NORTH CAROLINA GEOLOGICAL SURVEY

J. A. HOLMES, STATE GEOLOGIST

BULLETIN No. 10

GOLD MINING IN NORTH CAROLINA

AND

ADJACENT SOUTH APPALACHIAN REGIONS

BY

HENRY B. C. NITZE

AND

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STATE GEOLOGIST.

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LETTER OF TRANSMITTAL.

To His Excellency, Hon. D. L. Russell,

Governor of North Carolina.

Sir:—I have the honor to transmit for publication as bulletin 10 of the Geological Survey series, a report on the subject of Gold Mining and Mining Methods in North Carolina and adjacent South Appalachian regions. The Survey has received many requests for information concerning this subject, and it is in response to these that I recommend the publication of this report. Many applications for copies of it have been received in advance of its appearance.

Yours obediently,

J. A. Holmes,

State Geologist.

Raleigh, N. C.,

July 1, 1897.

PREFACE.

During the past few years the Survey has received from persons interested in gold mining in North Carolina, numerous inquiries concerning the mining and metallurgical methods which have proven most successful in operating gold mines in this and other South Appalachian regions. In response to these inquiries, an investigation was undertaken of this subject in 1895, by Mr. H. B. C. Nitze, of the Survey, and Mr. H. A. J. Wilkens, a mining expert of Baltimore, who visited during that year the more important mining regions in North Carolina and other Southern States. A preliminary report of their examinations was read at the Atlanta meeting of the American Institute of Mining Engineers (October, 1895), and was published in the Transactions of the Institute for that year.

In the present publication that paper has been partly reproduced, but it has been largely rewritten, elaborated and brought down to the end of 1896. No attempt has been made to describe all of the mines or even to present detailed descriptions of all of the more important mining regions to be found in North Carolina and adjacent States. Only such mining and metallurgical methods practiced in this and the other States are here described as it is believed will be found useful in a study of the best methods for use in the development of the North Carolina gold fields. This report may be regarded as being in a measure supplemental to Bulletin 3 (Gold Deposits of North Carolina), published by the Survey in 1896, which described with more detail the gold-mining regions in this State.

The descriptions given in the report are based almost wholly upon the personal examinations of Messrs. Nitze and Wilkens. They have, however, made use of data relating to the different mining regions to be found in Mr. Geo. F. Becker's valuable "Reconnoissance of the Gold Fields of the Southern Appalachians," and the reports by the several State Geological Surveys, the sources of information being indicated in each case by footnotes. Persons desiring to consult other publications

relating to this field will find a full bibliography in the above-mentioned report of Mr. Becker's, published by the U. S. Geological Survey.

Messrs. Nitze and Wilkens have been aided in the preparation of their statement concerning the Haile mine in South Carolina by Mr. A. Thies. Capt. John Wilkes, of the Mecklenburg Iron Works, Charlotte, N. C., has also aided them by the loan of drawings, maps and in other ways. Mr. Geo. B. Hanna, of the U. S. Assay Office, at Charlotte, N. C., has kindly furnished numerous notes concerning the history of mining and metallurgical methods in the entire South Appalachian region. In behalf of the Survey and of the authors, I desire to thank these gentlemen and many others, in different parts of the region, who have in various ways rendered assistance in the collection and preparation of information for this report. I desire further to thank the editors of The Transactions of the American Institute of Mining Engineers and The Engineering Magazine for permission to use electrotypes of plates prepared for those publications.

One of the existing needs of the North Carolina gold field is the establishment at central points in this region of practical plants that will successfully treat the low-grade sulphuret ores—plants that will do custom work at reasonable prices, and where individual miners can ship their ore and be paid for the same according to its value, as is the case in the great mining regions of the West.

J. A. Holmes.

GOLD MINING IN NORTH CAROLINA AND ADJACENT SOUTH APPALACHIAN REGIONS.

By H. B. C. Nitze and H. A. J. Wilkens.

CHAPTER I.

GEOGRAPHICAL AND GEOLOGICAL DESCRIPTION OF THE GOLD BELTS.

The gold fields of the Southern Appalachians are situated in the area of the crystalline rocks extending from the vicinity of Washington in a general southwesterly direction, through the piedmont and mountain regions of Maryland, Virginia, North Carolina, Tennessee, South Carolina, Georgia, and Alabama, to the vicinity of Montgomery.

The greatest width of the belt, as a whole, is attained in North Carolina, South Carolina and Georgia, where it is from 100 to 150 miles, narrowing down in Virginia and Maryland on the northeast and in Alabama on the southwest (see map, fig. 1).

In chapters III and IV the gold-mining counties of these States are given.

The general term crystalline rocks includes gneisses, argillaceous, hydro-micaceous, chloritic, siliceous and other schists and slates, limestone, granite, diorite, diabase and other eruptives, as well as certain volcanic porphyries, etc., and pyroclastic breccias. The age of these rocks is Archæan, Algonkian, and possibly in part Paleozoic. On the east they are covered by the Coastal Plain and in places by small patches of the Jura-trias (Newark), which latter also occur within the area in small isolated basins, notably in Virginia. On the west they are bordered by the Paleozoic rocks.

The rocks of the gold belt are decomposed to depths often reaching 50 and 100 feet. Mr. Becker has proposed and used the term "saprolite,"[1] signifying literally "rotten rock," as a general name for such thoroughly decomposed, earthy, but untransported rock.

For geological reasons and for descriptive convenience this gold belt

[1] "Reconnoissance of the Gold Fields of the Southern Appalachians, by G. F. Becker, *Sixteenth Annual Report of the U. S. Geological Survey*, 1894-5, part iii, pp. 289-90.

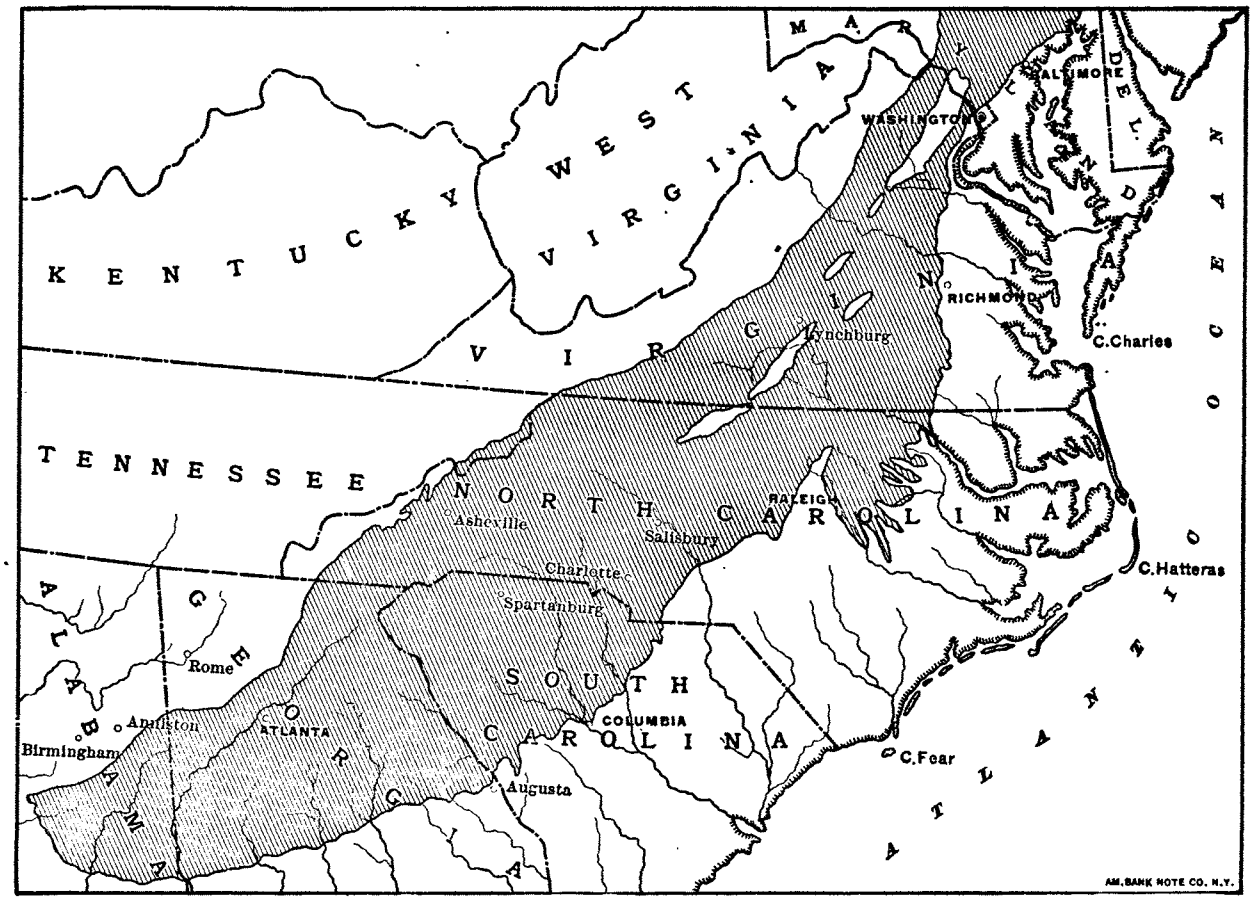


Fig. 1.—Gold Belt of the Southern States. Scale, 110 miles=1 inch. Shaded portion shows area of crystalline schists.

of the Southern Appalachians is differentiated into the following component belts:

1. The Virginia Belt.
2. The Eastern Carolina Belt.
3. The Carolina Belt.
4. The South Mountain Belt.
5. The Georgia Belt.
6. The Alabama Belt.

