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THE GOSSAN LEAD, CARROLL COUNTY, VIRGINIA

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U. S. Geological Survey

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THE GOSSAN LEAD, CARROLL COUNTY, VIRGINIA

By R. J. Wright and N. D. Raman

ABSTRACT

The Gossan Lead consists of a series of elongate sulfide lenses forming a northeast-trending mineralized zone 17 miles in length. The primary pyrrhotite ore carries about 0.7 percent copper and a similar amount of zinc. It is being worked at the Gossan mine as a source of sulfur for acid manufacture.

Most of the secondary copper ore has been exhausted by mining operations of the last century. Several localities have been found where small bodies of secondary ore may remain. These occurrences probably total less than 1,000 or 1,500 tons of ore, and their grade may be in the neighborhood of 5 percent copper. Secondary ore bodies of comparable tonnage may exist elsewhere along the middle portion of the lead. Several hundred thousand tons of gossan, which might be used as iron ore, remain.

INTRODUCTION

The Gossan Lead is a series of elongate sulfide lenses which form a mineralized zone running northeast for 17 miles through Carroll County, southwestern Virginia (fig. 1). The region is one of rolling hills whose summits preserve a nearly uniform skyline at elevations of 2,500 to 2,900 feet. Drainage is by west-flowing tributaries to the New River, and maximum relief is about 700 feet. Outcrops occur infrequently in streams and along steep slopes so much of the geology must be deducted through study of mine dumps, which are now overgrown.

In the late spring and summer of 1943 a field part of the U. S. Geological Survey examined the Gossan Lead and similar smaller deposits in Carroll and Grayson Counties. The portion of the Lead northeast of Chestnut Creek was mapped on aerial photographs, and two small areas were mapped in detail by plane table.

History. --Following the discovery of Ducktown the gossans of southwest Virginia were thoroughly prospected during the fifties of the last century. The secondary copper ore of the Gossan Lead was mined at this time and an extensive series of prospects and workings established over its entire length. A report by Richard O. Currey,^{1/} a physician of Knoxville, Tenn., gives the production to

1/ Currey, R. O., A geological visit to the Virginia copper region. Beckell, Haws and Co., Knoxville, Tenn., 1859; reprinted in the Virginias, vol. 1, pp. 70-71, Staunton, Va., 1880, as part of a report on the copper and iron region of the Floyd-Carroll-Grayson plateau of the Blue Ridge of Virginia, etc., pp. 62-64, 70-71, 74-77, 80-81, 95.

1859 as about 2,500 tons of 14 percent copper ore. Where they could be checked, several of Currey's figures were found inaccurate, and this casts some doubt on the general reliability of his data. Some time after the copper operations gossan was mined as iron ore at the Betty Baker and Gossan (Monarat) mines and along part of the Chestnut Creek segment.

At present the only activity is at the Gossan Mine about 5 miles north of Galax, where pyrrhotite ore is mined by the General Chemical Company, 40 Rector Street, New York City, as a source of sulfur for acid manufacture. The ore is

is concentrated and shipped by rail to Pulaski, Va., where it is roasted. The cinder is sent to Birmingham, Ala., as iron ore.

The General Chemical Company controls the southwest end of the Lead and two small tracts to the northeast. The remaining strike length is owned by the Virginia Iron, Coal and Coke Company, 310 Campbell Street, Roanoke, Va.

GEOLOGY

The region under consideration is along the western slope of the Blue Ridge, which is a zone of schists and gneisses bounded on the northwest by the younger Paleozoic sediments of the Appalachian geosyncline. This contact lies 2 to 3 miles northwest of the Lead.

The Lead is enclosed in the pre-Cambrian Lynchburg gneiss which may be equivalent to the Carolina gneiss, one of the oldest and most broadly distributed formations in the southern Appalachians. It has wide lithologic variation, but in this part of the Blue Ridge light-gray quartz-mica schist predominates, with minor occurrences of sericite schist, mica-garnet schist, amphibole gneiss and schist, and granitic zones. The foliation of the schists has a general N. 45° E. trend with a southeast dip averaging 60°. Except for infrequent local deviations the sulfide bodies parallel the schistosity. The Lead is bordered by light-gray sericite schist which is characterized by small polygonal holes thought to be formed by removal of feldspar grains, and by small crinkles which are usually horizontal or plunge slightly to the southwest.

STRUCTURE

The Gossan Lead is made up of a series of elongate sulfide lenses which succeed one another along a general northeast strike (fig. 1). Successive segments may be offset in either direction across the strike. In places the lenses parallel each other for short distances. Each segment trends about N. 50° E, and dips to the southeast. Diamond drilling has shown the average dip of the Betty Baker segment to be 47°, but at its northeast end the dip flattens markedly and the strike swings to the east.

The sulfides often include rounded and sometimes slickensided masses of schist, quartz, and aplite. In places fragments are so abundant that it seems apparent that the sulfides were emplaced in a brecciated zone. Ross 2/ described several successive stages of mineralization and suggest (p. 44) that they may have been initiated by recurrent movements along the zone of mineralization which

2/ Ross, C. S., Origin of the copper deposits of the Ducktown type in the southern Appalachian region: U.S. Geol. Survey, Prof. Paper: 179, 1935

periodically increased the permeability of the vein. The Lead is parallel to the major thrust faults of the region, and this together with the brecciated character at places suggests that the sulfide bodies were localized along a shear zone. No displacements within the lenses were noted. A cross fault near the Betty Baker mine has been reported by Ross 3/ but investigation failed to reveal any evidence of

3/ Ross, *idem.*, p. 83.

offset. At three localities splits extend from the ore body for short distances.

