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TIN DEPOSITS OF IRISH CREEK  
VIRGINIA

BY  
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AND J. S. VHAY

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## CONTENTS

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	Page
Abstract.....	271
Introduction.....	272
Location.....	272
Previous investigations.....	274
Field work and acknowledgments.....	274
Geology.....	275
Gneiss and schist.....	275
Granodiorite.....	277
Aplite.....	277
Basic dikes.....	278
Structure.....	278
Tin deposits.....	279
Quartz veins.....	279
Greisen.....	280
Late veins.....	282
Occurrence of cassiterite.....	283
Size and grade of ore bodies.....	284
Mine descriptions.....	285
History of development.....	285
Production.....	287
Mine workings.....	287
No. 1 workings.....	287
The main lodes.....	287
Possible extensions of No. 1 lodes.....	289
No. 2 workings.....	290
Nearby lodes.....	293
Outlying lodes.....	294
Reserves.....	295
Suggestions for prospecting.....	296

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## ILLUSTRATIONS

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	Page
Plate 43. Map of the No. 1 workings, Irish Creek, Va., showing location of samples and list of assays.....	286
44. Map of the No. 2 workings, Irish Creek, Va....	290
Figure 29. Map of Virginia, showing location of the Irish Creek tin district.....	273
30. Geologic map of the Panther Run area, showing location of mine workings and prospect pits.....	276



## TIN DEPOSITS OF IRISH CREEK, VIRGINIA

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By A. H. Koschmann, J. J. Glass, and J. S. Vhay

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### ABSTRACT

Cassiterite was discovered along Irish Creek in the Blue Ridge in the northern part of Rockbridge County, Va., in 1846, but active prospecting and development work were not begun until 1884. The production has been small, probably less than 1,000 tons of ore, and has come chiefly from workings on Panther Run, a small tributary near the headwaters of Irish Creek.

The country rock in the district consists of gneiss intruded by granodiorite, which in turn is cut by small dikes of aplite and basic rock, all probably of pre-Cambrian age. So far as is known the tin-bearing lodes are restricted to the granodiorite.

The cassiterite occurs in lodes, each of which ordinarily consists of a quartz vein bordered by greisen. The quartz veins range in width up to 9 feet, though most are less than a foot wide. The greisen forms a layer, which may be as much as 5 feet in thickness, on one or both sides of the quartz core. The greisen grades into the granodiorite, and apparently was formed from it by replacement. Cassiterite grains are disseminated through the greisen, and the mineral occurs in veinlets and in scattered pockets adjacent to the quartz. Both the unfractured quartz and the granodiorite are barren.

The lodes are a product of four stages of mineral deposition with intervening stages of crushing. Quartz was deposited during the first stage, cassiterite, muscovite, beryl, and probably wolframite during the second, muscovite, siderite, ankerite, fluorite, biotite, phenakite and chlorite, together with rare grains of sulfides, during the third, and nontronite, vermiculite, hematite, montmorillonite, clinozoisite, and calcite during the fourth.

The main development work has been along Panther Run, a tributary of Irish Creek. The only workings now open are on the east side of Panther Run; they are known as the No. 1 workings. Other workings, known as the No. 2 group, are situated 1,200 feet southwest of the No. 1 workings. Information regarding the number of lodes and the grade of ore is meager. Recent sampling of the accessible No. 1 workings shows that the greisen contains from 0.11 percent to 3.78 percent of tin, the average being about 1 percent. Available reports concerning the grade of ore in the No. 2 workings are less favorable. Very little is known regarding the scattered lodes that occur outside of the No. 1 and No. 2 workings, but assays from these lodes indicate that they contain appreciable quantities of tin. The occurrence of rich pockets of ore and the persistence of greisen in the explored lodes suggest that further prospecting in the area may be warranted.

## INTRODUCTION

Cassiterite (tin oxide) was discovered at Irish Creek, Va., in 1846. Since then there have been several attempts to produce tin commercially, notably in the periods 1883-85, 1889-92, and 1918-19. No systematic work was done between 1919 and 1942. In 1938 the writers, using funds granted by the Public Works Administration, made a detailed study of the workings now accessible, paying particular attention to the mode of occurrence of cassiterite and its associated minerals. This preliminary report presents some results of that study that are of economic significance.

Location

The Irish Creek district is in the central part of the Blue Ridge of west-central Virginia, near the boundary of Rockbridge, Nelson, and Amherst Counties, as shown on figure 29. The district is about 10 miles southeast of Steeles Tavern, a small village on U. S. Highway 11, midway between Staunton and Lexington, whence it can be reached by a well-graded dirt road. There is also a road from the east up the Tye River and another from Cornwall on the south.

Cassiterite has been found in an area of about 12 square miles along the headwaters of Irish Creek, at altitudes ranging from about 2,300 to 2,800 feet. The district is an area of considerable relief, but as the natural vegetation is heavy and the soil cover is deep even on steep slopes, outcrops are relatively scarce.

The only lodes that could be studied in detail are exposed on the east side of Panther Run, in the open workings hereafter referred to as the No. 1 workings. The No. 2 workings, on the west side of Panther Run, are larger but are caved in.

