hanging wall is Oriskany sandstone, and the foot wall is cherty Becraft limestone.

There are several shallow cave-like openings, and a deep tunnel which was sunk on an incline of  $33^{\circ}$  for a distance of 730 feet along the dip of the ore zone. Several side drifts were made from the tunnel, and different levels were opened at the bottom of the tunnel. The ore is said to hold its iron content to the bottom of the tunnel, but it is impossible now to examine the walls of the tunnel except at the very top.

A large surface working, known as the Farrow Bank, has been opened about one-half mile north of Lignite. The pit is extensive and exposes fairly rich ore which carries much manganese stain. The ore replaces the Oriskany sandstone and dips gently away from Rich Patch Mountain. The foot wall is cherty limestone, and the hanging wall is red clay.

The Oriskany mines occur on both sides of the narrow synclinal valley that lies between Rich Patch and Little mountains. The main workings are located along the outcrop of the Oriskany sandstone on the northern side of the valley, but prospects have also been located along the southern side. Little Mountain is a narrow anticline, and another Oriskany outcrop occurs on its southeastern side along the Craig Valley Branch of the Chesapeake and Ohio Railway, where it has been prospected in a small way.

The Oriskany and associated mines (including the Fenwick mine in Craig County) have been one of the greatest producing groups in the State, and their total production of ore since 1907 has been over 1,000,000 tons. The average annual production from 1912 to 1924 was 56,830 tons, and the maximum yearly production was in 1917, when 80,791 tons were mined. d'Invilliers estimated in 1907 that there were over 6,000,000 tons of available ore, and in 1924 Mr. L. G. Lackey estimated a reserve of 3,500,000

tens of ore "in sight."<sup>1</sup>.

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1. Information supplied to the writer by F. F. Musgrove, Treasurer, Alleghany Ore and Iron Company.
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It is probable that both of these estimates are somewhat optimistic; nevertheless, it is undoubtedly true that a large body of ore is readily available whenever conditions are suitable to warrant operation again. It is not an unreasonable statement to suggest that the Oriskany and associated mines represent the most promising Virginian reserve of limonite.

The general run-of-the-mine ore is estimated to contain 37-45 per cent. of iron. At present, a few tons yearly are sent to manufacturers of soap, lard, etc., where the ore is used because of its porous nature to increase the heat necessary for the refinement of those products.

The town of Lignite was established as a camp for the miners, but was abandoned in 1924 upon the closing of mining operations.

The Fenwick mine, which is located <sup>in Craig County</sup> a short distance west of the Oriskany mines, was formerly operated by the Lowmoor Iron Company. This mine is located along the same ore belt as the Oriskany workings, and is connected with the Craig Valley Branch of the Chesapeake and Ohio Railway by a standard-gauge track at Oriskany. The narrow-gauge railway of the Oriskany mines and the standard-gauge track of the Fenwick mine are only a mile distant from each other at the mines. The geologic conditions are entirely analogous in the Fenwick and Oriskany mines. Both are located along the same outcrop of Oriskany brown ores, and both mines lie just north of the "Romney" shale outcrop. Several

of the shafts are in the shale, with side-drifts extending horizontally and down to the ore horizon below the black shales. The ore rests upon buff-colored, fossiliferous Becraft chert which is partially decomposed to a soft, white, siliceous mass with some associated plastic clay. Some of the operations have been by steam shovels, and many shafts have been driven to facilitate underground mining.

The Grace Ellen mine, now owned by the Tredicate Company of Richmond, is located about a mile northeast of Lignite along the strike of the Oriskany sandstone on the southeastern side of the narrow shale valley. The openings were small, but considerable ore is reported to be present. The workings are at the 1,700-foot level, near the old Grace furnace which was first opened in 1849 and abandoned in 1890. A short distance southeast of the Grace Ellen mine is the Reid or Peanut Mine, elevation about 1,490 feet A.T., now abandoned.