MINERALOGY

Pyrrhotite is the dominant ore mineral with minor pyrite, chalcopyrite, sphalerite, and galena. Gangue minerals include quartz, feldspar, amphibole, chlorite, biotite, dolomite, and spessartite. Partings and irregular schist inclusions of random orientation are common throughout.

Analyses of Ore

	<u>Fe</u>	<u>S</u>	<u>Cu</u>	<u>Zn</u>	<u>Pb</u>
Betty Baker mine (a)	37.4%	33.8%	0.50%		
Betty Baker mine (b)	35.7	22.2	0.59	0.56%	0.38%
Wild Cat segment (c)	_____	25.0	0.7	0.7	_____

(a) Average of three shaft samples by Virginia Iron, Coal and Coke Co., 1928.

(b) Average of analyses from 24 diamond drill holes by Virginia Iron, Coal and Coke Co., 1928.

(c) Grab sample of tunnel by U. S. Geological Survey, 1943.

The relative amount of sulfides in the vein material is quite variable along and across the strike. There is a complete gradation from nearly massive sulfides to sulfides sparsely disseminated in gangue material. The gangue may be schist into which sulfides have been introduced, or it may consist of hydrothermal silicate minerals--chlorite, biotite, amphibole, feldspar--deposited along with the metallic minerals. Along the northeast end of the Little Vine segment the mineralized zone is made up of quartz, spessartite, and rutile with sparse sulfides.

Corresponding to the variation in sulfide content of the primary ore is a variation in the ratio of iron oxide to weathered gangue minerals in the oxidation product. Upon weathering the massive sulfides develop a brown to maroon porous

gossan which is nearly pure iron oxide. Reserving the term "gossan" for this material, the other oxidation products were classified in the field as schistose gossan, limonitic schist, and stained schist, depending on the relative amount of iron oxide. The distinctions between these varieties are not definite, as classification was based on megascopic examination without benefit of analyses. No effort was made to determine whether the gangue was schist or non-metallic vein minerals. Stained schist has limited significance since the iron oxide may have been transported from another site by ground waters, but along the strike it may indicate low-grade mineralization. This material has been prospected at several localities.

SECONDARY COPPER ENRICHMENT

In oxidation of an ore body sulfides may be altered into sulfates, carbonates, or other soluble compounds which are removed by descending solutions and carried downward to the water table. Here there is a decrease in free oxygen and a change from oxidizing to reducing conditions so that the sulfides may be reprecipitated in a zone of concentration at or near the water table. The body of secondary sulfides lies in a nearly horizontal position between the unaltered primary sulfides below and the leached oxidized gossan cap above. Copper is one of the most easily transported and precipitated metals, and considerable enrichment may be attained in the secondary zone.

A purpose of the Geological Survey's field work was to investigate the Gossan Lead for any reserves of secondary copper ore which may have escaped the mining operations of the last century. In evaluating various sections of the deposit for secondary ore, consideration was given to four factors: 1) extent of previous mining and prospecting, 2) topography, 3) copper content of the primary ore, and 4) width of primary ore.

1) Reserves can be expected only in parts of the deposit which were not exhausted during previous mining operations. Production has been mostly from tunnels driven in the secondary zone although some shafts were driven for ventilating or exploratory purposes. To estimate the extent of mining an effort was made to determine the length of the tunnels. Those which were open or could be made accessible by slight digging were entered, examined, and measured. When caved the approximate length was estimated from the size of the dumps. Gossan iron ore has been mined in open-cuts in places along the Lead. These openings are said to have broken into former copper tunnels or bottomed in primary ore, so here there is little chance for secondary ore.

2) Topography affects the extent of secondary enrichment. Under steep slopes the inclination of the water table is appreciable, and there is a marked movement of ground water downward toward the streams. Upon reaching the water table descending copper-bearing solutions may be dispersed by the ground water circulation before copper sulfides can be precipitated. A flat upland is more favorable to enrichment because here the ground water is essentially static, and sulfides can be concentrated in a zone without interruption. Enrichment is also favored on uplands because the depth from ground surface to water table is greater there than along slopes. Thus a larger portion of the ore body is exposed to oxidation and more copper may be removed for concentration below.

3) The amount of copper available for concentration in the enriched zone also depends on the relative copper content of the primary ore. Hence a rich primary ore favors development of rich secondary ores. The massive sulfide ores of the Lead average 0.6-0.7% Cu. No analyses are available for the less massive ore or for

mineralized schist. Presumably the mineralized schist would carry less copper than the more massive ore; also less sulfur is available to form acid solutions for the removal of the copper. For this reason gossan and schistose gossan are more favorable indications for the occurrence of secondary ore than limonitic schist or stained schist.

4) The horizontal width of the primary ore is important in that it determines the maximum possible width of the secondary ore body.