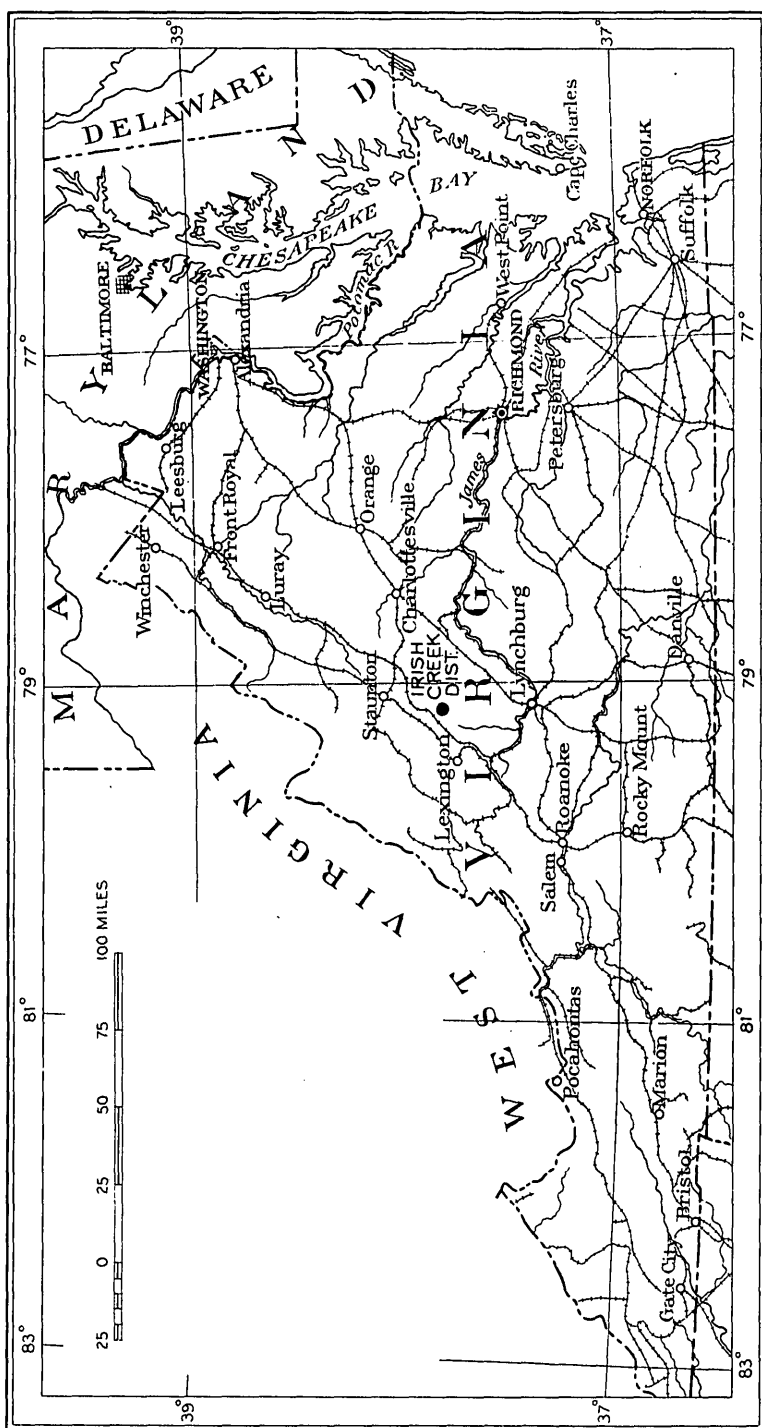


Figure 29.—Map of Virginia, showing location of the Irish Creek tin district.

### Previous investigations

The Irish Creek district was described by several investigators in the period 1883-85,<sup>1/</sup> and was mentioned briefly by Graton<sup>2/</sup> in 1906. Ferguson,<sup>3/</sup> in 1918, described the tin deposits more fully and gave a brief account of the regional geology. The geology of the region has been described in greater detail by Watson and Cline<sup>4/</sup> and by Watson and Taber.<sup>5/</sup>

### Field work and acknowledgments

Koschmann spent five days at Irish Creek in November 1938, all three authors spent a week there in December 1938, and short visits were made at other times by the authors and their colleagues. A geologic map was made of an area on Panther Run, a small tributary to Irish Creek, where the most extensive workings of the district are situated.

Mr. W. Spencer Hutchinson, consulting engineer, kindly supplied copies of his unpublished progress reports, containing maps and assays, which describe the development work done in 1918-19 by the Richards Co., Inc., of Boston. These reports were made available to us with the consent of Mr. W. S. Young, treasurer of the company. We are also indebted to Mr. G. W. Schultz of Reading, Pa., who made available to us a report on

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<sup>1/</sup> McCreath, A. S., and Pratt, Franklin, report to F. J. Kimball, dated October 15, 1883: The Virginias, vol. 5, pp. 150-151, 1883.

Campbell, H. D., letter to Jedediah Hotchkiss, October 23, 1883: The Virginias, vol. 5, p. 151, 1883.

Massie, F. A., report to the Virginia Tin Mining & Manufacturing Co., quoted in Mineral Resources U. S., 1883-84, pp. 600-601, 1885.

Winslow, Arthur, Tin ore in Virginia: Eng. and Min. Jour., vol. 40, p. 320, 1885.

<sup>2/</sup> Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, p. 44, 1906.

<sup>3/</sup> Ferguson, H. G., Tin deposits near Irish Creek, Va.: Virginia Geol. Survey Bull. 15-A, 1918; Tin deposits of Irish Creek, Va.: Eng. and Min. Jour., vol. 105, pp. 5-7, 1918.

<sup>4/</sup> Watson, T. L., and Cline, J. H., Hypersthene syenite and related rocks of the Blue Ridge region, Va.: Geol. Soc. America Bull., vol. 27, pp. 193-234, 1916.

<sup>5/</sup> Watson, T. L., and Taber, Stephen, Geology of the titanium and apatite deposits of Virginia: Virginia Geol. Survey Bull. 3-A, 1913.



the district made in 1900 by Mr. A. C. Ledoux, and one made by Prof. W. O. Crosby at an earlier, unspecified date, presumably 1890 (see p. 286). C. S. Ross made microscopic determinations of the clay minerals; H. G. Ferguson and F. C. Calkins critically read the manuscript; and Ward C. Smith contributed valuable assistance in condensing and summarizing the more comprehensive draft of this paper.

#### GEOLOGY

The rocks exposed in the Panther Run area (see fig. 30) are gneiss and schist, granodiorite, aplite, and basic dikes. The gneiss and the granodiorite represent major rock types widespread in the Blue Ridge; the aplite and basic dikes are of minor importance. All the known tin deposits are in granodiorite.

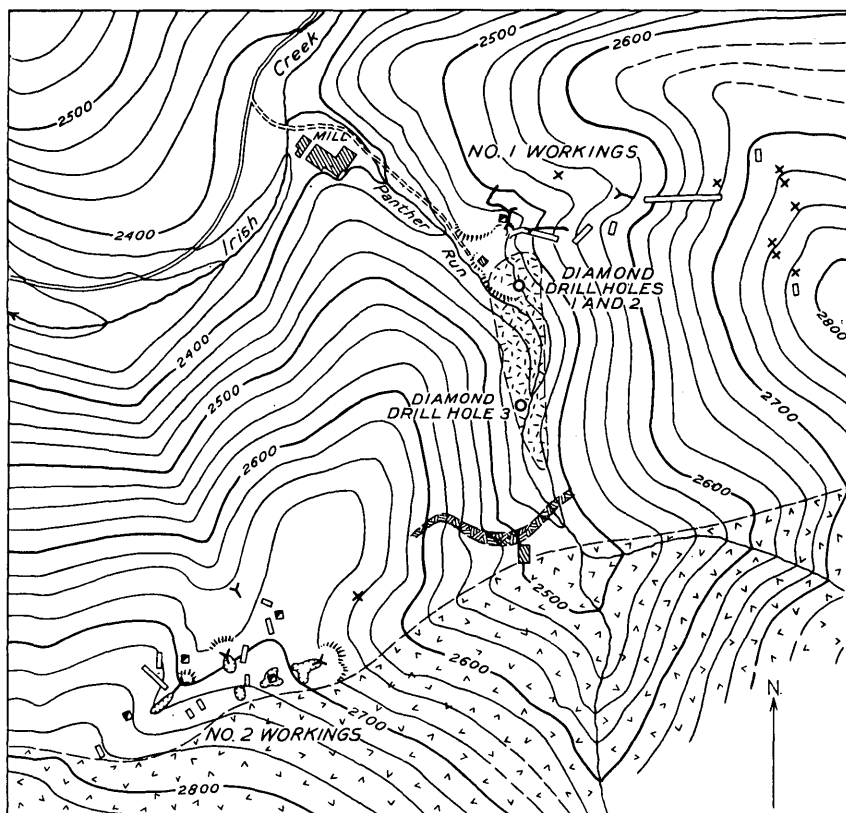
These crystalline rocks are all believed to be of pre-Cambrian age. The granodiorite, which has no gneissic structure, appears to be younger than the gneiss and older than the aplite and basic dikes.