Other divisions might be made as, for instance, the isolated belts of auriferous rocks west of the Blue Ridge in Virginia, North Carolina, Georgia and Tennessee, and various minor belts in Georgia and Alabama; but such subdivision is unnecessary for the purposes of this paper.

In Bulletin 3, "The Gold Deposits of North Carolina," the Carolina Belt has been differentiated into the Carolina Slate, the Carolina Igneous and the Kings Mountain belts. For the purpose of this paper, however, where the geological descriptions of these various belts can only be briefly taken up, the above six main divisions will suffice, and for fuller and more detailed descriptions the reader is referred to the following papers:

"Reports on the Surveys of South Carolina," by O. M. Lieber, Columbia, S. C., 1856, 1857, 1858, and 1859.

"A Reconnoissance of the Gold Fields of the Southern Appalachians," by George F. Becker.[1]

"The Gold Deposits of North Carolina," by H. B. C. Nitze and G. B. Hanna.[2]

"The Lower Gold Belt of Alabama," by William B. Phillips.[3]

"Mineral Resources of the Upper Gold Belt (of Ala.)," by Wm. M. Brewer and others.[4]

Work has been in progress by the Geological Surveys of Georgia and Alabama on the gold fields, and reports from these respective bureaus are expected to be published shortly.

1. THE VIRGINIA BELT.

This belt begins in Montgomery county, Maryland, and extends in a southwesterly direction, parallel to and on the east side of the Blue Ridge, to the North Carolina line. The best and most reliable, though incomplete, information regarding the geology of this region is given in the early reports of Prof. William B. Rogers (1835, 1836 and 1840).[5]

The width of the belt is from 9 to 20 miles, covering an area of some 4000 square miles, and its best developed portion is in Fauquier, Cul-

[1] *U. S. Geological Survey, Sixteenth Annual Report*, 1894-95, part iii, pp. 251-331.
[2] *North Carolina Geological Survey*, Bull. No. 3, 1896.
[3] *Geological Survey of Alabama*, Bull. No. 3, 1892.
[4] *Geological Survey of Alabama*, Bull. No. 5, 1896.
[5] *The Geology of the Virginias*, D. Appleton & Co., New York, 1884, pp. 74-80, 131-132, 458-460.

peper, Stafford, Orange, Spottsylvania, Louisa, Fluvanna, Goochland and Buckingham counties.

THE COUNTRY-ROCKS.

The rocks of the Virginia belt are mica-gneisses and schists, often garnetiferous, hydro-micaceous and chloritic. The strike is N. 20°–30° E., and the dip easterly at varying angles. Mr. S. F. Emmons[1] gives the prevailing strike in Montgomery county, Maryland, as north and south, and the dip nearly vertical or very slightly inclined to the eastward. Granite and diabase dikes occur in the region, and these are sometimes sheared. In some private notes on the Arminius pyrite mine, in Louisa county, Va., Mr. Becker says:

"The principal country rock is a series of micaceous schists. . . . . Indications are not wanting that a portion of these schists is of sedimentary origin. . . . . On the other hand, it is equally certain that the most prominent characteristics of the schists are of dynamic origin. . . . Much of the schist looks as if it were derived dynamically from granite."

THE QUARTZ-VEINS.

The auriferous quartz-veins conform in the main to the strike and dip of the enclosing rock. However, their origin is not coeval, the schistose structure antedating the formation of the veins. Neither must their approximate conformity to the country be taken in the absolute sense, for they often cut the schists at small angles both in dip and strike. The structure of the veins is irregularly lenticular, varying from a few inches to several feet in thickness. The wall-rock is often impregnated with auriferous pyrites to considerable extent. Some of these veins are of remarkable persistency and continuity, as, for instance, the Fisher lode in Louisa county, which has been opened for a distance of some five miles along the strike to a maximum depth of 220 feet by the Warren Hill, Louisa, Slate Hill, Luce and Harris mines.

The gravel placer deposits of the Virginia belt are in all respects similar to those of other gold regions.

A small isolated gold belt is situated on the west side of the Blue Ridge in Montgomery, Floyd and Grayson counties, but it is of little economical importance and will not warrant more than this passing mention. The auriferous copper ores of Ashe and Watauga counties, N. C., also appear to belong here.

2. THE EASTERN CAROLINA BELT.

This forms a small and narrow area in Halifax, Warren, Nash and Franklin counties. It is covered on the east by the Coastal Plain and

[1] "Notes on the Gold-Deposits of Montgomery county, Md.," by S. F. Emmons, *Trans. Am. Inst. Min. Eng.*, xviii, 391-411.

bounded on the west by the Louisburg granite. The country rock is diorite, in great part sheared to a chloritic schist (as at the Mann-Arrington mine). The strike of the schists is N. 50°–60° E., and the dip 25°–40° S.E. Other intrusives, such as diabase, occur in the region.

THE QUARTZ-VEINS.—These occur (1) as lenses, from minute size up to 12 inches in thickness, interlaminated in the schists or cutting them at small angles; (2) as a reticulated network in the massive rocks. It is stated that the saprolites are auriferous over large areas and will repay hydraulic mining.

3. THE CAROLINA BELT.

This belt is one of the most extensive and important in the Southern Appalachians, though lying far to the east of the Blue Ridge. It is situated in the central Piedmont region, and extends from the Virginia line in a southwesterly direction across the central part of North Carolina into the northern part of South Carolina, where it sinks beneath the Coastal Plain, making its re-appearance in Abbeville county, S. C., and in Wilkes, McDuffie and adjacent counties in Georgia, near Augusta. There are no mountain chains in the Carolina belt, the only prominences of consequence being a low range of hills known as the Uharie mountains, in Montgomery county, N. C., and the isolated peaks of Crowders and Kings mountains in Gaston county, N. C., extending into York county, S. C.

The belt varies in width from 8 to 50 miles; it is bounded on the east by the Jura-trias (Newark) and the coastal plain formations.

THE COUNTRY-ROCKS.

The gold-bearing rocks of the Carolina belt are (1) argillaceous, sericitic and chloritic metamorphosed slates and schists; (2) devitrified ancient volcanics (rhyolite, quartz-porphyry, etc., and pyroclastic breccias); (3) igneous plutonic rocks (granite, diorite, diabase, etc.); (4) siliceous magnesian limestone; (5) sedimentary pre-Jura-trias slates. The Jura-trias conglomerates along the eastern boundary have also been found to contain gold, but not in quantities of economical importance.

The argillaceous and sericitic[1] slates and schists, though in general highly metamorphosed and sheared, show many evidences of sedimentary origin. The siliceous magnesian limestones (Kings mountain, etc.), must be included here. All of these rocks are non-fossiliferous and must be provisionally classed as Algonkian. They are often silicified in varying degrees up to a completeness which renders the rock so

[1] The general term "talc" schists, so often used, is very loosely applied, and generally incorrectly, as the true "talc" schists are comparatively rare; it should, from a mineralogical standpoint, more properly be hydro-mica or sericite schists.

hard that it resists scratching with a knife. The chloritic schists are more truly the crystalline schists, and probably represent the sheared basic eruptives. They are even porphyritic and brecciated in places. They are not so abundant as the argillaceous schists, and are richer in accessory metamorphic minerals, such as garnet and epidote.

The general strike of the schistosity is N. 20°–55° E., and the predominating dip to the N. W. from 55°–85°. In many cases the force producing schistosity and slaty cleavage appears to have acted downward from the N.W., developing normal faulting with but little deformation.

The volcanic rocks occupy irregular patches along the eastern border of the belt, in close proximity to the western edges of the Jura-trias basins. They comprise both acid and basic types. The acid rocks are generally devitrified to such an extent that their real character is no longer recognizable to the naked eye, and they appear as ordinary cherts or hornstones, although flow-structure is at times still discernible. Microscopic examination shows them to belong to the class of rhyolites and quartz-porphyries. They are sometimes sheared into schists, as for instance at the Haile mine, S. C. The basic types are dark green in color and perhaps pyroxenic in composition; they are sometimes massive porphyrites, but more generally sheared into schists. The pyroclastic breccias consist of angular fragments of the acid rhyolites and porphyries in a basic matrix. The age of these ancient volcanics is believed to be pre-Cambrian. They seem to be analogous to, and probably contemporaneous with, similar rocks of the South mountain in Maryland and Pennsylvania, and other points along the Atlantic coast. The igneous plutonic rocks lie on the western side of the central slates; they consist of granites, diorites, gabbros, diabases, etc. In point of age they are supposed to be younger than the slates and schists on the east. Diabase dikes are common in the Carolina belt, and appear in general to have exercised a favorable influence on the richness of the ore-bodies which they intersect; the ores often are richer in the vicinity of the dikes. At the Haile mine, in Lancaster county, S. C., this is very marked.