DESCRIPTION OF INDIVIDUAL SEGMENTS

For convenience in detailed description the Lead northeast of Chestnut Creek is divided into eight segments. Several of these are structural units offset from adjacent segments. Others are separated only by a decrease in mineralization along the strike. The segments are named after mines that were formerly located there or by local physical or cultural features. Workings on the accompanying map (fig. 2) are identified by giving their distance in feet from the northeast end of the map, as measured on the scale along the upper and lower edges of the figure.

Betty Baker segment. -- The Betty Baker segment comprises the northeastern end of the Lead. Open-cut mining of gossan iron ore has been extensive here, and gossan has been removed from the entire length of the segment. Massive primary sulfides with unoriented schist inclusions are exposed in a cut at the north end (fig. 3). Similar material comprises the dump from two shafts, now flooded, in the open-cut at 4,000.

The primary ore body has been explored by 9,276 feet of diamond drilling done in 1928 by the Virginia Iron, Coal and Coke Company. Drilling has shown the ore body has an average eastward dip of 47° and averages 14 feet in thickness. Schist partings are common, the number and thickness varying greatly along strike. Dip of the vein decreases at its northern end, and a transverse open cut suggests a swing in outcrop to the east (figs. 3 and 4). Similar deviation in strike occurs in the country rock. Unfortunately the general lack of outcrops prohibits location of the vein walls except in the large open-cut. The structure contour plan (fig. 5) indicates that the northeast end of the segment is deformed by a synclinal fold plunging gently to the south. Except for a 45-foot zone of gossan crossing county route 752 to the northeast, no evidence of mineralization was noted north of the transverse open-cut. The gossan zone could not be traced in either direction from the road.

Because of the extensive open-cut operations along the Betty Baker segment, it is believed that no reserves of secondary ore remain.

Little Vine segment. -- The Little Vine segment comprises both quartz-spessartite and sulfide mineralization. A little manganese stained quartz float can be found immediately north of county route 768, becoming more abundant south of the road. Material on dumps shows oxidized spessartite in a quartz gangue with

occasional rutile prisms. This type of mineralization persists for 1,000 feet southwest of the road to 10,800, where gossan and a little primary sulfides appear on the dumps. A longitudinal trench and two short adits continue for 600 feet southwest of this point. The material on the dumps includes quartz and gossan chunks. One adit exposes mineralized schist and in the other, developed in the oxidized zone, the schist is stained by limonite.

Sulfide mineralization in the Little Vine segment is sparse and irregular, so conditions are unfavorable for secondary copper enrichment.

Little Reed Island segment. -- The Little Reed Island segment appears as a four-foot wide zone of primary sulfides in a cut along county route 769. From here heavy gossan float persists for 400 feet northeast of the road, but only schist can be found along the strike beyond that point. In short adits northeast of the road the gossan is 1 1/2 to 2 1/2 feet wide.

The vein can be traced southwest across the intermeander spur of Little Reed Island Creek by three adits--two on the south and one on the north side--and by gossan float along the crest of the spur. The adits show the width of the sulfide body as about 4 feet. Scattered limonitic schist appears on the north side of the next intermeander spur along strike to the southwest, disappearing on the south slope of the spur.

Because of the steep slopes elsewhere the crest of the northern intermeander spur is the most favorable section of the Little Reed Island segment for secondary copper enrichment. The adit on the north side is 60 feet long, and the one on the other side of the crest, 425 feet beyond, is open for 200 feet to a cave-in. At both openings the vein is so narrow that the original reserves of secondary ore could not have been large. It is doubtful that any reserves of secondary ore remain between the faces of the two adits.

Cranberry segment. -- The Cranberry segment was one of the most extensively worked portions of the Lead, with the Cranberry, Fairmont, and Brown and Stevenson mines located there. Sulfides crop out along U. S. Highway 52 for 300 feet across the strike. Fairly massive sulfides occur near the edges of the mineralized zone but the central part contains abundant schist. South of the road gossan passes into stained schist along strike, indicating a marked decrease in the intensity of mineralization.

Gossan float, several caved adits, and numerous prospect or air shafts, usually with primary sulfides on the dumps, mark the course of the vein for 2,500 feet northeast of route 52. At one place exploration has indicated a split which persists on a north strike for 600 feet from the main vein. Workings in the 2,500 foot interval are concentrated in the southwest 1,500 feet where gossan float is most abundant, but the adit at 23,900 has given access to the secondary zone of the northeast end. This tunnel is caved 180 feet from the portal and exposes a width of 4 to 7 feet of gossan.

Mineralized rock continues northeast from the adit at 23,900 almost to Little Reed Island Creek. Gossan in the adit at 23,600 is 1 1/2 to 4 feet wide, and gossan float occurs sparsely on the slopes to the northeast. Four feet (horizontal width) of primary sulfides outcrop in the bed of the small tributary to Little Reed Island Creek. Sulfides are also exposed within 2 feet of the surface in the cut at 22,000 where the slope is quite steep. No evidence of mineralization was found north of this point.

The most favorable part of the Cranberry segment for secondary copper enrichment is the 2,500-foot length northeast of U. S. 52, where a wide mineralized zone crosses a gently rolling upland. Elsewhere the vein is narrower, and relief is marked.

Judging from the extensive workings along the southwestern portion of the 2,500 foot interval it seems almost certain that all the secondary ore has been removed here. The northeast 1,000 feet has been worked less thoroughly, but the secondary zone has been entered by the adit at 23,900, and the large dump indicates that the working was extensive.