#### Gneiss and schist

The gneiss is a banded rock consisting mainly of feldspar and quartz, with a minor proportion of dark minerals. The rock has been considerably altered to sericite and chlorite, and it encloses a few masses of chloritic schist. Some of the schist, composed of pink feldspar in a chloritic groundmass, grades into the surrounding gneiss. Ferguson <sup>6/</sup> mentions a purple slate in the No. 2 workings, but it was not seen by the authors. None of these rocks was studied in detail.

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<sup>6/</sup> Ferguson, H. G., op. cit. (Bull. 15-A), p. 13.



## EXPLANATION



Basic dike



Aplite



Granodiorite



Gneiss and schist



Mine workings



Caved shaft



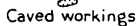
Portal



Pit



Trench



Caved workings



Dump

100 0 500 1,000 Feet

Contour interval 25 feet

Datum is mean sea level

Figure 30.--Geologic map of the Panther Run area, showing location of mine workings and prospect pits.

### Granodiorite

The granodiorite where fresh is a dark greenish-gray, coarse-grained rock, and has a porphyritic appearance because of the segregation of the light- and dark-colored minerals. The most abundant mineral is andesine; it is accompanied by much orthoclase, microcline, and microperthite and a little quartz. The principal dark mineral is pyroxene (hypersthene with some pigeonite); the minor ones are brown and green hornblende, a blue-green sodic (?) amphibole, and biotite. The accessory minerals include zircon, apatite, and an opaque mineral thought to be titanomagnetite. These accessory minerals, especially the titanomagnetite, are notably abundant in clusters of pyroxene grains or their alteration products. The rock also contains some sericite and chlorite.

The granodiorite has apparently had a long and complex history of alteration, but no attempt has been made during this study to determine which of its minerals are primary and which were formed later. In addition to the widespread mineralogic alteration found in the granodiorite, other more local intense mineralogic and structural alterations are conspicuous in some places. Chief among these is the replacement of dark minerals by epidote; the resultant rock, called unakite,<sup>7/</sup> is common in the Blue Ridge.

Some of the granodiorite has been altered to cassiterite-bearing greisen, which forms an important part of the tin lodes, and is described in the section on the tin deposits.

### Aplite

A fine-grained light-colored rock is exposed along Panther Run just south of the No. 1 tunnel. It consists chiefly of quartz, potash feldspar, and albite, all in grains that average

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<sup>7/</sup> Watson, T. L., and Cline, J. H., op. cit., p. 220.

less than 0.1 millimeter in diameter. Although the rock closely resembles aplite, it may possibly be a granitized inclusion of quartzite in the granodiorite.

#### Basic dikes

Several small dikes of a fine-grained dark-colored rock were seen in the granodiorite, but only one is large enough to be represented on the geologic map. The rock consists mainly of pigeonite, epidote, biotite, chlorite, with a little titanomagnetite, pyrite, leucoxene, and quartz. The rock is probably an altered diabase, though some of it may be altered pyroxenite, like some bodies of similar rock that occur a few miles to the southwest.<sup>8/</sup>

#### Structure

The prevailing structural trend in the region is northeastward and the nearest important structure, a fault northwest of Panther Run described by Ferguson,<sup>9/</sup> strikes northeast. Shear zones exposed in the No. 1 workings also strike northeast and dip southeast, but many small faults strike northwest and dip southwest.

The tin-bearing lodes, the location and orientation of which are believed to be fissure-controlled, trend N. 70° E. to N. 60° W. in the No. 1 workings, and dip steeply either northward or southward. In the No. 2 workings the lodes trend N. 45°-70° E. and dip 50°-70° S.<sup>10/</sup> Other lodes in the district have different trends, and apparently there is no simple pattern for the entire district, although within small parts of it the lodes are probably more or less parallel, as are those in the No. 1 workings.

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<sup>8/</sup> Watson, T. L., and Cline, J. H., op. cit., p. 231.

<sup>9/</sup> Ferguson, H. G., op. cit. (Bull. 15-A), p. 3, fig. 2.

<sup>10/</sup> Idem, fig. 3.

## TIN DEPOSITS

The tin deposits at Irish Creek are veinlike lodes in the granodiorite; none have been found in the other rocks. Typically, one of these lodes consists of a quartz vein, bordered on both sides by greisen. The quartz veins evidently were deposited as fissure fillings at the beginning of mineralization, and the greisen was formed afterward by replacement of granodiorite. Cassiterite, the only tin mineral, occurs in coarsely crystalline masses adjacent to the quartz veins, and as small grains disseminated in the greisen.

The minerals of the lodes were deposited in several stages separated by periods of fracturing, and the groups of minerals formed in each stage are distinguishable in part on the basis of difference in degree of deformation. Additional details on the sequence of mineralization are discernable also in such features as crosscutting veinlets, pseudomorphs, and residual structures, of which some may be seen in the field and others only under the microscope. From all these evidences the following sequence may be deduced: (1) Quartz veins; (2) greisen; (a) older minerals in the greisen, including cassiterite; (b) younger minerals in the greisen; (3) late minerals.

Quartz veins

The quartz veins branch and are rather irregular in trend and thickness; most of them are from 3 to 8 inches thick, but some attain a thickness of more than 12 inches, especially at intersections. Apparently the veins at the No. 2 workings are thicker; a single vein there is said to be 9 feet thick.<sup>11/</sup> Commonly the vein quartz forms a solid core, but in some places where it is much fractured it is criss-crossed with seams of greisen, or is even partly replaced by greisen so that only

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<sup>11/</sup> Hutchinson, W. S., unpublished report.

irregular inclusions of quartz remain. The quartz is dull bluish-gray in color, and under the microscope much of it displays wavy extinction.

### Greisen

The greisen occupies a narrow zone 1 inch to 5 feet in thickness between the irregular quartz veins and the granodiorite into which it grades. In most places the greisen zone is thicker than the quartz vein, but the relative thickness of the two differs greatly from place to place, and in some places the greisen is without a central quartz vein.