Analyses from the Oriskany group of mines are as follows:

	A.	B.	C.	D.	E.
Metallic iron	44.60	40.37	45.88	52.26	47.15
Insoluble residue	.....	21.81	16.29	.....	15.20
Silica	22.30	.....	.....	8.93	.....
Phosphorus	.....	0.43	0.12	0.12	0.11
Manganese	.....	0.69	2.18	.....	1.98

- A. Ore from Fenwick Mine. 1.
- B. Ore from Reid Mine. 2.
- C. Ore from Oriskany Mine. 2.
- D. Ore from "Craigs Creek" Mine. 3.
- E. Ore from Oriskany Mine. 4.

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1. Holden, R. J.; op. cit., p. 446.
  2. Holden, R. J.; op. cit., p. 443.
  3. Froehling and Robertson; A handbook of the minerals and mineral resources of Virginia; Richmond, 1904, p. 62.
  4. Furnished to the writer by the Alleghany Ore and Iron Company.
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Callie and Adjacent Mines:

A group of Oriskany mines was operated by the Princess Furnace Company on the eastern slope of Rich Patch Mountain, near the Alleghany-Botetourt county-line. Chief of these is the Callie mine, which is the northernmost of the group. The Circle and Wilton mines adjoin the Callie, and all of the openings are near Callie furnace. The mines are well up the flanks of the mountain at elevations between 1,500 and 1,600 feet above sea-level. The rocks in this vicinity are nearly vertical, and in some cases are actually overturned so that the ore zone appears to rest upon the "Romney" shale with the Oriskany and Helderberg rocks overlying it. The normal direction of dip is toward the southeast, whereas in the overturned areas the dip may be as much as 60° to the west. Much loose lump ore can be found along the outcrop of the Oriskany horizon, and the ferruginous zone reaches local thicknesses of 30-50 feet.

The following analyses show the nature of the ores:

	A.	B.	C.	D.	E.	F.	G.
Metallic iron	46.17	45.62	56.77	51.57	59.41	60.05	51.60
Silica	.....	.....	.....	13.46	.....	1.96	9.20
Phosphorus	0.07	0.67	0.50	0.05	0.28	0.29	0.29

- A. Ore from Callie Mine.<sup>2.</sup>
- B. Ore from Callie Mine, F. A. Gooch, analyst.<sup>3.</sup>
- C. Ore from Wilton Mine, H. Froehling, analyst.<sup>4.</sup>
- D. Ore from Wilton Mine, J. B. Britton, analyst.<sup>5.</sup>
- E. Ore from Wilton Mine, J. B. Britton, analyst.<sup>5.</sup>
- F. Ore from Wilton Mine, J. B. Britton, analyst.<sup>6.</sup>
- G. Ore from Wilton Mine, H. Froehling, analyst.<sup>1.</sup>

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1. Froehling and Robertson; op. cit., p. 62.
2. Holden, R. J.; op. cit., p. 442.
3. Harder, E. C.; op. cit., p. 249.
4. The Virginias, Vol. V, 1884, p. 52.
5. The Virginias, Vol. III, 1882, p. 23.
6. The Virginias, Vol. III, 1882, p. 78.

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Big Hill Mines:

The Big Hill mines are located on the east side of Big Hill, about 3 miles south of Glen Wilton. Big Hill is a symmetrical, oval anticline in which Helderberg and Silurian strata crop out as an island in the Devonian shale outcrop of the valley area between Rich Patch Mountain and the Eagle Rock Range. Exploration at this point was begun in 1880, although a small prospect had been locally operated before. Regular mining was begun the following winter, and a horizontal shaft was driven into the base of the hill across the strike of the shales which dip at considerable angles. A fair show of ore was encountered about 1,650 feet above sealevel, and several thousand tons of ore were shipped out. A second shaft was sunk, and several open pits were developed along the contact of the yellow Onondaga shale and the Becraft limestone. A narrow-gauge railway was constructed to connect the mine with the Chesapeake and Ohio Railway at Gala, 2 miles to the south. The mines were operated by the Longdale Iron Company from 1900 to 1905, when the ore was shipped to the Longdale Furnaces at Longdale. Shortly thereafter, mining operations were discontinued, and the prospect has long since been abandoned. The mine buildings have been removed, the tracks taken away, and the shafts and openings are now caved in.