The Cranberry portion of the Lead has the largest reserves of gossan iron ore. Very little information could be obtained about dimensions of the gossan cap, but rough estimates indicate at least 100,000 tons of ore. Ross ^{4/} gives the reserves as 750,000 tones, an estimate by John F. McKee. According to this report the

^{4/} Ross, C. S., op. cit., p. 79.

gossan extends for 3 1/2 miles, so McKee's figure probably includes some gossan bodies to the southwest in addition to the one at Cranberry.

Wild Cat segment. -- The Wild Cat segment is separated from adjacent segments, which are along the strike, by a marked decrease in intensity of mineralization. It includes the sites of the former Wild Cat and Ann Phipps mines.

The northeast two-thirds, from 28,000 to 32,300 is marked by frequent workings with gossan and occasional primary sulfides on the dumps. Gossan is most abundant at each end of this 4,300 foot interval. Workings are correspondingly numerous at the extremities, and it is likely that the vein has been mined out there. The central portion has been mined from four adits at 30,100, 30,600, 30,800, and 31,000. The one at 30,800 is caved while the others are respectively 155,200 and 90 feet in length. Streaks of secondary ore occur in faces of the three open tunnels, the greatest observed width of ore being 2 feet. It is apparent that about 100 feet

of unmined ground remains between ends of the adits at 30,100 and 30,600. The tunnel at 30,800 cannot be measured, and it is not known whether the vein between it and 31,000 has been mined out. South of 32,300 the vein can be traced for 1,000 feet by pits and one adit with stained schist, limonitic schist, and occasional gossan on the dumps. Sparse, stained schist float was found southwest of the workings.

The Wild Cat segment is well mineralized except for the southwest 1,000 feet, and the topography is, in general, favorable for enrichment. One hundred feet of ground remain unmined between the ends of the adits at 30,100 and 30,600, and there possibly is a small body of secondary ore here.

Sarah Ellen segment. -- The Sarah Ellen segment extends for about 1 1/2 miles southwest of 35,300. Southwest of county route 744 the rock is weakly mineralized, as shown by dumps of stained schist and schist near the pits and prospect shafts. Northeast of the road workings are more abundant and are concentrated where favorable indications were found. A zone of heavy gossan float between 36,300 and 37,000 has been prospected by trenches and shafts and the secondary zone entered by two adits. Schistose gossan appears on dumps along a similar zone from 38,000 to 38,500. Here, too, an adit with a large dump has been driven into the base of the gossan. The secondary ore has probably been exhausted at these two localities.

Siliceous gossan float persists for 70 feet northeast and 150 feet southwest of the trench at 35,700 and except for the trench it has not been prospected. The zone ends a short distance southwest of three adits at 35,900, each of which is less than 20 feet long. Gossan is most abundant at 35,700 where some blocks are as much as 3 feet in diameter. The gossan indicates a lens of sulfides with a probable length of 220 feet and of unknown width. The topography is favorable to enrichment, and possibilities for small unmined body of secondary ore are good.

Copperas Hill segment. -- The Copperas Hill segment is northwest of the general strike of the Lead and is separated from the Sarah Ellen segment by about 3 miles in which evidence of mineralization is limited to occasional iron stains in the country rock. Immediately north of Crooked Creek stained schist float is seen, and beginning at the crest of the north valley wall gossan appears around numerous old workings. The lower portion of the valley wall is quite steep so that gossan is not developed and primary sulfides outcrop for a maximum width of 30 feet in the gully which marks the course of the vein. Near 60,000 the vein splits, a limb extending southwest for 300 feet parallel to the main ore body.

For 1,200 feet southwest of the creek the course of the vein across a small intermeander spur is marked by two trenches with gossan on the dumps. One includes primary ore as well. The vein passes under the tip of a curve in the creek and continues southwest for 2,200 feet. Mineralization of the southwest end is slight. At no point in the 2,200-foot interval could the vein width be determined, but a 12-foot gossan zone is exposed in one pit, neither wall being visible. Near 63,200 the vein trends nearly north for a short distance, while a split persists on a northeast strike for 150 feet.

The Copperas Hill segment crosses a strongly dissected region, and the prevailing steep slopes are unfavorable to secondary copper enrichment. Considerable prospecting but little mining has been done here.

Chestnut Creek segment. -- The north end of the Chestnut Creek segment is one of the widest mineralized zones on the entire Lead. The great variety in the type of material on the dumps from the numerous trenches and pits indicates marked variation in intensity of mineralization, both across and along the strike. The gossan

is very siliceous, and it forms only a small percentage of the oxidized material. On the detailed plane table map of this area, (fig. 6) three zones in which gossan occurs on the dumps are outlined by dotted lines. These areas may indicate underlying lenses of massive sulfides.

The rest of the Chestnut Creek segment is marked by schist, stained schist, and limonitic schist except for a section of gossan from 68,900 to 70,000. The southwestern half of this 2,100 foot interval has been developed by open-cuts from which gossan iron ore was mined. These are up to 60 feet in width, and one exposes a 30-foot thickness of gossan. Gossan appears on trenches along a hill slope for 1,000 feet northeast of the end of the open-cut. The width here could not be determined, but the small amount of float suggests that it is not great.