The greisen is dark gray to dark green, and for the most part fine-grained and crystalline. Its most conspicuous and abundant mineral is muscovite, which forms both isolated crystal plates, as much as 7 millimeters in diameter, and fine-grained aggregates. Quartz and fluorite are also abundant. One channel sample of typical greisen contained 49 percent of muscovite, 27 percent of quartz, 17 percent of fluorite, and 7 percent of other constituents; some other samples contained more fluorite than quartz. It is uncertain just how much of the quartz is residual from the original granodiorite and how much was introduced during the alteration to greisen, but it seems probable that most of the introduced quartz went into the veins and that relatively little was added in the greisen zones.

The greisen was formed mainly by replacement of granodiorite but partly by replacement of vein quartz. In partly replaced granodiorite there are altered but still recognizable feldspar grains and clusters of zircon, apatite, and titanomagnetite or leucoxene grains similar to those in the unaltered granodiorite. Greisen that apparently was formed from vein quartz does not contain these minerals.

The older group of minerals in the greisen includes cassiterite, beryl, coarse muscovite, and perhaps wolframite and

ilmenite. Most grains of cassiterite and beryl and some plates of muscovite are crushed or distorted and are more or less cemented or replaced by other minerals, all of which indicates their early formation. Muscovite in 0.5- to 1-millimeter grains is common throughout the greisen, though generally most abundant and coarsest adjacent to the quartz veins or, in some places, next to coarse cassiterite crystals that are distributed along fractures. Muscovite is also abundant along fractures within the quartz veins, where it makes up some nearly solid masses of coarse mica. The beryl crystals are pale greenish or yellowish, commonly 1 to 2 centimeters long and about 2 millimeters in diameter. The beryl is most abundant at the edges of quartz veins, where there are masses of crystals; many crystals extend 1 to 2 centimeters into the quartz vein. Smaller crystals are scattered in the greisen. Only one crystal of wolframite was found; its relation to the other greisen minerals is uncertain, but it may belong with this group. Ilmenite may have been formed at this stage, for there are grains of leucoxene with a prismatic habit that suggests derivation from ilmenite. Cassiterite will be discussed more fully in a section that follows.

The younger group of minerals in the greisen includes muscovite of relatively fine grain, siderite, ankerite, leucoxene, sulfides, fluorite, biotite, phenakite, and chlorite. These minerals are undeformed except at the younger fractures containing the latest minerals. The fine-grained muscovite is notably undeformed, though otherwise it is much like the earlier-formed muscovite. The carbonate mineral in the greisen is close to siderite in composition, but a vein of ankerite 1 inch wide and about 5 feet long was found in the east-west tunnel (see pl. 43); this ankerite vein had apparently been formed by replacement of quartz. Most of the siderite is in small masses that surround little clusters of apatite, zircon, and leucoxene, but the mineral also forms veinlets in greisen, and it occurs, associated

with coarse-grained fluorite, in fairly large masses adjacent to or within some veins of quartz. The leucoxene is partly in grains whose forms suggest derivation from titanomagnetite and partly in prismatic grains as if derived from ilmenite. Pyrite and sphalerite are sparsely scattered through the greisen of the No. 1 workings, and arsenopyrite was found in the No. 2 workings.<sup>12/</sup> Bismuthoplagionite ( $5 \text{ PbS} \cdot 4 \text{ Bi}_2\text{S}_3$ ) containing specks and veinlets of chalcopyrite and blebs of an undetermined mineral was found in the No. 1 workings. The bismuthoplagionite resembles galena, but has a prismatic habit.

Fluorite occurs in small irregular grains widely disseminated through the greisen, in veinlets, and in relatively large masses associated with siderite.

Some irregular clusters and masses of biotite occur in the granodiorite adjacent to the lodes. Most of the greisen contains veinlets of chlorite, as well as much scattered chlorite formed by replacement of muscovite or biotite. Phenakite (beryllium orthosilicate), usually associated with chlorite, occurs both as pseudomorphs after prismatic beryl and as irregular grains.

#### Late veins

The late minerals are present in small amounts and are spottily distributed. The final stages of mineralization are represented by small masses of nontronite and of a mineral that is probably vermiculite, and by veinlets of hematite. Montmorillonite occurs along a fault that cuts the lodes in the northwest part of the No. 1 workings (pl. 43), and in small irregular bunches nearby. Calcite and clinozoisite form a thin veinlet that seals a small fault in chloritic greisen at the face of the east-west tunnel.

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<sup>12/</sup> Ferguson, H. G., op. cit. (Bull. 15-A), p. 7.



Occurrence of cassiterite

As seen in hand specimens, the cassiterite is dark brown and much stained with iron oxides. In thin sections, the prevailing color is grayish brown, and some of the larger grains are zoned. The best crystals have short pyramidal forms, but complete crystals are rarely found, especially in the coarser material, where nearly all the grains are thoroughly crushed. Even some very small crystals are crushed to a microscopic dust.

Cassiterite is unevenly distributed in the lodes. In the No. 1 workings, coarsely crystalline masses of cassiterite occur sporadically in greisen near the quartz veins or fractures. A few scattered crystals and clusters of crystals were seen in the fractured quartz veins, and in places there are narrow veins of nearly solid cassiterite. The association of coarse, easily recognizable cassiterite with the vein quartz tends to give the impression that quartz and cassiterite were formed at the same time, but this cannot be true, for a large part of the cassiterite is scattered through the greisen in small grains, evidently formed at the same time as the greisen and later than the vein quartz.

Although the tiny cassiterite grains in greisen generally cannot be seen with the unaided eye, their abundance is readily apparent under the microscope in concentrates of the heaviest minerals. These concentrates were prepared by crushing to minus 60-mesh size and quartering the samples, which originally weighed from 10 to 50 pounds, and separating the crushed material into three parts with bromoform (sp. gr. 2.8) and methylene iodide (sp. gr. 3.3).

The largest portion of the separated samples is that having a specific gravity less than 2.8. It consists of the light minerals quartz, andesine, orthoclase, microcline, beryl, calcite, montmorillonite, nontronite, and vermiculite. The minerals in

the intermediate portion are muscovite, biotite, chlorite, apatite, fluorite, phenakite, ankerite, pyroxene, hornblende, and rarely epidote and tourmaline. The heaviest portion contains the cassiterite, accompanied by siderite, ilmenite, chalcopyrite, zircon, titanite, hematite, titanomagnetite, limonite, sphalerite, galena, and pyrrhotite.

#### Size and grade of ore bodies

The tin content of the richest sample collected from the No. 1 workings during the present study was 3.78 percent, and the average for five samples was 1.12 percent. According to Hutchinson,<sup>13/</sup> samples cut in the main tunnel of the No. 1 workings, across the lode at 5-foot intervals, had an average tin content of 1.23 percent. As Hutchinson's samples had an average length of 3.7 feet, and thus represented minable widths of ore, his figures indicate that the average tenor for minable widths is at least 1 percent of tin.