The ore is limonitic and is associated with the thin Oriskany sandstone and the upper Becraft limestone directly below the base of the Onondaga and "Romney" shales. It is nodular and occurs both in irregular masses and as replacements of the limestone. Analyses of ore from these mines are reported as follows:

	A.	B.	C.	D.	E.
Metallic iron	55.28	44.08	56.67	44.89	56.77
Silica	4.63	23.60	3.91	.....	4.96
Alumina	3.14	2.17	0.63	.....	.....
Lime	1.26	1.15	0.09	.....	.....
Phosphorus	0.726	0.404	0.795	0.342	0.504

- A. Dark rock-ore, Otto Wuth, analyst.)<sup>1</sup>.  
 B. Brown ore, Otto Wuth, analyst. )  
 C. Brown Hematite, J. Blodgett Britton, analyst.<sup>2</sup>.  
 D. H. Froehling, analyst.<sup>3</sup>.  
 E. H. Froehling, analyst.<sup>4</sup>.

1. The Virginias, Vol. III, 1882, p. 39.  
 2. The Virginias, Vol. II, 1881, p. 109.  
 3. The Virginias, Vol. V, 1884, p. 52.  
 4. Froehling and Robertson; op. cit., p. 62.

The mines are not now operated, and the observed reserves of ore are small.

The Retreat and Adjacent Mines:

The Retreat mine is located at the head of Back Creek in a sag along the crest of Mays, or Orebank, Mountain, about 10 miles north of Buchanan. The ore occurs in regular lumps and masses upon the Helderberg and Oriskany formations and was mined in open cuts and pits over an area of nearly an acre at an elevation of 2,900 feet above sealevel. The workings are now entirely abandoned, and the cuts and trenches have largely fallen in, although considerable loose ore still remains in piles near the workings. Several analyses have been made of ore from these mines, and some of these are given in the following table..

	A	B
Metallic iron	54.85	47.60
Phosphorus	0.085	0.489
Silica	.....	13.66
Sulphur	tr	.....

- (A. J. L. Campbell, analyst.<sup>1</sup>.  
 B. H. L. Froehling, analyst.<sup>2</sup>.)

1. Campbell, J. L.; The "Purgatory" iron property, Botetourt Co., Virginia; The Virginias, Vol. 1, 1880, p. 157.  
 2. Froehling and Robertson; A handbook of the minerals and mineral resources of Virginia; Richmond, 1904, p. 62.

The ores from this mine and adjacent prospects were chiefly smelted in the Retreat Furnace, located near the head of Purgatory Creek. A narrow-gauge railway formerly connected some of these workings with the Etna Furnace, also located along Purgatory Creek.

Two other prospects of former interest were developed in the vicinity of the Retreat mines. The Mays prospect, elevation 2,500 feet A.T., is located on the west slope of Mays Mountain, north of its junction with Green Spur and about 2½ miles due west of Saltpetre Cave. Karnes prospect, elevation 2,500 feet A.T., is located on the west slope of Back Creek Mountain, about 1 mile west of Karnes Spring. Analyses of ore from these prospects follow.

Analyses of Oriskany brown ore  
on Purgatory Mountain

	A	B	C
Metallic iron	41.800	56.55	56.35
Phosphorus	0.094	0.112	0.112
Sulphur	tr.	tr.	.....
Silica	.....	.....	6.47
Metallic manganese	.....	.....	0.23

(A. and B. J. L. Campbell, analyst.  
C. H. L. Froehling, analyst.)

- A. Limonite from Mays Bank. )<sub>1</sub>.
- B. Limonite from Karnes Bank, )
- C. "Potsdam lump ore," Purgatory Mountain. )<sub>2</sub>.

- 1. Campbell, J. L.; op. cit., p. 157.
- 2. Froehling and Robertson; op. cit., p. 62.

Another prospect was developed in Hickory Hollow about 3½ miles due north of Saltpetre Cave and a short distance north of, and above, Hickory Hollow Branch. This working was known as the Salisbury mine, elevation 2,250 feet A.T., and ore taken from it was formerly used to supply Salisbury Furnace, located near the junction of James River and Catawba Creek.