The sedimentary pre-Jura-trias slates, mentioned above as the fifth class of gold-bearing rocks, are perhaps best developed near Monroe, Union county, N. C., and have therefore been called the Monroe slates. These slates are but little indurated and lie in flat-bedded alternating synclinals and anticlinals. They cover a considerable area, extending from Monroe northward and eastward, and appearing in Stanly and Montgomery counties. They dip under the Jura-trias conglomerate near Polkton, 20 miles east of Monroe, and might be looked upon as Lower Paleozoic; but the absence of fossils, so far as present search has gone, must, for the time being, place them provisionally in the Algonkian.

THE GOLD ORES.

The gold ores in the Carolina belt exist in two principal structural forms: (1) as quartz fissure-veins; (2) as pyritic impregnations, accompanied by irregular stringer-like and lenticular quartz intercalations in the country schists and slates. The fissure-veins in the slates and schists are generally difficult to distinguish as such. Their structure is much more evident in the granitic and other eruptives. In the schists the larger and more regular quartz lodes lie apparently interlaminated with the country, or have the appearance of lenticular intercalations; however, even here they can usually be shown to intersect the schistosity, generally at very low angles.

The age of the ore deposits is later than that of the force which produced schistosity, from the fact that fragmental inclusions of sheared country-rock are not rare in quartz. The fissuring force was, therefore, subsequent to the shearing force. Certain maximum lines of faulting may have been developed, which made room for the larger fissure-veins, on either side of which smaller dislocations formed belts of variable width. It is certainly most natural that, in a rock like slate or schist, the rupturing force should have been exerted along the lines of least resistance, that is, along the cleavage planes, and that the predominating fissures should, therefore, have been formed in that direction. Isolated instances of cross-fissures occur, but they are rare.

A very usual occurrence of the ores is that of irregular, finely-divided disseminations of auriferous sulphurets and fine gold, accompanied by small stringers and lenses of quartz in the country slates and schists, which are usually silicified, at least to some extent. This form of deposit bears close resemblance to the Scandinavian "fahlbands," which are described as belts of schists impregnated with sulphides. In the Southern Appalachian field they form the small and large bodies of low-grade ores (Haile mine, Russell mine, etc.). The shape of these ore-bodies is lenticular; their outline, however, does not necessarily conform with the strike and dip of the schists, but is determined rather by the degree of impregnation. Very often, also, the wall-rock of the quartz fissure-veins is impregnated for some distance with auriferous sulphurets.

The gravel placers of the Carolina belt present no features differing from those of similar deposits in other gold regions.

GENESIS OF THE ORE-BODIES.

No definite proof of metasomatic formation of the ores has been observed; and the most reasonable hypothesis for their formation is that of the ascension and percolation of heated carbonated and alkaline waters carrying silica, metallic elements and sulphides in solution, and the depo-

sition of their mineral contents in the open spaces through which they circulated, by relief of pressure, reduction of temperature, and perhaps certain chemical reactions. The frequent silicification of the slates and schists has been noted, and must be ascribed to this permeation of the silicified waters.

The character of the quartz varies from saccharoidal to vitreous, usually inclining to the latter. The sulphurets are chiefly pyrites; chalcopyrite, galena, mispickel and zinc-blende occur in certain localities, notably at the Silver Hill and Silver Valley mines, in Randolph county, N. C. Copper ores (chalcopyrite) in some of the North Carolina mines are auriferous to such an extent as to make them valuable for gold also, as for instance at the Conrad Hill. Tellurides have been found in very small quantities, as at the Kings Mountain mine, N. C. Among the more common gangue minerals, besides quartz and sulphurets, are chlorite, barite and carbonates.[1]

THE AGE OF THE ORE DEPOSITS.

The formation of the ores took place subsequent to the production of schistosity. The fact that the Jura-trias conglomerates, on the east, contain gold proves that the origin of the gold must have been pre-Jura Triassic. The presence of gold-bearing fissure-veins in the Monroe slates shows that their age must be Algonkian or later. The existence of ore-bodies in the pre-Cambrian volcanic rocks furnishes another clue; and thus it becomes probable that the age of the gold ores in the Carolina belt is Algonkian.

4. THE SOUTH MOUNTAIN BELT.

This belt is situated in the western part of North Carolina, and takes its name from the South mountains, one of the eastern outliers of the Blue Ridge. The principal mining region embraces an area of 250 to 300 square miles, in Burke, McDowell and Rutherford counties, extending from Morganton to near Rutherfordton, a distance of about 25 miles, with an average width of 10 to 12 miles. The gold veins of northern Burke and Caldwell counties on the north, and Cleveland and Polk counties, N. C., on the south, as well as Spartanburg, Greenville and Pickens counties, S. C., might be considered as belonging to this general belt; but no extensive operations have been carried on there.

THE COUNTRY-ROCKS.

In the South mountain region, the crystalline rocks are for the most part Archæan micaceous (biotite) and hornblendic gneisses and schists,

[1] Mr. Becker, in the paper referred to above, pp. 274-278, tabulates no less than 60 gangue minerals, besides quartz, pyrite, and the ordinary products of decomposition.

having an eminently lenticular structure. They are often garnetiferous and contain also many of the rarer accessory minerals, such as zircon, monazite, xenotime, etc. These gneisses are considered to have been igneous granites and diorites, subsequently rendered schistose by dynamo-metamorphism. The general strike of the schistosity is N. 10°–25° W., and the dip 20°–25° N.E. To the northwest of South Muddy creek and Vein mountain, however, the strike is generally N. E. and the dip S. E. This is the case also in the northern part of the general belt, in Caldwell county.

Isolated masses of pyroxenite and amphibolite occur as rounded inclusions or blebs, from less than 1 to nearly 100 feet in diameter, in the gneiss. They are looked upon as basic segregations from the original igneous magma out of which the gneisses were formed. They alter to talc and serpentine.

Pegmatites are of frequent occurrence in the gneisses, and like them their structure is usually lenticular. At several points there are indications of pegmatite dikes. Granite dikes occur in the South mountain region; and in the northern part of the belt, in Caldwell county, a very persistent and continuous dike of aphanitic olivine diabase has been observed. Brown mountain, in the northern part of Burke county, is made of granite.

THE QUARTZ-VEINS.

The auriferous quartz-veins of the South mountain belt form a system of parallel fissures of remarkable regularity, striking N. 60°–70° E. and dipping 70°–80° N.W. Their thickness varies from that of a knife-edge to 4 feet. The great majority are from less than 1 to 3 inches in thickness, lying in zones of scores of small veins; the larger ones (1 to 4 feet) are few and far between. Normal faulting has been observed in a few instances. The ore is quartz, usually of a milky white color, generally saccharoidal and seldom vitreous or glassy. It is often stained brown and is cellular from decomposed sulphurets. The sulphurets are pyrite, galena, chalcopyrite, and zinc-blende. All observations go to show that the vein-matter is formed from ascending mineralized solutions. There is no evidence of the replacement of the country rock by ore.

In the South mountain region proper there are five parallel lines or zones along which these quartz-veins appear to be concentrated:

1. The Morganton zone, passing through Morganton, along Little Silver creek and through the Neighbor's place to North Muddy creek.

2. The Huntsville zone, passing over the southern end of Huntsville mountain.

3. The Pilot mountain zone, passing over Halls knob, Whites knob,

Pilot mountain, Brackettown, and Vein mountain, to and beyond the Second Broad river.

4. The Golden valley zone, passing across the upper end of the Golden valley (valley of the First Broad river) and crossing Cane and Camp creeks to the Second Broad river.

5. The Idler mine zone, about 3 miles north of Rutherfordton.

The great majority of these auriferous quartz-veins are too small to be profitably worked individually. Of the larger and more promising veins which have been worked, the "Nichols," at Vein mountain (18 inches to 3 feet), and the "Idler," near Rutherfordton (22 inches), may be mentioned.

THE PLACER DEPOSITS.

The principal mining ground of the South mountain region is that of the placer deposits. These are of three classes: 1. The gravel deposits of the stream-beds and bottom-lands, deposited by fluviatile action. 2. The gulch and hillside deposits, or accumulations due to secular disintegration and motion induced by frost action and gravity. 3. The upper decomposed layer of the country-rock in place, the saprolites.

In the first class the gravel is water-worn, rounded to subangular, and the deposits are from 1 to 2 feet in thickness. In the second class the gravel is usually quite angular, and the deposits are from a few inches to several feet in thickness. In the third class gravel is of course absent, the washable ground consisting of the upper decomposed layer in place, the gold being derived directly from the partially disintegrated quartz-veins.