Several lots of ore that were taken from the No. 1 workings were of much higher grade than these channel samples, but that was because rich pockets were mined selectively wherever possible. This fact can readily be deduced from Hutchinson's statement that 19.4 tons of ore assaying 13.9 percent tin was taken from a lode in the upper 25 feet of the shaft in the No. 1 workings. The shaft is 7 by  $4\frac{1}{2}$  feet, and if all the rock in the upper 25 feet had been included in the lot of ore the average grade would have been about 4 percent rather than 13.9 percent. Other lots of ore from the No. 1 workings contained 2.11, 3.33, and 20.00 percent of tin; these also came from rich pockets.

The tin content of the lodes in the No. 2 workings is said to be less than 1 percent. According to Hutchinson, of 14 samples cut across the lode in the main tunnel at 5-foot intervals,

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<sup>13/</sup> This and the following citations of Hutchinson's findings are based on his unpublished reports.

11 samples contained only a trace of tin and 3 contained 1.61, 1.62, and 1.81 percent. Of two lots taken from pockets, one consisted of 1,800 pounds of ore containing 1.16 percent, and the other of 1,200 pounds containing 9.2 percent of tin.

The width of the lodes is suggested by the map of the No. 1 workings (pl. 43), in which the main tunnel explores one lode for a length of 120 feet and lateral workings explore a faulted segment of a lode 50 feet long. The average width of the lode in the main tunnel, as indicated by the samples already mentioned, was 3.7 feet. The depth to which the lodes extend is unknown.

### MINE DESCRIPTIONS

#### History of development

Although cassiterite from Irish Creek was identified in 1846 by Prof. Armstrong of Washington College, Lexington,<sup>14/</sup> there is no record of prospecting in the district until after a specimen from the Martha D. Cash property, probably from the No. 1 group of lodes, was identified as cassiterite by T. Massie <sup>15/</sup> in the spring of 1883.

The Virginia Tin Mining & Manufacturing Co., which was organized in the summer of 1884,<sup>16/</sup> did considerable prospecting and development work during the next two years. A shaft 40 feet deep was sunk on the No. 2 group of lodes and about 3,000 pounds of ore from this shaft was sent to England as a trial lot. Apparently, also, about 1,000 tons of tin ore had accumulated on the dumps <sup>17/</sup> by the end of 1886, but information regarding its source and the time at which it was mined is not available.

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<sup>14/</sup> Mineral Resources U. S., 1893, p. 180, 1894.

<sup>15/</sup> Letter from E. Whitehead in The Virginias, vol. 5, p. 38, 1884. The identification was confirmed by Prof. Dewey of the Smithsonian Institution and by J. P. Kimball of Lehigh, Pa.

<sup>16/</sup> The Virginias, vol. 5, p. 154, 1884.

<sup>17/</sup> Mineral Resources U. S., 1889-90, p. 120, 1892.

Several high-grade specimens of tin ore were sent to the New Orleans Exposition of 1884-85.<sup>18/</sup> In 1886 the property became involved in litigation and operations stopped.<sup>19/</sup>

In 1886 the Lexington Tin Mining Co. was formed, and in a report to that company J. Hotchkiss <sup>20/</sup>described the prospecting that had been done up to that time. The report lists about 40 shafts, tunnels, and cuts, spread over an area "nearly 10 miles long by 4 miles wide." Apparently this company did no mining or development work.

Nothing definite about the district is again recorded until 1889, when the Boston Tin Mining Co. obtained an option and took steps to develop and test the deposits.<sup>21/</sup> In 1890 the district was examined by W. O. Crosby, and early in 1892, when 2,000 tons of ore had been mined, a \$50,000 concentrating mill was put up. Three trial runs were made on a total of 290 tons of ore averaging 3.3 percent tin, and 2,400 pounds of concentrates averaging 43 percent tin were shipped to Boston to be smelted.<sup>22/</sup> This work was stopped, however, in the spring of 1892 <sup>23/</sup>by litigation over ownership.

Because of uncertainty about the title of the property, no further systematic work was done until 1918, when explorations were begun by the Richards Co., Inc., of Boston. The work of cleaning out the old workings was begun in October 1918, and there followed a period of rather intensive development under the supervision of Mr. W. Spencer Hutchinson. The No. 2 workings were cleaned out and extended, and at the No. 1 workings some trenching was done and the present tunnel was driven. This work stopped in August 1919. In April 1942, the Bethlehem Steel

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<sup>18/</sup> The Virginias, vol. 5, pp. 181, 196, 1884; vol. 6, p. 25, 1885.

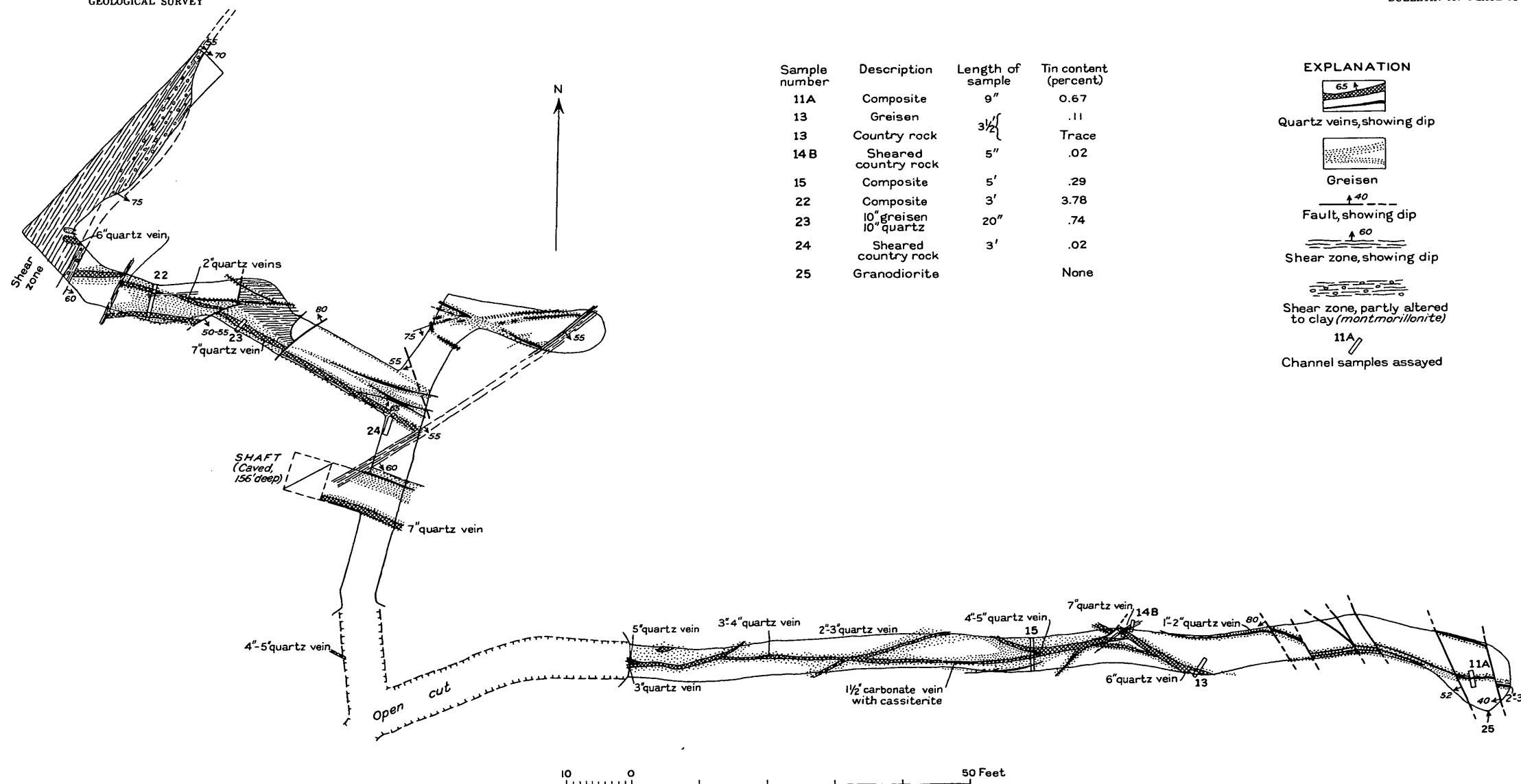
<sup>19/</sup> Mineral Resources U. S., 1893, pp. 180-182, 1894.