Other workings along Purgatory Mountain include the following prospects: McCarty prospect, located near the southwest end of Purgatory Mountain about  $\frac{1}{4}$  mile north of James River; Holmes prospect, located along the eastern flank of Purgatory Mountain about  $2\frac{1}{2}$  miles northeast of Springwood; Lee prospect, elevation 1,450 feet A.T., located on the eastern flank of Purgatory Mountain about 1 mile northwest of Buchanan; and Bald prospect, located near the crest of Purgatory Mountain about  $\frac{1}{2}$  mile southeast of Cartmell Gap. None of these prospects, however, was developed to any extent.

Manganiferous ore has been reported on Purgatory Mountain, north of Buchanan. The openings were made by C. M. Stranahan of Covington, along the west slope of the mountain near the outcrop of Oriskany sandstone. The ore is reported to have contained 37 per cent. of metallic manganese and 8 per cent. of iron.<sup>1.</sup>

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1. Stose, G. W., and Miser, H. D.; op. cit., p. 112.

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Another prospect is reported near the head of Penn Branch below Cartmell Gap, and about  $\frac{1}{4}$  mile south of the creek. A third prospect is reported 2 miles farther north near the top of Round Hill. These prospects were not visited by the writer.

#### Sand Bank Mine:

The Sand Bank iron mine is located on the northwestern flank of the southern end of North Mountain, 2 miles northeast of Daggers Springs. This mine was opened in Oriskany limonite, which accumulated at the top of the Helderberg group. It is reported that the ore had a local thickness of 40 feet, and it was mined for several hundred feet along its strike, chiefly by open cuts.

Some attempt was made to follow the ore below the surface, but the workings are now entirely abandoned. The dip of the rock is to the northwest at an angle that is slightly greater than the slope of the mountain. A long, steep incline connects the mines with a washer and crusher which were located along a tributary of Mill Creek, about 1 mile east of Daggers Spring. A broad-gauge railway formerly connected the mine camp with the Chesapeake and Ohio Railway at Gala. At the present time little can be seen of the character of the ore body and its structural relations, as the operations are grown over and slumped in.

The adjacent Cook or Ruhl Mine is of more importance as a producer of manganese than of iron. The mine was worked in 1911, and it was then said to have produced over 100 tons of high-grade manganese ore. The earlier ore is described as carrying 54 per cent. of manganese; later ore contained 35 per cent. manganese. The workings, at elevations about 2,150 feet above sealevel, were cuts and tunnels which are now caved in. The ore body consists of a tabular mass about 4 feet thick in residual clay parallel to the bedding of the clay and sandstone. The ore occurs in shoots and lumps, irregularly distributed through the clay. The ore minerals are psilomelane, some manganite, and a little wad,<sup>1</sup> but there are too little values for commercial development. There are some indications of this ore for several

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1. Stose, G. W., and Miser, H. D.; Manganese Deposits of Western Virginia; Virginia Geol. Survey Bull. 23, 1922, pp. 109-112.

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miles along its strike, especially toward the southwest, but at no point was enough workable ore observed to warrant development.

The Burman Prospect:

The Burman prospect<sup>1</sup>. is located about 4 miles east of

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1. Stose, G. W., and Miser, H. D.; op. cit., p. 111.

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Daggers Spring. It occurs about 2 miles northeast of the Cook mine, on the southwest slope of Panther Mountain at an elevation of about 1,900 feet above sealevel. At this point, a surface cut about 20 feet long was made in 1910. The deposit is in residual clay developed from Helderberg limestones which dip to the southeast at an angle of 60°. The ore consists of nodules of slabby manganite which replaces the clay and limestone. It is quite free from iron and silica and is of good grade. Only a meager quantity, however, is exposed.

Sheetz Mine:

An abandoned mine in Oriskany ore occurs on Rathole Mountain, 1½ miles northeast of Eagle Rock. The workings are about 500 feet above the flood-plain of James River, and a small quantity of ore was hauled by wagon to Gala. The openings are on the old Sheetz property and also upon a tract known as the Peake property.

An analysis of ore from the vicinity of these mines is as follows:

	4.
Metallic iron	59.64
Phosphorus	0.462
Silica	2.46

4. Ore from Peake's property, North Mountain.<sup>1</sup>.

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1. Froehling and Robertson; op. cit., p. 62.