Near the Chestnut Creek segment are two other sulfide bodies. One thousand feet east of the segment a cut on the Norfolk and Western Railway exposes 4 feet of mineralized schist. This zone can be traced by workings for 3,000 feet to the northeast. The northeastern end, where relief is not so great as near the creek, has been extensively prospected by trenches, shafts, and adits. Gossan has limited distribution. About 1,300 feet east of the north end of the Chestnut Creek segment a few trenches have shown a little gossan and limonitic schist. A small lens of sulfides is suggested here.

The most favorable portions of the Chestnut Creek segment for secondary ore reserves are the three areas of gossan in the broad mineralized zone at the north end. The 1,000-foot length of gossan northeast of the open-cut would be of interest except for the appreciable slope there.

The Great Outburst. --The Lead extends for about 2 1/4 miles southwest of Chestnut Creek, and this portion has been called the "Great Outburst" because of the thickness of the ore body. The gossan has been removed by opencuts, and the primary ore is now being mined at the Gossan Mine. Workings here have explored the vein for more than 3,000 feet along the strike. Over most of the length the ore body is from 40 to 100 feet wide, dipping 30°-35° southeast. In plan it exhibits a sinuous pattern which follows two trends having strikes of N. 40° -45° E. and N. 10°-15° E.

Dalton Hill area. --The Dalton Hill area is a zone of mineralization one mile east of the Gossan Lead in the vicinity of the Cranberry segment. The locality was explored at the time when work was being done on the Lead, and about 1939 C. H. Thompson, Hollins, Virginia, investigated the prospect for secondary ore.

Workings have explored the gossan at six points:

- 1) East of county route 770 at 26,000 prospect shafts have gossan on the dumps for a strike length of 800 feet.
- 2) West of county route 770 at 25,700 a trench and pits show a horizontal width of about 50 feet of gossan. A shaft dug here by Thompson is still open. On the dump are gossan, weathered secondary sulfides, and primary sulfides disseminated in a gangue of quartz and carbonate. According to Thompson the secondary zone is 3 feet thick and analyzed 3.5 percent copper. The gossan cannot be traced in either direction on the surface.
- 3) Immediately west of county route 770 at 24,300 a trench has been dug on a band of gossan float about 400 feet wide. It cannot be traced along strike.
- 4) Trenches have prospected a band of gossan float which crosses county route 705 about 600 feet east of its intersection with route 770. The zone is about 40 feet wide and can be traced for about 150 feet north and 230 feet south of the road.

5) A similar zone of gossan float, about 30 feet wide crosses route 705, 330 feet farther east. Float can be followed 200 feet south of the road but only a few feet north of it.

6) Primary sulfides in a quartz-carbonate gangue are exposed by a pit in a stream valley at 21,900. Gossan float occurs for 650 feet northeast of the stream but cannot be found to the southwest.

The random location of the gossan occurrences and the lack of continuity along strike suggest a group of small sulfide lenses in the schist. The primary ore on the dumps does not have high concentration of sulfides. The topographic situation here is favorable to secondary enrichment.

MINOR DEPOSITS IN CARROLL AND GRAYSON COUNTIES

Reported occurrences of copper, pyrite, or pyrrhotite in Grayson County and elsewhere in Carroll County were investigated. Disseminated pyrite appears frequently in the country rock and was the only sulfide mineral at most of the localities visited.

A small sulfide body occurs on the property of O. N. Shumaker in Grayson County immediately west of the New River, about one mile north of the mouth of Little River. An adit which is now flooded and a small caved shaft are the only workings. The dumps contain dirt, brown siliceous gossan, and primary sulfides. The latter consists of pyrrhotite and minor chalcopyrite in a quartz gangue. No gossan was found elsewhere in the vicinity; the sulfide lens must be quite small.

The "Native Lead" was visited at one locality near Grape Hill, northeastern Carroll County. Here native copper occurs as small grains in pods of quartz and epidote a few inches in length. The pods are separated by partings of schist and

constitute a zone as much as a few feet in width. Three cupriferous zones were observed, all accordant with the schistosity. The copper is distributed irregularly and grade is low. Further investigation does not appear warranted because of the sparse and erratic mineralization.