<sup>20/</sup> Hotchkiss, Jedediah, in Mineral Resources U. S., 1885, pp. 371-376, 1886.

<sup>21/</sup> Mineral Resources U. S., 1889-90, p. 121, 1892.

<sup>22/</sup> Ulke, Titus, in Mineral Resources U. S., 1893, p. 181, 1894.

<sup>23/</sup> Idem, pp. 180-182.



Co. began a campaign of exploration by diamond drilling, and in May 1942 three drill holes, whose locations are shown on figure 30, had been completed. By June 1942 a fourth hole was completed, and a fifth had been begun.

### Production

Presumably all the ore that has been mined in the district has come from the No. 1 and No. 2 workings. The recorded production, which is summarized in the table below, reflects the practice of mining rich pockets.

Tin ore mined from No. 1 and No. 2 workings

Workings	Date	Tons	Tin content	
			Percent	Pounds
No. 1:				
Open cut.....	1890-92	290	3.33	19,314
		1,710	Unknown	Unknown
Open cut.....	1890-92	<u>1</u> /90	2.11	3,798
Tunnel.....	1918-19	.6	20.00	240
Upper 25 feet of shaft....	1918-19	19.4	13.9	5,393
Open cut.....	1918-19	140.0	1.45	4,060
Open cut.....	1918-19	2.5	1.00	50
No. 2:				
40-foot shaft.....	1884-86	1.5	<u>2</u> /	.....
Accumulated on dumps.....	1884-86	1,000	Unknown	Unknown
Tunnel 201.....	1918-19	.9	1.16	21
Tunnel 201.....	1918-19	.6	9.2	110
Pit 214.....	1918-19	1.0	16.0	320
Pit 214.....	1918-19	1.8	7.65	275
Open cut north of tunnel 202.....	1918-19	3.1	14.0	868
Open cut and tunnel.....	1918-19	.6	<u>3</u> /15.0	180
Prospect.....		.6	Unknown	Unknown

1/ Left on dump, according to W. S. Hutchinson.

2/ This lot was shipped to England, and its grade is unknown. It was probably hand-sorted ore.

3/ Estimated.

### Mine workings

#### No. 1 workings

The main lodes.---The No. 1 workings include about 340 feet of tunnels, which are still open, and an exploratory shaft, said to be 156 feet deep, which is now caved and filled with water.

(See pl. 43.)

The No. 1 workings expose a number of approximately parallel lodes and segments of lodes in the typical granodiorite. The number of individual lodes present is unknown, because it is impossible to correlate the various segments. These strike approximately N. 65° W., and most are vertical or dip steeply to the south, though one in the northwest end of the workings dips 65° N. The lodes are cut by several faults of unknown displacement and by many small slips.

The lodes consist of a medial vein of quartz from 2 to 7 inches wide, bounded on one or both sides by 1 inch to 5 feet or more of greisen. The greisen, though not uniform in width, persists along the strike of the quartz vein; and in a few places greisen was found with no quartz vein.

Cassiterite occurs in large, widely scattered lenses, in veinlets, or as disseminated grains which are chiefly in the greisen but rarely in the quartz. Masses of cassiterite up to 14 inches wide are reported to have been found in the vein in the shaft,<sup>24/</sup> and Winslow,<sup>25/</sup> in describing the outcrop of the lode, mentions a "veinlet of solid cassiterite an inch or more thick" cutting micaceous quartz.

An average tin content for the lodes in the No. 1 workings of about 1 percent, in minable widths, is indicated both by assays and by the records of ore that has been mined. The average tin content of five samples collected by the authors was 1.12 percent. The location of these samples and the assays are shown on plate 43. The composite samples were taken across the entire width of the lodes; the length of cut ranged from 9 inches up to 5 feet, and the samples include the quartz vein as well as the greisen. Cassiterite could not readily be seen in the greisen except in sample 22. Samples taken in 1918-19 by W. S. Hutchinson averaged 1.23 percent of tin. These samples

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<sup>24/</sup> Hutchinson, W. S., unpublished report.

<sup>25/</sup> Winslow, Arthur, Tin ore in Virginia: Eng. and Min. Jour., vol. 40, p. 320, 1885.

were cut along the back of the main tunnel at 5-foot intervals, and the average length of cut was 3.7 feet.

Possible extensions of No. 1 lodes.--Ferguson <sup>26/</sup> reports a 3-inch quartz "vein" found in a small open cut about 100 feet north of the No. 1 workings and states that it contained "a considerable amount of beryl in long, slender crystals and some muscovite in small plates. The granodiorite next to the vein is greatly altered, but the alteration here consists of replacement of the original rock by an aggregate of muscovite and beryl, rather than of muscovite and fluorite as in the other veins. No cassiterite was seen in the specimens from this vein." This vein is probably the continuation of the lode exposed in the northwest workings of tunnel No. 1. What is believed to be the eastward extension of this same lode was prospected in a 160-foot open cut beginning about 410 feet N. 77° E. of the portal of the tunnel. Hutchinson reports that cassiterite was found in float below the opening and a "sample taken across the vein, including both walls, assayed 1.02 percent over a width of 10 inches." Three other samples from the cut are reported as follows:

Description	Tin (percent)
General sample of 2-inch	
"vein".....	4.76
Soft material picked out of	
2-inch "vein".....	6.31
Sample across 2 feet.....	2.99

A 95-foot tunnel, 325 feet N. 73° E. of the portal of tunnel No. 1 and 106 feet above it, driven to explore this lode, failed to find it. The tunnel cut two diabase dikes which, according to Hutchinson, displaced the lode.