5. MINOR BELTS IN NORTH CAROLINA.

On the west side of the Blue Ridge, in Henderson county, N. C., gold has been mined at the Boylston mine. The country rocks are fine-grained mica- and hornblende-schists, in part much crumpled. The general strike is N. 20°–30° E., and the dip is N.W. The schists are cut by a granite dike. The valley of Boylston creek is made up of schistose limestone, underlying these crumpled schists. These rocks are probably to be classed in the Ocoee, which by some is supposed to be Algonkian and by others Paleozoic, and by others still, it is believed to contain formations of different ages ranging between these two. This isolated belt, however, has little economic importance in connection with gold deposits.

Another belt of auriferous rocks is that in which some unimportant placer-mining operations have been prosecuted in Swain, Jackson, Macon, Clay, and Cherokee counties, N. C. The country-rock is supposed to be largely Ocoee. In Tennessee the petty stream deposits of

Polk, McMinn, Monroe and Blount counties are probably in the same horizon.

6. THE GEORGIA BELT.

The Georgia belt is probably of next or equal economic importance to the Carolina belt. Beginning in Rabun and Habersham counties, in the northeastern corner of the State, it extends in a southwesterly direction through the important mining town of Dahlonega, and thence to the Alabama line in the vicinity of Tallapoosa. This is in the Piedmont region of the State, lying on the southeast side of the Blue Ridge. Although the maximum width (N.W. and S.E.) over which the mines are distributed is as great as 30 miles, the principal portion of the belt, which extends from near Canton, in Cherokee county, through Dahlonega and Nacoochee, to Clayton, in Rabun county, is concentrated in a width of 4 miles or less. It is to this latter portion that the following geological descriptions more especially relate.

THE COUNTRY-ROCKS.

The rocks of this belt resemble in many respects those already described under the South mountain belt in North Carolina. They are Archæan micaceous and hornblendic gneisses and schists, which probably represent sheared granitic and dioritic rocks. At the Murray mill, on Yahoola creek, near Dahlonega, a large mass of unsheared granite may be seen; and massive granite is reported to exist on Yonah Peak, near Nacoochee. These gneisses and schists are banded in narrow, lenticular-shaped layers, from 2 to 20 feet wide. A dark-colored, schistose hornblende rock, locally known as "brick-bat," is of frequent occurrence. Its structural relations are very difficult to determine; at times it is conformably interlaminated with the other schists (as at the Hedwig mine, near Auraria); again, it appears to have no regular relation in its position to the adjoining schists, which are cut off by it or very markedly disturbed in their strike, bending around the "brick-bat" mass, and developing a crumpled or folded structure in the schistose laminæ (as at the Singleton and Lockhart mines, near Dahlonega). It is possible that these "brick-bat" masses, which appear to be dioritic in origin, are magmatic segregations or blebs, similar to the pyroxenic and hornblendic blebs described in the South Mountain region,[1] though, as a rule, larger. The prevailing strike of the gneisses and schists is N. 20°–30° E., and the dip 30°–60° S.E. Locally, however, in the presence of the dioritic masses, as explained above, this changes to northwest strikes with northeast dips. The rocks are often garnetiferous and contain rarer accessory minerals, such as monazite,[2] though

[1] See page 18, above, and Bull. 3, *North Carolina Geological Survey*, 1896, p. 157.

[2] At the Glades Post-Office, in Hall county, 10 miles northeast of Gainesville, monazite has been found in some quantity.

to a much lesser degree than in the South mountain rocks. The depth of the saprolites in the Georgia belt reaches a maximum of about 100 feet.

Diabase dikes, such as are common in the Carolina belt, are not found in the Georgia belt. Granitic dikes are, however, not uncommon in the Nacoochee region.

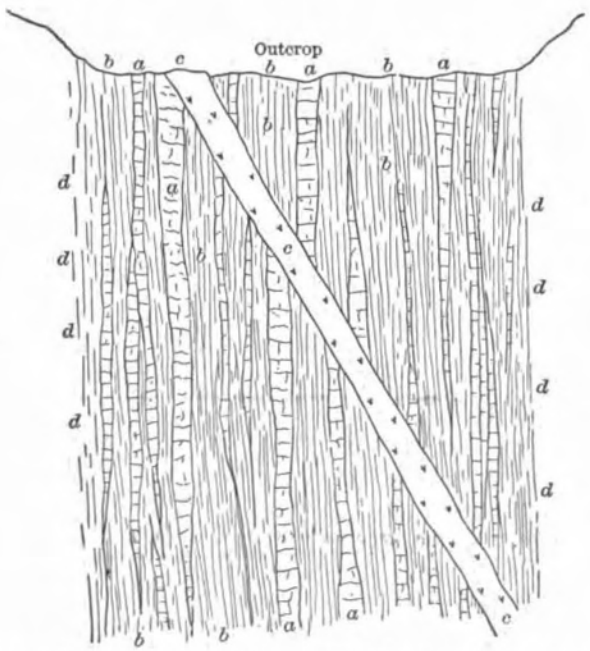


Fig. 2.—Cross-section in Opening at Thompson mine, near Nacoochee, Ga. Scale, 1 inch=2 feet. *a*, quartz; *b*, slate; *c*, granite dike; *d*, wall rock.

The accompanying sketch (fig. 2) represents a small pegmatite dike at the Thompson mine, 4 miles west of Nacoochee, showing the development of normal faulting. Similar granitic dikes have been found in Cherokee county, near the Franklin mine. In the Dahlonega district, although no unquestionable well-marked dikes are seen in place, Mr. Becker[1] calls attention to the possibility that some of the unusually sharply marked sheets in the gneiss might be intrusive.

THE ORE DEPOSITS.

Certain bands of the gneisses and schists have been fissured and filled with gold-bearing quartz and sulphurets. These fissures are in the

[1] "Reconnoissance of the Gold Fields of the Southern Appalachians," *Sixteenth Annual Report of the U. S. Geological Survey*, 1894-5, part iii, p. 296.

main parallel to the schistosity of the rock, though not uncommonly they cut the same at low angles. To a large extent they are aggregated in a zone of numerous narrow and discontinuous lenses and stringers through more or less definite bands of the gneiss, which, taken altogether, form the vein. This is well illustrated in Fig. 2. Mr. Becker has designated such a system, a "stringer-lead."[1] In these narrow, sharply-banded gneisses and schists of different material, such as they are in this part of the Georgia belt, it is natural that the fracturing force, once exerted in a certain band, should have been more or less confined to this one, both longitudinally and transversely, the walls of the band forming the walls of the ore-body. This is in fact the case. At times the fissuring is confined to the light-colored mica-gneisses, at other times to the dark-colored ferromagnesian gneisses and schists. The "brick-bat" schists rarely contain ore-bodies. The thickness of the veins is from less than 3 to as much as 20 feet; they are frequently close together, separated by non-auriferous bands of gneiss; and the total width of the ore-bearing ground reaches as much as 200 feet (Singleton mine, Dahlonega). The extent of fissuring must depend largely on the degree of homogeneity of the material, as well as on the intensity of the fracturing force. Where the rock is of homogeneous composition and the force uniformly exerted, the effect would be a more or less evenly distributed shattering, with few gaping fissures, and the whole mass would be permeated by the gold-bearing solutions, with the formation of auriferous and pyritic impregnations, with some small quartz-stringers. At the Hedwig mine, near Auraria, for instance, regular quartz masses of any size are altogether absent, the ore-body being composed of soft, sandy, mica-gneisses and -schists containing only a few, small and isolated quartz-stringers. Again, under different conditions, the effect was the production of a large number of small open fissures, inducing the consequent formation of numerous small lenticular quartz-stringers; and such is the usual case in the Dahlonega ore-bodies (fig. 2, p. 22). Or, where the rock mass was of still greater heterogeneity, and the forces of greater or more varied intensity, lenticular fissures have been opened, of such size and extent as to allow a more or less complete filling by solid auriferous and pyritic quartz, from 3 to 14 feet in thickness; while, further along the strike, though the fracturing extends to the same width and the walls hold out, the intervening space of country has simply been shattered, or opened only in small spaces, but was nevertheless filled with pyritic impregnations and quartz-stringers, (as at the Franklin mine in Cherokee county, where these barren portions of the vein are called horses). But the

[1] "Reconnoissance of the Gold Fields of the Southern Appalachians," *Sixteenth Annual Report of the U. S. Geological Survey*, 1894-5, part iii, p. 283.

leads are continuous, usually for considerable distances. At the Lockhart mine, near Dahlonega, for instance, the Blackmore vein, 3 to 6 feet in thickness, has been opened by a drift 400 feet long. At the Franklin mine, in Cherokee county, the ore-body has been explored by underground workings for 1000 feet, and the continuity of the vein has been traced for three-quarters of a mile by isolated shafts. The regularity of the vein structure at the Franklin is exhibited by well-defined walls, and by the presence of a soft "gouge" on both the foot and hanging, even where there is no marked quartz filling.

Small, clean-cut cross-fissures occur in the Georgia belt, as at the Franklin mine, where the filling is chiefly calcite.