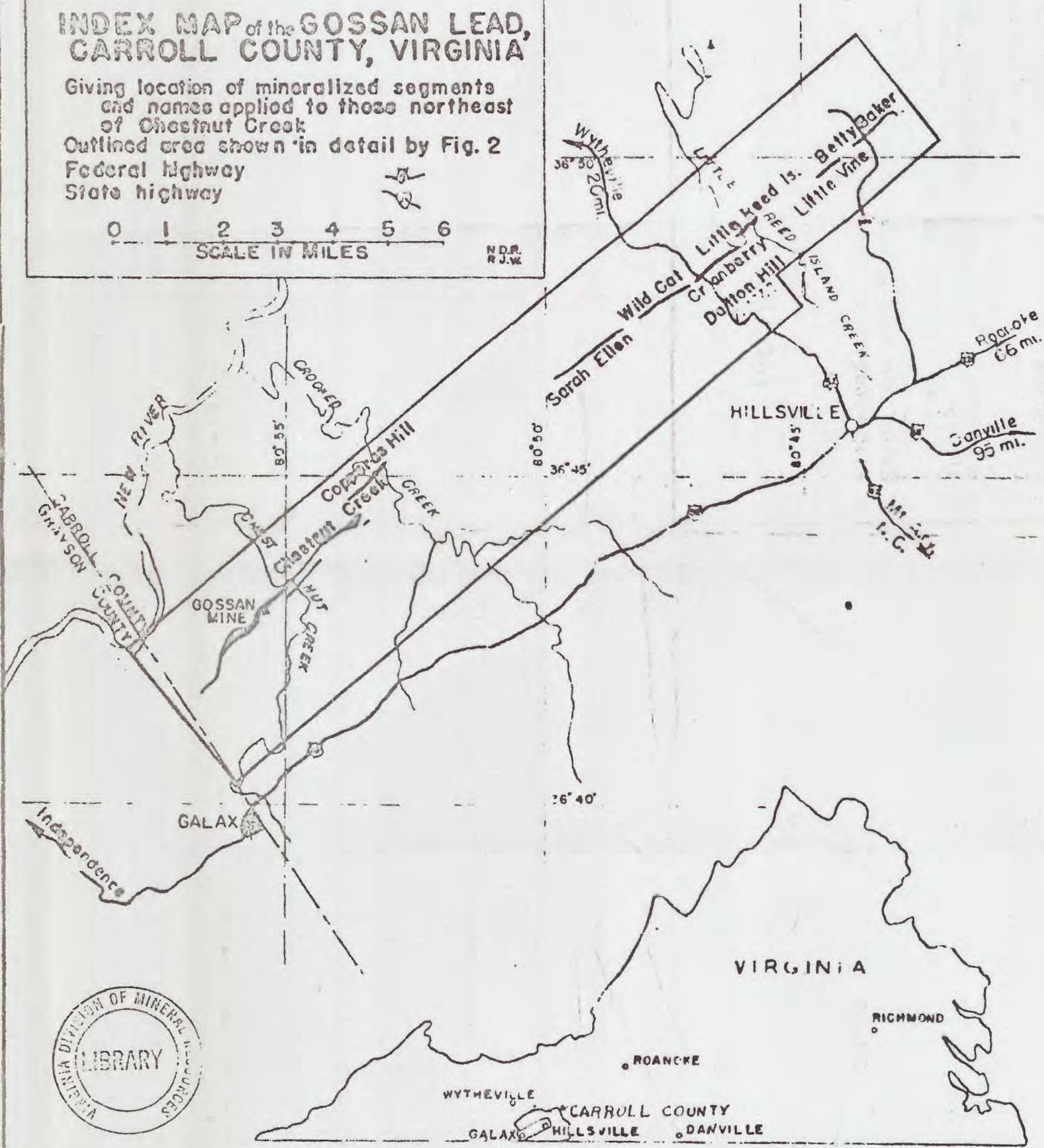
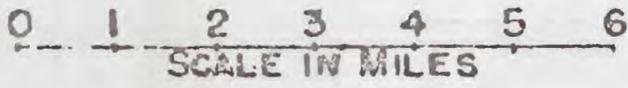
ORE RESERVES

Secondary copper ore. -- Two factors have favored the formation of secondary copper deposits on the Gossan Lead--the presence of a series of large massive sulfide lenses extending along a strike length of 17 miles, and the deep weathering that the region has undergone. On the other hand, the apparently uniform low copper content of the primary ore, less than 1 percent copper, has necessarily limited the amount of copper concentrated by weathering processes. The detailed investigation by the Geological Survey in 1943 showed that the secondary copper deposits of the Gossan Lead had been very extensively prospected and mined during the past century. Old records, perhaps not altogether reliable, indicate that about 2,500 tons of secondary ore containing 14 percent copper was produced up to 1859; probably none has been produced since then. Probably no more than a total of several thousand tons of secondary copper ore, whose grade is doubtful, remain on the Gossan Lead. This reserve consists of many small blocks of unmined ground scattered from one end of the Gossan Lead to the other, whose mining at the present time would require many small hand operations. The most likely localities for occurrences of such unmined remnants of secondary ore are along the Wild Cat, Cranberry, and Dalton segments where conditions are favorable for enrichment and no open-cut work has been done.

Gossan iron ore.--At three places along the Lead gossan has been mined as iron ore. Bodies of gossan remain at several localities but reserves are not large, nor was it possible to determine what types may be suitable for iron ore. Perhaps 100,000 tons of gossan remain at the Cranberry segment. The only other occurrence of appreciable size are along the northern portions of the Wild Cat and Sarah Ellen segments.

Primary sulfide ore.-- Large reserves of primary sulfides remain. The tonnage is greatest where the sulfides are massive and the vein is wide. These conditions prevail along the Betty Baker segment, south half of the Cranberry segment, north portion of the Wild Cat segment, most of the Copperas Hill segment, the central portion of the Chestnut Creek segment, and in the "Great Outburst," now being mined for pyrrhotite. The average copper and zinc content of the primary ores is about 0.5 to 0.7 percent of each metal.