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Roaring Run Oriskany Mines:

These mines are located on the southeast slope of Rich Patch Mountain about 4 miles north of Horton, Botetourt County. The adjacent manganese workings have also been called the Horton Prospect. The manganese openings lie at the top of a spur of the mountain at an elevation of about 1,600 feet above sealevel. The iron workings are somewhat lower, and were first opened on a commercial scale about 1880, although the Roaring Run furnace had been previously built in 1832, and minor production of iron was in progress during the War between the States. The deposits occur in shaly sandstone at the top of the Helderberg group. The formations are steeply tilted to the southeast, and the ore zones thus occur in narrow belts. The actual workings consist of surface cuts with several shallow shafts aligned along the strike of the outcrop. The manganese ore consists of lumps and nodules of hard psilomelane embedded in a fine yellowish clay. This ore is often mamillary or botryoidal, and some of the lumps run up to 100 pounds in weight. The iron ores occur in the same general zone and consist of brown limonitic ores intermixed with much sandy material. An analysis of iron ore from these workings is here given.<sup>1</sup>

Metallic iron	51.28
Phosphorus	0.616
Silica	11.09

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1. Froehling and Robertson; op. cit., p. 62.

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It is reported that the Oriskany ores from these mines were mixed with Clinton hematite from the same general locality before they were smelted in the local furnace.

Craig County

Very little iron mining has been undertaken in Craig County, the most important single working being the Fenwick mine, described above with the Oriskany mines of Botetourt County, which it adjoins.

A number of small iron prospects were opened in Potts Creek Valley in the vicinity of Paint Bank. These iron showings were at one time considered to be of great economic importance, but no verification of that prophecy has ever occurred. Among the more important prospects were the following: Given, Cornfield, Paint Bank, Haupt, Rowan, Loop, Valley Branch, and Humphreys prospects.<sup>1.</sup>

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1. Holt, H. A., and Snyder, A. C.; The iron ores of Potts Valley, Virginia; Lewisburg, West Virginia, 1891, pp. 1-38.

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None of them was ever seriously operated.

A few manganese mines were at one time operated in the county, and additional prospects were reported. The Chevy Mine<sup>2.</sup> consists

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2. Stose, G. W., and Miser, H. D.; op. cit., pp. 115-117.

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of a number of scattered cuts in the southeast slope of Sinking Creek Mountain, 12 miles southwest of Newcastle. The principal opening is a deep cut in Helderberg sandstones and underlying clays at the 1,950-foot level. The ore consists of psilomelane, which occurs in pockets in the clay and in fissures in the sandstone. Several hundred tons of ore were mined between 1916 and 1920, but operations then closed have not been opened.

Other local manganese prospects have been reported, but at no other point has more than surficial prospecting been pursued. The Red Brush prospect<sup>1.</sup> on Big Branch of Johns Creek, 5 miles

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1. Stose, G. W., and Miser, H. D.; op. cit., pp. 112-114.

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due northwest of Newcastle, consists of a few small openings in sandstone along the creek about 1,750 feet above sealevel. The ore is largely psilomelane, replacing the clay beneath the sandstone. The ore is reported to run about 38 per cent. manganese, 15-20 per cent. silica, and 2-5 per cent. iron. The Cliff Prospect,<sup>2.</sup> on the southeast slope of Sinking Creek Mountain,

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2. Stose, G. W., and Miser, H. D.; op. cit., pp. 114-115.

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3 miles south-southwest of Newcastle, consists of two tunnels in clays directly below the Oriskany sandstone, at an elevation of about 2,200 feet above sealevel. The ore is said to run 40 per cent. manganese and iron together, or 14 per cent. pure manganese.

Several prospects and minor workings, but no important mines, of iron and manganese have been reported from Monroe County, West Virginia. Most of these adjoin the Virginia prospects of Craig and Alleghany counties, and all are in, or near, Potts Creek Valley.<sup>3.</sup>

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3. Reger, D. B., and Price, P. H.; Mercer, Monroe, and Summers counties; West Virginia Geol. Survey, County Reports, 1926, pp. 749-770.

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A small quantity of manganese ore has been taken from the Goodykeantz prospect, elevation 2,600 feet above sealevel, on the summit of Moss Mountain, 4 miles north-northwest of Paint Bank. Other West Virginian iron prospects include the McGlone, Patton, and Bradley openings.