The pitch of the ore-bodies in the Georgia belt is as a rule to the northeast. The filling of the fissures is quartz, carrying pyrite and rarely chalcopyrite. Among the most interesting gangue minerals may be mentioned garnets, which in cases have been found to be auriferous.[1] Another occasional, though rare, gangue mineral is tourmaline. Gold in close association with a tellurium mineral has been found in the so-called "Boly Fields" vein on the banks of the Chestatee river.[2] The character of the quartz varies greatly, from very saccharoidal to extremely vitreous types, and from clear transparent to milky-white in color, sometimes smoky.

The genesis of the ore deposits is best explained by the ascension theory; there is no evidence of substitution. The formation of the ore deposits was subsequent to the force that sheared the country-rock, from the fact that fragments of the schistose country occur in the quartz.

The character of the gravel placer deposits in the Georgia belt is similar to that in the South Mountain belt.

THE CAROLINA BELT IN GEORGIA.

Mention has already been made (p. 15) of the extension of the Carolina belt into Wilkes, McDuffie and adjacent counties, Georgia.

MINOR BELTS IN GEORGIA.

The crystalline rocks of Georgia are comprised in the large area lying north of a straight line drawn from Augusta to Columbus. Within this area there are, besides the principal gold-ore belts mentioned above, a large number of minor belts; in fact, almost every county in the region claims some discovery of the precious metal. Among the more important are a belt including portions of Gwinnett, Milton, DeKalb, Fulton, Campbell, Fayette, Coweta, Meriwether and Troup counties; and a

[1] "Reconnoissance of the Gold Fields of the Southern Appalachians," *Sixteenth Annual Report of the U. S. Geological Survey*, 1894-5, part iii, pp. 279, 297.

[2] See paper by Dr. Wm. P. Blake, *Trans. Am. Inst. Min. Eng.*, Vol. xxv, 1896, p. 802.

small belt lying on the northwest side of the main Blue Ridge divide, in Towns, Union and Fannin counties, extending into Clay county, N. C.

7. THE ALABAMA BELT.

The Alabama belt might be considered a continuation of the Georgia belt. However, principally as a matter of convenience for reference, it is spoken of and described separately here. It comprises an area of about 3500 square miles, situated in the crystalline rocks of Cleburne, Randolph, Talladega, Clay, Tallapoosa, Chambers, Coosa, Elmore and Chilton counties. This is the southwest extremity of the southern Appalachian gold field.

On the latest geological map of Alabama,[1] the gold-bearing rocks of this area are distinguished as: 1. The semi-crystalline Talladega shales of Algonkian age, including argillaceous and hard, greenish, sandy shales (often graphitic); 2. The crystalline schists of Archæan age, including mica-schists, which, on the one hand, grade through gneisses into granite, and, on the other, into siliceous schists; garnetiferous hornblende-schists, probably of dioritic origin, also occur. The general strike is N.E. and the dip S.E.

The quartz-veins are interlaminated in these rocks, coinciding imperfectly with the dip and strike of the schistosity. From a structural geological standpoint, the veins bear much similarity to those of the Dahlonega type. From a mining standpoint, however, they are different, not forming the wide belts of numerous parallel leads, as in Dahlonega. The quartz is usually glassy; the sulphurets are in the main pyritic, and the gangue minerals are those of usual occurrence in gold-bearing quartz-veins elsewhere. The character of the placer deposits presents no novel features.

[1] Geological Map of Alabama, with Explanatory Chart, *Geological Survey of Alabama*, 1894.

CHAPTER II.

HISTORICAL NOTES: MINING, METALLURGICAL AND STATISTICAL.[1]

EARLY DISCOVERIES OF GOLD IN THE SOUTH APPALACHIAN REGION.

For an account of probably the earliest discoveries of gold in the southern part of what is now the United States by the Spanish explorers we refer the reader to Mr. G. F. Becker's paper, *Reconnoissance of the Gold Fields of the Southern Appalachians.*[2]

Reports of the existence of gold in the Southern States antedate the time of the Revolutionary war, as for instance, in South Carolina at the Brewer mine in Chesterfield county, and in North Carolina at the Oliver mine in Gaston county, the Dunn mine in Mecklenburg county, and the Parker mine in Cherokee county.

However, no absolutely authentic references to these can be obtained, and the date of the first actual discovery of gold in this country must remain shrouded in uncertainty.

Jefferson, in his *Notes on Virginia* (1782), mentions the discovery of a nugget containing 17 dwts. of gold four miles below the falls of the Rappahannock river. The U. S. Mint reports give the first returns from Virginia in 1829. For North Carolina the first mint returns appear in 1793; but the first mention of any specific find of gold in North Carolina is of a 17-pound nugget, discovered on the Reed plantation in Cabarrus county, in 1799.

Mills, in his *Statistics of South Carolina*, notes the occurrence of gold in Abbeville and Spartanburg districts as early as 1826, but the first U. S. mint returns from this State are given in 1829.

The gold placers in Burke and McDowell counties, North Carolina, (South Mountain belt) were first worked in 1829, and immediately traced southwestward through South Carolina into Georgia.

John Witheroods, of North Carolina, claims to have first discovered gold in Georgia in 1829 at Duke's creek, near Nacoochee, Habersham county;[3] but Jesse Hogan, also of North Carolina, claims to have taken

[1] We are indebted to Mr. Geo. B. Hanna, of the Charlotte Assay office, for valuable notes relating to the History of Mining and Metallurgical Operations in North Carolina.

[2] *Sixteenth Annual Report of the U. S. Geological Survey*, part iii, 1894-5.

[3] Now in White county, which was later formed from a part of Habersham.

out gold previously in a branch of Ward's creek near Dahlonega, which was then in the "Cherokee Nation." The earliest mint returns from Georgia appear in 1830.

Dr. Wm. B. Phillips[1] gives 1830 as the probable approximate date of the first discovery of gold in Alabama. There were, however, no mint returns from this State until 1840.

Perhaps one of the chief reasons that the discovery of gold came so much later in Georgia and Alabama than it did in North Carolina and Virginia, was that this part of the country was then occupied by the Cherokee Indian Nation, under the supervision of the United States, and was not open to white settlers, although the latter repeatedly intruded.

After the discovery of gold, the long pending efforts of the States to acquire these Indian lands were stimulated and accelerated by the added thirst for the precious metal, and were finally successful in 1830, when the State laws were extended over the Nation and the Indians were removed. The mining region in Georgia was surveyed into 40-acre lots, which were distributed by lottery. A caustic writer of the time says that, "intrusive mining ceased then and there, and swindling mining commenced."

The first mention of gold in Tennessee is from Coco creek, Monroe county, in 1831,[2] and this date corresponds with that of the first mint receipts.

The earliest record of gold in Maryland is in 1849,[3] from the farm of Mr. Samuel Ellicott in Montgomery county, about 12 miles north of Washington, where a depth of 50 feet was said to have been reached, and about $3000 in gold to have been taken out. The mint reports, however, show no returns previous to 1868.

EARLY MINING OPERATIONS.

The greatest activity of gold mining in the South seems to have followed closely on the first discovery, being most marked from 1829 to 1836, and probably due to the working of the more accessible virgin placers and more easily mined outcrops. The mint receipts show a renewed activity from 1839 to 1849, caused perhaps by more systematic vein explorations and improved methods. In the early fifties, the Californian discoveries abated the interest in the Southern gold field, and attracted the mining population westward, causing a natural depression in the output; from that time on there was a general decrease until the

[1] *Geological Survey of Ala.*, Bull. No. 3, 1892, p. 10.
[2] Safford's *Geology of Tenn.*, 1869, p. 490.
[3] Emmons, E., *Proceedings of the American Philosophical Society*, 1849, Vol. v., p. 85; see also *Am. Jour. Sci.*, Vol. xvii, 1830, p. 202.

practically total cessation caused by the Civil War. Since then there have been spasmodic revivals and depressions, due undoubtedly in a great measure to local causes and excitements, and to the financial condition of the country at large. Considering the small total output of the South, such fluctuations may have been caused by the successful working of a single mine, shown for instance, by the increased production of South Carolina since 1890, owing to the revival of the Haile mine.

The first practical, systematic mining operations appear to have been in North Carolina, beginning about the year 1800. From 1804 to 1827 (inclusive) this State furnished all of the gold produced in the country, amounting to $110,000. The progress up to 1820 was very slow, and mining was restricted to a very limited area. Prof. Olmstead, the first State Geologist of North Carolina, in his writings,[1] estimated the extent of the then known gold country at 1000 square miles. He says: "The gold country is spread over a space of not less than 1000 square miles. With a map of North Carolina, one may easily trace its boundaries, so far as they have been hitherto observed. From a point taken eight miles west by south of the mouth of the Uwharie, with a radius of eighteen miles, describe a circle; it will include the greatest part of the county of Montgomery, the northern part of Anson, the northeastern corner of Mecklenburg, Cabarrus—a little beyond Concord on the west—and a corner of Rowan, and of Randolph. In almost every part of this region gold may be found in greater or less abundance at or near the surface of the ground. Its true bed, however, is a thin stratum of gravel enclosed in a dense mud, usually of a pale blue, but sometimes of a yellowish color. . . . Rocky river and its small tributaries, which cut through this stratum, have hitherto proved the most fruitful localities of the precious metals."