Another lode or set of lodes with a southerly dip was found in open cuts <sup>27/</sup> about 160 feet north of the main tunnel. A 5,000-pound sample yielded assays averaging 1 percent tin.

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<sup>26/</sup> Ferguson, H. C., Tin deposits near Irish Creek, Va.: Virginia Geol. Survey Bull. 15-A, p. 11, 1918.

<sup>27/</sup> Hutchinson, W. S., unpublished report.



The large number of lodes in the immediate vicinity of the No. 1 workings indicates a rather broad zone or system of lodes. Although information is too meager to determine whether the lodes are unsystematically scattered over the region or are closely spaced, forming a zone or system with barren ground beyond, the persistence of the greisen is an encouraging feature.

#### No. 2 workings

The early work at Irish Creek was concentrated principally on the No. 2 group of lodes, located on the hill west of Panther Run about 1,200 feet south of the old mill. The workings on this group of lodes were caved in at the time of the present investigation, and the information presented here is gathered chiefly from progress reports by W. Spencer Hutchinson. Other information is found in the accounts by Hotchkiss,<sup>28/</sup> Campbell,<sup>29/</sup> Brown,<sup>30/</sup> Winslow,<sup>31/</sup> and Ferguson,<sup>32/</sup> of the early exploration. There are approximately 850 feet of workings, chiefly in three tunnels, shown in plate 44. Tunnel 201 is the easternmost and lowest in altitude of the No. 2 workings. It consists of about 220 feet of lateral workings and a 27-foot winze near the breast; also a 12-foot raise connecting with tunnel 204. Tunnel 204 has the most extensive workings. These lie essentially to the west of tunnel 201, and are about 12 feet higher in altitude. It has about 518 feet of crosscuts and drifts, all made prior to 1918. Several pits, shafts, and trenches are found at the surface. Tunnel 202 is the westernmost and highest of the workings exploring the No. 2 group of veins. It is 131

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<sup>28/</sup> Hotchkiss, J. J., Tin ore in Virginia: The Virginias, vol. 4, pp. 150-151, 1883, and vol. 5, p. 38, 1884; Silver and gold in Virginia tin belt: The Virginias, vol. 4, p. 168, 1883.

<sup>29/</sup> Campbell, Harry D., Tin ore in the Blue Ridge of Virginia: The Virginias, vol. 4, p. 151, 1883.

<sup>30/</sup> Brown, W. G., On cassiterite from Irish Creek, Rockbridge County, Va.: Am. Chem. Jour., vol. 6, pp. 185-187, 1885.

<sup>31/</sup> Winslow, Arthur, Tin ore in Virginia: Eng. and Min. Jour., vol. 40, p. 320, 1885.

<sup>32/</sup> Ferguson, H. G., Tin deposits near Irish Creek, Va.: Virginia Geol. Survey Bull. 15-A, 1918.

TUNNEL 205  
ELEV. 2635'

OPEN CUT 301



## EXPLANATION

- ⊠ Foot of raise
- Head of winze

TUNNEL 204  
ELEV. 2683'

TUNNEL 201  
ELEV. 2670'

OPEN CUT 214

INCLINED  
RAISE

REPORTED COURSE OF CAVED TUNNEL

PLAN

CAVED SHAFT  
ELEV. 2753'

TUNNEL 202  
ELEV. 2710'

QUARTZ CROPPINGS

## PROJECTION

50 0 100 Feet

MAP OF THE NO. 2 WORKINGS, IRISH CREEK, VIRGINIA

After W. Spencer Hutchinson  
March 1919

471317 O - 42 (Faces p. 290)

feet long and connects with the bottom of a caved shaft. Scattered over the area are several other caved pits and trenches.

Not much is known of the character or composition of the lodes. Most of the descriptions refer to the quartz veins, but whether or not greisen is associated with the quartz is not clear. Greisen was found on some of the dumps, and Hutchinson refers to altered tin-bearing granite or country rock next to the vein; it therefore seems probable that greisen is present, presumably accompanying the quartz veins.

Apparently the workings explored a group of lodes similar to the No. 1 group. According to Hutchinson the ground in the workings is much broken and the lodes are cut and displaced by slips. It is therefore impossible to state the number of individual lodes, or anything about their lengths or the relation of one to another. This group of lodes has a known length of approximately 500 feet and strikes about N. 70° E. Individual quartz veins range in strike from N. 45° E. to N. 70° E., and in dip from 50° southward to vertical. Whether or not this group of lodes is the faulted equivalent of the No. 1 group cannot be determined. The fault zone found in the westernmost part of the No. 1 workings has displaced the western extension of the No. 1 group of lodes, but nothing is known of the direction of movement nor of the amount of displacement along the fault.

In tunnel 201 a northwesterly crosscut 49 feet long at a point 67 feet from the portal passes through broken and decomposed granite said to be in a fault zone. No lodes were found in the crosscut, although some quartz could be seen on the west side. It was thought that some lodes found farther west would be intersected by this crosscut, but they evidently were cut off by the fault.

At 110 feet from the portal of tunnel 201, a mass of arsenopyrite 10 feet long and 6 inches to 2 feet wide was found.

Crystals of cassiterite were sparingly distributed through the arsenopyrite and a lens of cassiterite of unreported size was found nearby. A winze 27 feet deep and dipping 53° was sunk on this vein. The arsenopyrite continued to the bottom but pinched to a narrow stringer. Cassiterite was very scarce, and water coming in at the bottom discouraged further sinking.

According to Hutchinson, only 3 out of 14 samples taken across the back of tunnel 201 (pl. 44) at 5-foot intervals along the 35-foot stretch 94 to 129 feet from the portal, contained appreciable quantities of tin. These three best samples contained 1.61 to 1.81 percent of tin; the other 11 showed only a "trace."

The workings of tunnel 204, driven before 1918, were thoroughly sampled by the Richards Co., but the sampling, according to Hutchinson, "disclosed nothing of consequence," and, he adds, "there are no stopes or other evidence of ore having been mined that would indicate that the former operators found anything either."

A small pit (No. 214) dug at the southwest end of an old caved pit above the crosscut about 60 feet from the portal (pl. 44) struck a pocket which yielded about a ton of ore containing 16 percent tin. A shaft 5 feet deep was sunk on the ore and yielded 3,600 pounds of ore which assayed 7.65 percent tin, but when this ore pinched out the work here was discontinued.