FIG. 1
**INDEX MAP of the GOSSAN LEAD,
 CARROLL COUNTY, VIRGINIA**
 Giving location of mineralized segments
 and names applied to those northeast
 of Chestnut Creek
 Outlined area shown in detail by Fig. 2
 Federal Highway
 State highway



Verifax copy

Fig 1

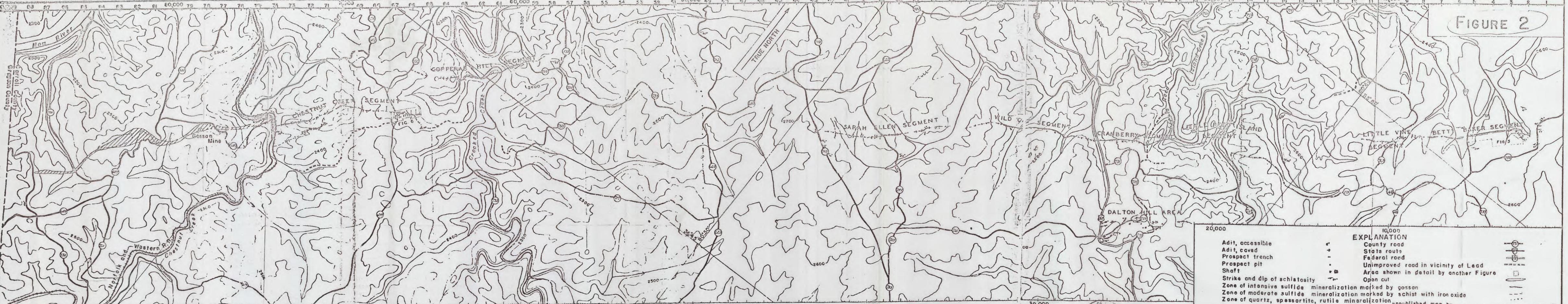


FIGURE 2



GOSSAN LEAD, CARROLL COUNTY, VIRGINIA

FEET 10,000 8,000 6,000 4,000 2,000 1,000 0
SCALE 1:24,000

Verifax copy



EXPLANATION	
Adit, accessible	○
Adit, caved	◊
Prospect trench	-
Prospect pit	•
Shaft	⊕
Strike and dip of schistosity	↖
Zone of intensive sulfide mineralization marked by gossan	—
Zone of moderate sulfide mineralization marked by schist with iron oxide	- - -
Zone of quartz, spessartite, rutile mineralization unpublished map by J. Volney Lewis, U.S. Geological Survey, 1935	⋯
Mineralized zone southwest of Chestnut Creek, after A. J. Volney Lewis, U.S. Geological Survey, 1935	⋯
Geology northeast of Chestnut Creek mapped on aerial photographs by N. D. Raman and R. J. Wright, U.S. Geological Survey, 1943	⋯
Base map northeast of long. 80° 45' taken from county road map, topography sketched from aerial photographs. Rest of base map from Max Meadows (1:62,500, 1930) and Galax (1:62,500, 1933) quadrangles. Contour interval 100'.	

N.O.R.
R.J.W.

2 sheets

48-3

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS

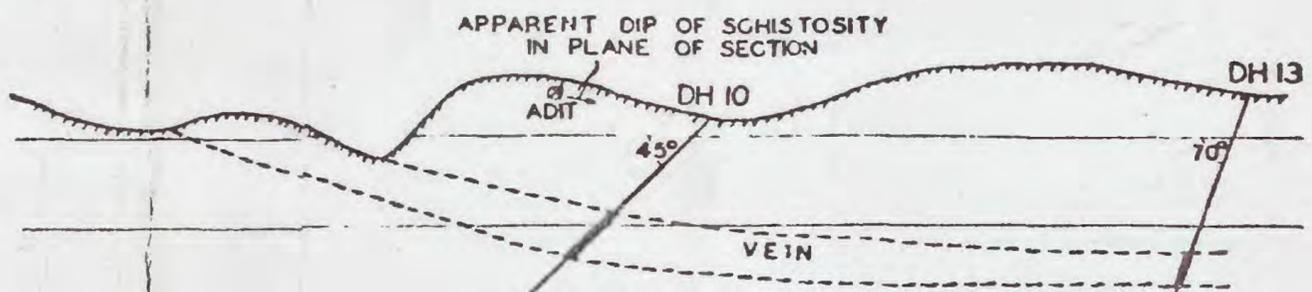
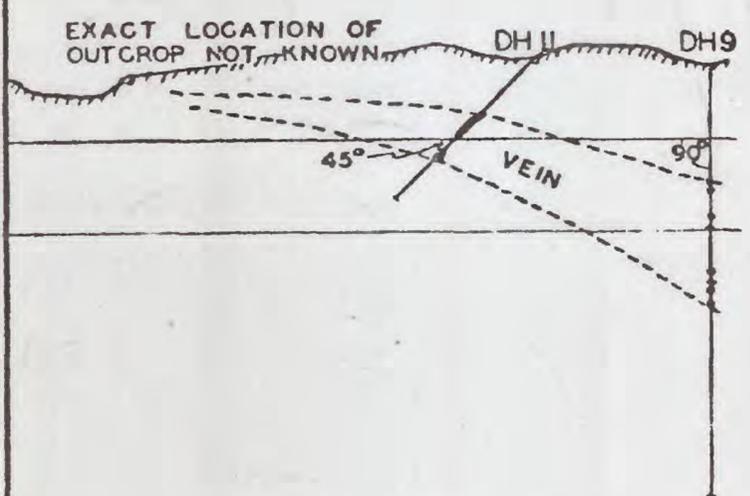
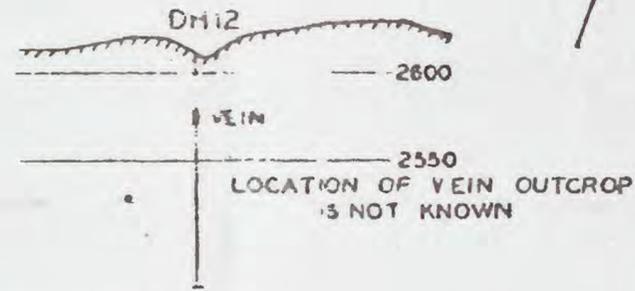
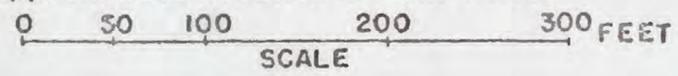