In 1820 articles began to appear in the public journals calling attention to the North Carolina gold deposits, and itinerant German miners and mineralogists had already come into the country in some number.

In 1821, when Olmstead wrote, there was a considerable mining population, whose average earnings were from 60 to 65 cents per day (approximately 65 to 70 cents in the present standard of gold coinage). The toll paid to the owners of the land varied from one-fourth to occasionally one-half of the yield. The dust came to be quite a medium of circulation, and miners were accustomed to carry about with them quills filled with gold, and a pair of small hand-scales, on which they weighed out gold at regular rates, (for instance, 3½ grains of gold was the customary equivalent of a pint of whiskey). The gold found its way largely

[1] *Am. Jour. Sci.*, 1825.

into the country stores in exchange for merchandise at the rate of 90 to 91 cents per pennyweight (96 to 97 cents present standard).

In these early days farming and gold digging went, in many cases, hand in hand; and this is indeed still true, to some extent, at the present day. When the crops were laid by, the slaves and farm hands were turned into the creek-bottoms, thus utilizing their time during the dull seasons. Where mining proved more profitable than planting, the former superseded the latter entirely. Thus, in speaking of the Tinder Flats placer in Louisa county, Va., Silliman says:[1]

"Jenkins is in the habit of substituting a fall working in the gold, for which he obtains $1000 annually, as a compensation for his tobacco crop, which he relinquishes in favor of the gold."

Some of the more prominent localities developed into regular mining camps, where continuous and extensive operations were carried on. Such were, for instance, Arbacoochee and Goldville, Ala.; Auraria and Dahlonega, Ga.; and Gold Hill and Brindletown, N. C. In the latter place it is stated that just before the California excitement as many as 3000 hands might have been seen at work on one of the streams of the region.[2] In 1853 there was a population of about 2000 in the Gold Hill camp.

When Lumpkin county, Ga., was organized in 1832, Dahlonega (then called New Mexico) had a population of 800. During the mining boom Dahlonega had a population of 5000, and Auraria (then called Knucklesville) 2000 to 3000.[3]

At Goldville, Ala., between 1840 and 1850, there was a population of at least 3000.

The first work, naturally, was the washing of the stream placers. After these were exhausted, attention was turned to the gravel deposits lying under cover of the alluvium. These were worked by sinking pits, and raising the gravel by hand labor. Where it was necessary the pits were drained by large vertical bucket-wheels, for which the power was derived from the stream directly, or by flume lines with over-shot or under-shot wheels.

EARLY MINING AND METALLURGICAL METHODS.

The first primitive washing, as in other newly discovered gold countries, was probably done with the pan. As the workings grew more extensive, this was superseded by the rocker, long tom and sluice-box; and, indeed, these original devices survive to the present day.

[1] *Report to the President and Directors of the Walton Mining Company.* By Prof. B. Silliman, Jr., Fredericksburg, Va., 1836.

[2] *Ores of North Carolina*, 1887, p. 312.

[3] Recollections of A. G. Wimpy (a very old citizen of Dahlonega, Ga.) published in the Dahlonega *Signal*, Aug. 20, 1883.

The rockers in use to-day are of two types. The first is essentially a panning process, using a minimum amount of water, the operation being an intermittent one. This type of rocker is closed at both ends, the discharge being over the side; it will be described, with illustrations, as now in use at the Crawford mine (p. 94). The second type consists of a hollow segment of a log closed at the upper end. It is set on a slight inclination, about 6 inches in 10 feet, and is provided at the lower end with grooves or strips that act as mercury pockets or riffles. When used on gravel it is provided at the upper end with a shallow box having a round punched or slotted iron bottom. The length of this type of rocker is 5 to 10 feet. The gravel and clay are thrown into the box, where a constant stream of water, together with the rocking motion and stirring with fork or shovel, disintegrates the material. The pebbles and bowlders are thrown out with the fork, while the fine portions are washed down the bottom. The rocking facilitates the settling and amalgamation of the gold and the discharge of the tailings. Two men work at one rocker or set of rockers, so joined together as to move in harmony. One throws the gravel from the pit into the box, or directly into the rockers, and the other sits or stands above the rockers moving them with his feet, disintegrating the gravel with a fork and discharging the coarse material. Rockers of a similar type are at present in use at several mills for handling pulp and blanket washings. (See Plate I.)

Where sufficient flowing water is at hand, the sluice box and long tom are used, as they handle larger quantities with less labor. The sluice box, generally 8 to 10 feet long, 20 inches wide and 12 inches deep, provided with riffles and a perforated charging plate at the head, fulfils the same purpose as the rocker; being stationary, however, it requires a larger amount of water to carry off the tailings.

It is interesting to note that at the Beaver Dam mine, in Montgomery county, N. C., a large rocker, about 10 feet long by 3 feet wide, was operated as early as 1825 by steam power, the engine having been imported from England.

Tuomey,[1] in 1854, mentions ground-sluicing of side-hill deposits at Arbacoochee, Ala., by aid of a ditch and a series of trenches into which quicksilver was poured. It is probable that this method of working existed even prior to that day.

HYDRAULIC METHODS.

The first use of the hydraulic method of mining was probably early in the forties, previous to the California gold discoveries, in the western part of North Carolina, although on a much smaller and modified

[1] *Second Biennial Report on the Geology of Alabama*, p. 70, Montgomery, 1858.

LOG ROCKERS, GOLD HILL, N. C.

A small stream of water pours from the crude V-shaped trough above into the upper end of each of the larger troughs below, and washes the gravel and soil out at their lower ends.

(See also p. 60.)

CHILIAN DRAG-MILL AND ROCKERS, NEAR GOLD HILL, N. C.

(See page 33.)

scale as compared to its present application. Mr. Wm. H. Ellet, writing in the *Mining and Statistic Magazine*[1] early in 1858, in reply to Hon. T. L. Clingman's inquiry of December, 1857, says:

"I avail myself of my earliest leisure to answer your inquiries in relation to the hydraulic gold-mining operations lately introduced by Dr. M. H. Vandyke, in some of the western counties of North Carolina. . . . . My observations in the hydraulic process were made during the month of April[2] at the Jamestown mine,[3] in McDowell county, N. C. The water was there conveyed . . . . about 4 miles. The uniform descent was 4 inches to the hundred feet. . . . . The number of hose pipes employed was four. The mass of earth moved in nine working days was 20 feet in depth, 82 in length and 26 in breadth, being at the rate of 1184 cubic feet, or 966 bushels, per day for each hose. . . . . The labor employed . . . . was that of four men and two boys. . . . . The yield in gold was $5.13 per day for each hose employed.

Shortly afterwards a further publication appeared in the same magazine,[4] from which the following extracts are taken:

"The Wilkinson gold mine in Burke county, N. C., is owned by Dr. Van Dyke, and is worked by the hydraulic process. The water is brought . . . . by a canal or aqueduct for a distance of 15 miles. . . . . The water is not brought upon these mines at a very high head, only about 40 feet. There was only one pipe in operation at the time of my visit. The water passed through a 6-inch hose and a nozzle of 1½ inches. . . . . The average yield of the mine . . . . was about $5.00 a day to each hand. . . . . Obtaining a sample of the gold of this mine, we passed over about 2 miles to the Bunker Hill mine, also in Burke county. This was formerly known as the Brindleton mine. It is owned and worked by Rev. Benjamin Hamilton. . . . . It is now worked by the hydraulic process. . . . . The amount of water is limited, sufficient only for about two pipes, which is brought in a small ditch for a distance of 4 or 5 miles. . . . . The Collins mine in Rutherford county is owned and worked by Dr. Van Dyke. The water is brought to this mine in a canal about 4 miles in length, at an elevation of 150 feet, and sufficient in amount for 20 pipes, and will command nearly 1000 acres of surface. . . . . Jamestown mine, McDowell county, N. C., [is] also worked by Dr. Van Dyke. The deposit workings embrace about 400 acres. The water is brought by a canal at an elevation of 70 feet, and is five miles in length. There is water enough here for 20 hose pipes."

Prof. Wm. P. Blake (in 1858) in a "Report upon the Gold Placers of Lumpkin county, Georgia, and the Practicability of Working them by the Hydraulic Method, with Water from the Chestatee River,"[5] says:

"Desiring to see the results obtained [by Dr. M. H. Van Dyke] in North Carolina, and thus to be enabled to form a better judgment of the probable results in Georgia, I first visited the placers in Burke and McDowell counties

[1] Vol. x, pp. 27-30, January 1858. Our attention was called to this and related articles by the interesting paper of Prof. Wm. P. Blake, published in the *Transactions of the American Institute of Mining Engineers*, October 1895, entitled *Notes and Recollections Concerning the Mineral Resources of Northern Georgia and Western North Carolina.*

[2] 1857.

[3] Afterwards and at present known as the Vein Mountain mine.

[4] Vol. x, pp. 393, 394, May, 1858.