According to Hutchinson, two parallel quartz veins called the North vein and the South vein are exposed in tunnel 202. The North vein was followed for 60 feet and had a maximum thickness of  $5\frac{1}{2}$  feet, but it is said to have been less regular than the South vein, and assays of three samples from it showed no tin. The South vein, exposed for 33 feet, dips about 50° S.; it has an apparent maximum thickness of 9 feet, but in general it is 6 feet or less in thickness. Five samples, apparently representing the quartz vein, showed no tin in the assay; one

sample across 5 feet of the vein assayed 2.92 percent tin, but a second sample showed none. A sample across  $3\frac{1}{2}$  feet of vein rock in the bottom of an open cut 30 feet east of the caved shaft, believed to be part of the South vein, assayed 0.70 percent tin. Here, then, as in the veins in the No. 1 workings, cassiterite was found only in pockets. The high-grade specimens of cassiterite and wolframite which were found on the dump must have come from such pockets. A 9-foot north crosscut 60 feet from the portal revealed no other quartz vein, and samples from a cut-out in the wall of the drift opposite, where it had been reported that ore was found in the earlier development, did not encourage further work in that direction.

Nearby lodes.--Hutchinson also reported that a large amount of trenching was done to explore the veins between the old mine workings, and also what he calls the north vein--probably the one just north of tunnel 202 (fig. 30 and pl. 44). A rich pocket here yielded 6,100 pounds of ore assaying 14 percent tin. A shaft was started in the bottom of an open cut, but the ore pinched out in about 6 feet. A narrow seam of ore showed in the end of the open cut, and a tunnel at least 40 feet long was driven from which 1,200 pounds of ore, estimated to run 15 percent tin, was produced. No ore showed in the face, however, and a short crosscut to the north failed to disclose ore. About 15 feet north of the portal of this tunnel is a small prospect on a parallel vein; according to Hutchinson, 1,200 pounds of "good ore" was taken from this prospect and there was a showing of ore in the face.

Open cut No. 301 is apparently on a quartz vein. Samples of vein matter from the south side of a heavy quartz outcrop in the hanging wall, one 5 feet from the surface and another 10 feet from the surface, are said to have showed no tin when assayed, but a footwall specimen, whose depth is not given, assayed 0.90 percent tin.

The grade of ore in the No. 2 group of lodes, according to these data, is apparently lower than that in the No. 1 group. Here as in the No. 1 group, the ore seems to have occurred in rich pockets and in narrow veinlets, but it is not clear from the available reports whether or not the cassiterite was in greisen, nor whether the sampling was adequate. Apparently most of the sampling was of quartz and "altered rock" in which cassiterite was discernible to the eye. Even though rich pockets may have been found, that fact would hardly warrant further work unless it were known that greisen occurs persistently. Thorough mapping and sampling of the greisen needs still to be done before the value of this group of lodes can be fairly appraised.

#### Outlying lodes

Cassiterite has been reported to occur over a wide area adjacent to the No. 1 and No. 2 groups of lodes. Ferguson <sup>33/</sup> found six scattered veins, "apparently of some promise," on the ridge north of Irish Creek, northwest of the No. 1 and No. 2 workings. These veins have a more northerly strike than those just described. According to Ferguson's report, they consist of quartz, and most of them contain mica, limonite, and some cassiterite.

Winslow <sup>34/</sup> showed the location of the known veins on the map accompanying his report. One group of five veins, on the south side of Irish Creek and about 6,500 feet west-southwest of the mill on Panther Run, have a general westerly strike and southerly dip. The middle vein is said to be 3 feet thick, and an average sample from it contained 1.12 percent tin. Another vein about 1 foot thick, situated about 2,400 feet west of the No. 2 workings, was reported to contain 0.63 percent tin.

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<sup>33/</sup> Ferguson, H. G., op. cit. (Bull. 15-A), pp. 13-14, and fig. 2.

<sup>34/</sup> Winslow, Arthur, op. cit., p. 320.

Apparently greisen accompanies most of the veins, for Winslow <sup>35/</sup> states that "the gangue of the veins \* \* \* generally is a dark earthy rock composed largely of quartz, with iron pyrites, mica, and various earthy minerals, among which the cassiterite is disseminated in small crystals and in fine grains indistinguishable to the naked eye."

Hotchkiss <sup>36/</sup> reports the presence of tin in many prospects in an area of about 12 square miles, "about 3 miles wide from northwest to southeast, and about 4 miles long from northeast to southwest." Unfortunately the locations are not described, and no maps accompany the report. Samples collected from 11 localities, not including the No. 1 and No. 2 groups, contained from 0.1 to 3.25 percent of tin and averaged 0.805 percent. Hotchkiss also points out <sup>37/</sup> that "the openings that have been made are so located as actually to expose to inspection fully 600 feet of the vertical depth of the tin veins of this region \* \* \*." Hotchkiss concludes that <sup>38/</sup> "the prospecting that has been done, the condition of the veins as exposed and their richness in metallic tin \* \* \* warrant the conclusion that an abundance of high-grade ore can readily be obtained from these localities."

#### RESERVES

The ore body exposed in the No. 1 workings is the only potential reserve in the district that is even partly blocked out. Its average tin content is about 1 percent. The total length of the lode now exposed is about 330 feet and the average width about  $1\frac{1}{4}$  feet, if one assumes that the width is about one-fourth that of the 5-foot wide drifts. Assuming 12 cubic

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<sup>35/</sup> Winslow, Arthur, op. cit., p. 320.

<sup>36/</sup> Hotchkiss, Jedediah, in Mineral Resources U. S., 1885, pp. 371-376, 1886.

<sup>37/</sup> Idem, p. 376.

<sup>38/</sup> Idem, p. 375.

feet of ore to the ton, the ore body would contain about 3,400 tons of ore per 100 feet of vertical extent. The general assumption that the lodes continue at least 100 feet seems warranted, although accurate vertical or horizontal projections cannot be made because of the many slips and faults.

No estimates can be made of possible reserves in the caved No. 2 workings or in outlying prospects.

#### SUGGESTIONS FOR PROSPECTING

The small amount of exploration that has been done in the Irish Creek district leaves the extent of its tin deposits still undetermined. The principal need seems to be a general prospecting of the area underlain by granodiorite, which, so far as is known, is the only country rock of the tin lodes. In prospecting, the quartz veins are a convenient but not wholly reliable guide to possible tin deposits; the greisen zones, however, are a valuable guide to ore, because they probably are present wherever tin occurs. The greisen is readily distinguishable from the granodiorite, a fact which not only aids prospecting but is important in selective mining, as the granodiorite is barren.

At present it is not known whether the lodes are grouped into narrow systems or are scattered unsystematically in the granodiorite. Widespread trenching normal to the strike of known veins would seem to be the best means of determining the distribution or grouping of lodes, and later local diamond drilling should give a fairly accurate idea of the amount and grade of greisen in these zones.