## FURNACES

A considerable number of old iron furnaces have been erected in west-central Virginia. The earlier furnaces were charcoal; later ones either were built for coke or were adapted for coke burning from earlier charcoal furnaces. Practically all are either demolished or abandoned.

The Etna furnace, located 3 miles northeast of Buchanan, was built in 1792 but was later abandoned. It was rebuilt in 1842 and is reported to have been in operation from 1861 to 1865; it has long been in ruins. Lucy Salina furnace, on Simpson Creek 10 miles east of Clifton Forge, was built in 1827 and abandoned in 1852. The Retreat furnace on Purgatory Mountain, 9 miles north of Buchanan, was built in 1827 and abandoned in 1849. Salisbury furnace, near the junction of Catawba Creek and James River, was built in 1827, abandoned in 1849, rebuilt in 1869 to a capacity of about 4,000 tons, and continued in blast until 1884. Rebecca furnace, 1 mile southeast of Dagers Springs, was built in 1830 and abandoned about 1850. Roaring Run furnace, 7 miles northwest of Eagle Rock, was constructed in 1832 and rebuilt in 1854. It was in operation during the War between the States. Jane furnace, near Dagers Springs, was built in 1835 and abandoned in 1850; and Rumsey furnace on Dunlap Creek, Alleghany County, was also abandoned in 1854. Dolly Ann furnace, 3 miles east of Covington, was originally erected in 1848 and was rebuilt, 6 years later, to continue in operation until the close of the War between the States. Australia furnace, on Simpson Creek, was built in 1854 to replace the Lucy Salina furnace, but was also abandoned after the War. All of the above were charcoal furnaces.

Grace furnace, 14 miles west of Eagle Rock, was built as a charcoal furnace in 1849. It burned in 1864 and was rebuilt in 1874 as a coke furnace. Callie furnace, 2 miles north of Glen Wilton, had a similar history. Of the larger blast furnaces, the Longdale furnaces on Simpson Creek, the Lowmoor Iron Company's furnace at Lowmoor, the Oriskany Ore and Iron Company's furnace at Iron Gate, and the Princess furnace at Glen Wilton were the most important. None of these has been in operation for some time, and the last furnace in the region to be in blast was the Iron Gate furnace operated by the Alleghany Ore and Iron Company and closed in 1923. During the summer of 1930 the Lowmoor furnace was demolished and the usable parts shipped out of the State.

#### FUTURE DEVELOPMENT

From the foregoing descriptions it may be readily seen, although there is a considerable showing of iron ore in this region, that the present economic possibilities are far from promising. There is no doubt that a large quantity of iron ore of fair grade is accessible to transportation facilities, and available for relatively easy mining. At present, however, its moderate quality and distance from steel-producing centers are sufficient to remove it from practical competition with cheaper and better ores already on the market.

At the Longdale, Oriskany, Lowmoor, Fenwick, and Stack mines, the reserves of ore in sight are sufficiently large to place them in the class of important reserves of limonite, and it is probable that some of the smaller workings may also fall into this group. A conservative estimate may be made that a total of 10,000,000 tons of workable ore is readily available

at these mines and could be utilized when operating conditions are more favorable than at present. With the inevitable exhaustion of higher-grade iron ores and a probable increased demand for steel, the time should ultimately come when operations may profitably begin again.

The manganese ores are less promising and are unlikely to enter successful competition with ores from other localities, unless their operation is stimulated by more abnormal conditions than are to be reasonably expected.

It is not advisable to predict the future of the Oriskany ore reserves. It seems probable, however, that they will not be commercially operated until a marked increase in the price of pig iron occurs so as to bring these ores into the market, or until improvements in metallurgical methods make possible the economical production of pig iron from this grade of ore. A combination of these factors might well bring the Oriskany ores into the field of successful operation. Other modifying features, such as cost of transportation, accessibility, and nearness to the steel-producing centers, are also controlling factors.

At present, the presence of bodies of these ores beneath the land of west-central Virginia adds little to property values. In a few generations, however, the ore-bearing lands may gain a more profitable premium.