[5] *Mining and Statistic Magazine*, vol. x, pp. 457-476, June, 1858.

where the [hydraulic] process is now in successful operation. . . . . The average yield, as shown by the results at several of the North Carolina placers, is about $6.00 a day to a pipe attended by two men, or by a man and a boy. At some of the placers the average is not less than $10.00 a day. . . . . At Brindletown, in the bed of a little brook which has a rapid descent, Mr. Hamilton has been washing very successfully with two pipes and five men and boys. . . . . I am confident that the yield cannot be less than $20.00 a day, even among the former excavations where the gravel has been washed over more than once before."

Lieber[1] mentions the hydraulic process as being practiced previous to 1859 at Pilot mountain in Burke County, N. C., and he evidently has reference to the above described localities.

The Dahlonega method (a combination of hydraulicking, sluicing and milling) originated in 1868.

The first record that we have of *dredge mining* is that carried on by a Mr. Gibson in 1843-4, in the Catawba river, Gaston county, N. C. The river sediments and gravel were scooped out on flatboats by men using long-handled scoops, and the material was carried ashore and washed.

Later on mechanical dredges of various designs came into use, chiefly on the Chestatee river, in Georgia.

The advent of the *hydraulic gravel elevator* dates from about 1883. It was first applied at Brindletown, N. C., and at Dahlonega, Ga. The well-known type of this mechanism, known as the Hendy lift, was employed at the Cincinnati Consolidated Company's mines in Dawson county, Ga., in 1883. The plan was to divert the Etowah river and to suck up the gravel from the old channel.

The Roy Stone method[2] was experimented with in the Chestatee river in 1883, but the results are not known.

The Crandall hydraulic elevator,[3] as used at the Chestatee mine, Georgia, in 1895, contains important improvements over other types of similar mechanisms.

VEIN MINING. FREE-MILLING ORES.

Vein mining probably followed more or less closely on the exhaustion of the richer gravel deposits. The first account of vein mining is in 1825, at the Barringer mine, Stanly[4] county, N. C. In Virginia the veins of the Tellurium and Vaucluse mines were discovered in 1832; and in Georgia the Reynolds vein, lot No. 10, near Nacoochee, in White county, was discovered some time prior to 1834.

[1] *Supplementary Report to the Survey of South Carolina*, 1859, p. 154.
[2] *Trans. Amer. Inst. Min. Eng.*, vol. viii, p. 254.
[3] *Ibid.*, vol. xxvi, 1897, pp. 62–68.
[4] This part of Stanly was then a part of Montgomery county.

EARLY MILLING APPLIANCES.

For a long time the output was confined to the free-milling brown ores near the surface, and the ore was raised by horse-whim and hand-windlass, or even by baskets carried upon the backs of the miners. At first the gold from the ores of the decomposed outcrops of the veins was extracted by washing in rockers. The following quotation from Prof. Elisha Mitchell's *Report on the Geology of North Carolina* (1827), is pertinent here:

"The quartz is raised from the mine, broken to pieces, and those parts which are known to contain gold selected for washing. This part of the process is conducted in the same way as in Montgomery (county), except that the agitation is continued for a longer time, and that a small quantity of quicksilver is put into the rockers to collect the gold, by forming an amalgam with it."

The most primitive method of milling the quartz was undoubtedly by crushing in *hand-mortars* and subsequent panning. This is still carried on by the native tributors in certain districts. It was followed by the introduction of the *drag mill* (*arrastra*), the *Chilean mill* (Plate I, p. 30) and eventually the stamp-mill. The two former were evidently drawn from South American and Mexican practice, and were probably the first mechanical pulverizing machinery used.

As an illustration of some of the earlier milling methods, the following is taken from a report of the Supervising Committee of the United States Mining Company in 1835, on their mine near the Rappahannock river, Virginia:

"The plant consists of a crushing (rolls) and a vertical mill (stamping-mill) in a building 26 × 36 feet. Both mills are located on the ground floor and are propelled by a water-wheel 11 feet in diameter, with a 11-foot face. The crushing-mill has 3 sets of cylinders 2 feet in length and 15 inches in diameter, the first or upper set fluted, the other smooth. The ore is thrown into a hopper on the upper floor, from which it is conducted over an inclined shaking-table to the fluted cylinders, by which it is crushed to a size from ¼ to 1 inch in diameter. The crushed material is equally divided and goes to the two sets of smooth cylinders. By them it is further greatly reduced, ranging from impalpable powder to grains as large as coarse hominy. From these cylinders it falls into a sifter having the fineness and motion of the common meal-sifter, from whence the material which passes through is conducted to 12 amalgamators, constructed upon the principle of the Tyrolese bowls, making from 90 to 100 revolutions per minute. They perform the office of washing and amalgamating. The sand discarded by them, after being washed, is conducted through troughs to the vertical mill, where, being reduced to an impalpable powder, it passes in the shape of turbid or muddy water to another set of amalgamators similar to those above mentioned, and thence to the river. The portion of the ore reduced by the cylinders which passes over the sifters is conducted to the vertical mill, and is treated in the same manner."

The process at another Virginia mine, the Vaucluse, is described[1] in 1847 as follows:

"The machinery consists of a condensing Cornish mining engine of 120 horse-power; the mill-house contains 6 large Chilean mills; the cast-iron bed-plate of each is 5 feet 6 inches in diameter, and on it are two cast-iron runners of the same diameter, the total weight of the mill being 6200 pounds. The ores, on arriving at the surface, are divided into two classes: 1. The coarse and hard ore for the stamps; 2. Slate and fine ore for the Chilean mills. This is done by means of a large screen. The very large pieces are first broken by a hammer before they are fed to the stamps. All of the ores are ground with water, each mill being supplied with hot and cold water at pleasure. Twelve inches from the top of the bed-plate there is a wide, open mouth, from which the turbid water escapes to tanks. On the south side of the steam-engine is the stamp house and amalgamation mill, containing 6 batteries of 3 stamps each; these stamps, with the iron head of 125 pounds, weigh 350 to 380 pounds each. Each battery is supplied with water, and at each blow of the stamp a portion of the fine ore passes out of the boxes through the grates to the amalgamation room. Here are stationed 18 small amalgamation bowls of cast iron, 30 inches in diameter. The bowls are supplied with runners which move horizontally; in the center of these runners is an eye or opening like that in the runner of a corn-mill. The ground or finely-stamped ore, gold and water pass into this eye, and by the rotary motion of the same are brought into contact with the quicksilver deposited in the center, forming amalgam. From the amalgamators the pulp passes through 3 dolly-tubs or catch-alls, acting as mercury and gold tubs. After this the whole mass passes to the strakes or inclined planes, where the sulphurets are deposited and the earthy matter washed away. These sulphurets were formerly treated in two heavy Mexican drags or arrastras; but not answering so good a purpose, they have been altered into three heavy Chilean mills."

The collection of amalgam, retorting and melting was practically the same as to-day. The total plant at this mine was valued at $70,000.

Emmons gives the method of working the ores of Gold Hill, N. C., in the earlier days as follows:[2]

"The machinery employed at Gold Hill for separating gold, consists, first of the Chilean mill for crushing and grinding, after being broken by hammers, the Tyrolese bowls, the Burke rockers, and the drag-mill. . . . . The work for a Chilean mill of this ore is 70 bushels per day, and our mills run for 24 hours, with one or two short interruptions. They are all moved by steam-power, and all the water used in the mills is pumped from the mine. The Burke rocker is the principal and best saving machine employed. The drag-mill is also a good machine, is cheap, and easily kept in repair. On inspecting these operations when going on it is impossible to resist the conclusion that much of the gold is wasted along with the mercury."

Emmons further states the force employed at Gold Hill at that time for working the Earnhardt (Randolph) vein to consist of:

"66 miners paid by the month and 39 negroes hired by the year. The day of 24 hours is divided into three shifts of eight hours each for underground work."

[1] *Plan and Description of the Vaucluse Mine, Orange County, Va.* Philadelphia, 1847.
[2] *Geological Report of the Midland Counties of North Carolina*, 1856. E. Emmons, pp. 160 *et seq.*

The *stamp-mill*, or, as it was originally called, the "pounding mill," was most probably a European innovation. As early as 1836 a 6-stamp mill, with 50-pound stamps, was in operation at the Tellurium mine in Virginia. In 1837 a Frenchman erected a mill at the Haile mine in South Carolina. These primitive mills were constructed of wood, with iron shoes and die-plates; the general type of construction was similar to that of the present California mills, with the exception that the stems were square and did not revolve, the cams working in slots or recesses cut into the stems. A few of these old-fashioned mills may still be seen in operation in Georgia in the Nacoochee valley, seemingly serving the purpose of the tributors and petty quartz miners, and it is stated that they are operated at a fair profit. They are cheaply constructed, a 10-stamp mill with water-wheel and building complete costing about $150. The amalgamation is done on a copper plate of the width of the battery and about one foot long.

The first regular California battery was erected at the Kings mountain mine, in North Carolina, just after the war; and in 1866 a similar mill was built at the Singleton mine, in Georgia, by Dr. Hamilton.