Fig. 4
**SECTIONS of DIAMOND DRILL HOLES, NORTHEAST
 END BETTY BAKER SEGMENT, GOSSAN LEAD**

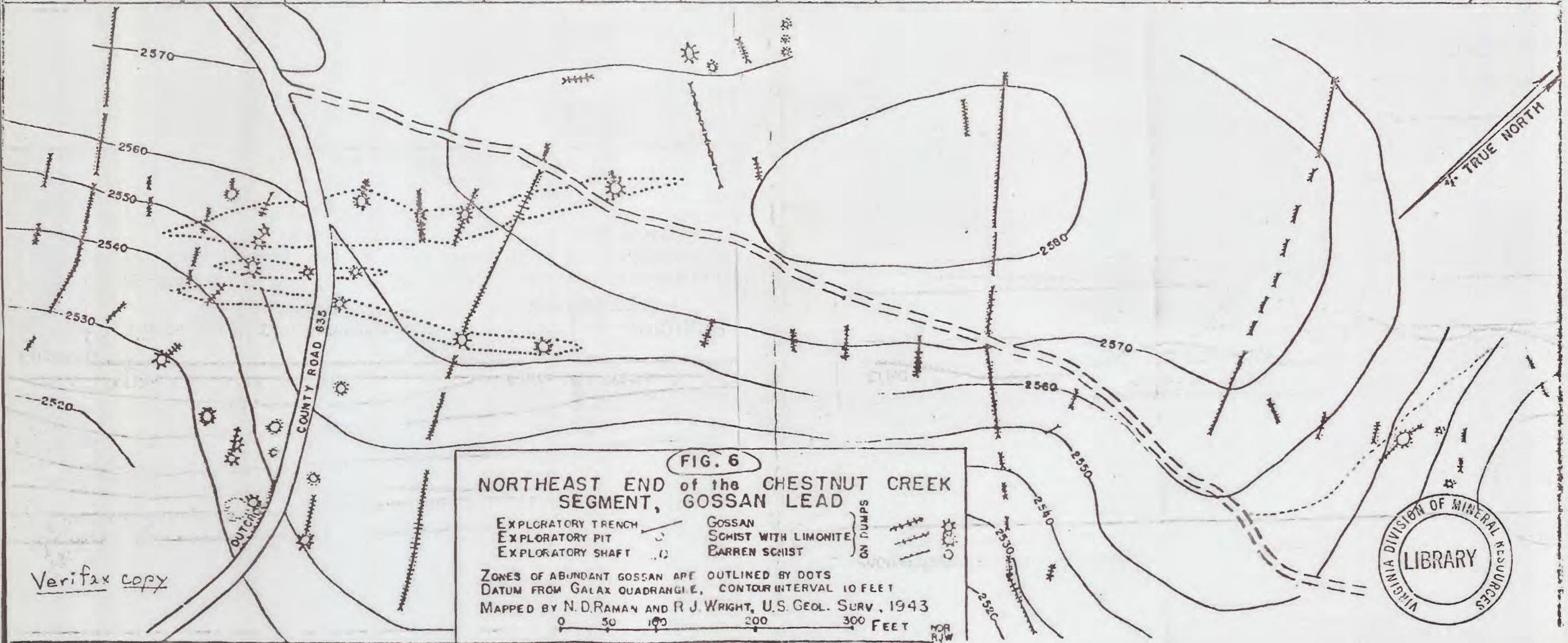
Plotted from data furnished by the Virginia Iron, Coal, and
 Coke Company. Sections face N47°E.
 Fig. 3 gives approximate location of drill holes.



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N.D.R.
R.J.W.

67,200 67,100 67,000 66,900 66,800 66,700 66,600 66,500 66,400 66,300 66,200 66,100 66,000 65,900 65,800



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FIG. 6
NORTHEAST END of the CHESTNUT CREEK
SEGMENT, GOSSAN LEAD

EXPLORATORY TRENCH	—	GOSSAN	} ON DUMPS
EXPLORATORY PIT	○	SCHIST WITH LIMONITE	
EXPLORATORY SHAFT	⊙	BARREN SCHIST	

ZONES OF ABUNDANT GOSSAN ARE OUTLINED BY DOTS
DATUM FROM GALAX QUADRANGLE, CONTOUR INTERVAL 10 FEET
MAPPED BY N. D. RAMAN AND R. J. WRIGHT, U.S. GEOL. SURV., 1943

0 50 100 200 300 FEET
MOR
RJW