Besides mills of Western manufacture, there are two types which are common to the South. One of these is an excellent 750-pound mill built by the Mecklenburg Iron Works of Charlotte, N. C., a slight variation of the Western type (described on p. 119). The other is the 450-pound Hall mill, which is peculiarly adapted to the saprolitic ores of the Dahlonega district in Georgia (described on pp. 110–113.)

Various types of *rotary pulverizers* and *pan amalgamators* have been introduced in the South from time to time, supposedly as improvements on the stamp-mill, as, for instance, the *Howland mill*, a flat circular disc revolving in an iron shell; and, similarly, the *Crawford* (with revolving iron balls) and the *Huntington mills;* the *Parson mill*, not unlike the Howland, but covered with a hood, and having the interior grinding surfaces coated with lead-amalgam; the *Meech mill*, in which the quicksilver was comminuted by superheated steam; the *Wiswell mill*, being practically an iron Chilean mill fed with corrosive sublimate in connection with an electric current; the *Nobles process*, in which the ore was ground to 100-mesh between buhr-stones and the pulp run over amalgamated slabs of zinc or lead. Revolving *Freiberg barrels* were also used at some of the mines. The *Blake system* of fine crushing, combined with subsequent wet grinding,[1] was introduced at the Haile mine in 1884, but was soon abandoned in favor of the present stamp-mill.

The above are simply cited as a few examples of the vast number of mechanical appliances for grinding and amalgamation with which the

[1] *Trans. Amer. Inst. Mining Engineers*, vol. xvi, p. 755.

mines of the Southern States have been overrun. Although some of these, notably the Huntington mill, are still in use at a few places, it has been quite clearly demonstrated that such grinding apparatus produces float gold and flours the quicksilver, besides which the mechanism is subjected to great strain and wear, against all of which defects the stamp battery, with plate amalgamation, has proven itself vastly superior, and through all of its vicissitudes it has held the field as the most economical and rational apparatus for milling and amalgamating gold ores.

TREATMENT OF SULPHURET ORES.

As soon as the water-level was reached in the mines, and the free-milling brown ores were practically exhausted, attempts were made to treat the undecomposed sulphurets.

MECHANICAL METHODS.

Probably the earliest method employed for the concentration of these sulphurets was that used at the Vaucluse mine in 1847 (described on page 34), which consisted in passing the material over strakes or inclined planes. This was probably followed by buddles, primitive bumping-tables and more especially by blankets. Log rockers were also used at an early date for this purpose. At the present day the Frue, Embrey and Triumph concentrators are in general use. Of these, the Embrey machine is considered by some to give better results, especially where skilled labor cannot be obtained, and where the sulphurets are not sized. Still, each one of the three finds its strong advocates, and the difference in perfection of concentration obtained by them is probably not material. In some cases—as, for instance, in the Gold Hill district—the finely-divided condition of the gold has led to the re-employment of blankets.

At the Reimer mine, North Carolina, a plant was in operation in 1883 in which the ore was comminuted in a series of crushers and 26-inch rolls; the pulp was sized into six grades, from 10- to 60-mesh, and each grade treated separately by a Bradford jig. This process is said to have given good results, but the plant was destroyed by fire soon after its erection and never rebuilt. The same system of jigging was at one time in use at the McGinn mine in North Carolina.

The earliest treatment of the concentrated sulphurets was by regrinding them (in the raw, unroasted state) in Mexican arrastras and Chilean mills, with subsequent amalgamation, as described above in the practice of working the ores at the Vaucluse mine, Virginia, in 1847.

In 1852-53, a Dr. Holland, of Massachusetts, introduced a roasting process at some mines near Charlotte, N. C., in which the pyritic con-

centrates were mixed with nitrate of potash or soda and roasted in a reverberatory furnace at a low heat.

Lieber stated[1] in 1856 that a process for roasting sulphurets, with subsequent amalgamation, had been introduced by a Mr. C. Ringel at a mine near Rutherfordton, N. C. (this was probably the Alta mine), and was afterwards practiced with success on old tailings at the Gold Hill and other mines in North Carolina.

In the past history of the Southern mines a vast number of roasting processes and furnaces have been introduced, many of them approaching the ludicrous, but they have never lasted beyond the experimental stage. Heap-roasting with salt was also tried.

Some of the furnaces, particularly of the well-known reverberatory type, were successful enough so far as the roasting went; the fault lay in the prevalent and popular belief that, by oxidizing the sulphurets, the difficulty of amalgamating the precious metals, which had been set free, would be removed, when in fact the resulting coating of iron oxide was nearly as fatal to the work as the sulphide had been.

The Bartlett method of making white lead-zinc oxide was introduced at the Silver Hill mine, North Carolina, in 1871-2. It consisted in roasting the concentrated galena-blende and condensing the zinc-lead oxide fumes, which made a good paint material. The process is said to have been carried on successfully until all the available suitable material was exhausted.

CHEMICAL TREATMENT.

The next step was in the direction of a chemical treatment of these refractory sulphurets. It would be useless to outline the numerous processes that were experimented with for this purpose. The South has been, much to its detriment, the "proving ground" of almost all the patent gold-saving processes invented, and the greater proportion of these have, as might have been predicted, resulted in utter failure. Of all these the chlorination process is practically the only survivor; and there is a possibility of the successful application of the cyanide process.

THE CHLORINATION PROCESS.

It was not until 1879 that the successful treatment of pyritic sulphurets was accomplished by the introduction of the chlorination process. In that year a Mears chlorination plant was erected at the Phoenix mine, North Carolina, under the management of Mr. A. Thies, who soon improved on and developed it into what is now universally known as the Thies process.

[1] *Report on the Survey of South Carolina for* 1856, p. 47.

In 1880 a chlorination plant (the Davis and Tyson Metallurgical Works) was erected two miles south of Salisbury, N. C. The process used was known as the Davis process, which differed from the Mears only in the method of precipitating the gold with charcoal instead of ferrous sulphate. These works were in spasmodic operation on custom ores for several years.

In 1881 a Davis plant was erected at the Reimer mine, North Carolina, but was shortly burned down, before thorough testing.

In 1882 the Plattner chlorination process was introduced at the Tucker mine, North Carolina, but was not successful, and in the following year the Mears process was substituted, which also had a short existence here. These failures were, however, most probably due to the impracticable application of the methods rather than to the character of the methods themselves.

Experiments were made several years ago by Mr. P. G. Lidner at the Brewer mine in South Carolina, and at Dahlonega, Ga., with a chlorination process for treating the ore in bulk; and a plant for a patent electrolytic-chlorination process was erected in 1895 at the Clopton mine, Villa Rica, Ga. None of these have, however, met with practical success.

At the present time the Thies process is in successful use at the Haile mine, South Carolina, and the Franklin and Royal mines, Georgia.

THE CYANIDE PROCESS.

The cyanide process has so far found but little application in the South. In May, 1892, Mr. Richard Eames, of Salisbury, N. C., experimented with cyanide at the Gold Hill mine, N. C., extracting 60 per cent of the assay value. In the summer of 1893, a 10-ton cyanide plant was working at the Moratock mine, N. C., but the operations were soon relinquished here on account of the low grade and character of the ore. Later in the same year, a cyanide plant was in operation at the Gilmer mines in Goochland county, Va.; with what success could not be ascertained. At the Franklin mine, Ga., a treatment of the ores with cyanide was attempted before the introduction of the chlorination process. It proved successful on the oxidized tailings from the old dumps; but the extraction from fresh sulphurets was insufficient to warrant its continuation.

In 1895 cyanide experiments were made at the Sawyer mine, in Randolph county, N. C., but were soon abandoned. In 1896 a 30-ton cyanide plant was erected at the Russell mine, N. C., by the American Cyanide Gold and Silver Recovery Company of Denver, Col., and a small plant was also built at the Cabin Creek (Burns) mine, N. C., by the same company, but neither of these has yet been put in practical operation.

OTHER CHEMICAL PROCESSES.

The *Hunt and Douglas process* was successfully applied in 1880 to the ores of the Conrad Hill mine, N. C. The roasted sulphurets were leached with a ferrous chloride solution, converting the copper to a soluble chloride, from which it was precipitated as metallic cement on scrap iron.

The *Designolle process*, which consisted in treating the roasted ore with corrosive sublimate in iron vessels, was only moderately successful in its application, for the reason that it made a very base bullion, the iron of the apparatus invariably precipitating any soluble salts formed in the roasting. It was worked for a time, during 1882-83, at a custom plant near Charlotte, N. C.; at the New Discovery mine, Rowan county, N. C. (1883), and at the Haile mine,[1] S. C. (1883).

A plant for the extraction of gold from pyritic concentrates, with the recovery of the sulphuric acid, was erected early in the present decade at Blacksburg, S. C., mainly for the treatment of custom ores. The concentrates were roasted in a Walker-Carter muffle furnace, which was connected with lead chambers. The amalgamation of the roasted product was carried on by a patent process known as the *Caloric Reduction Company's process*, the principle of which was a volatilization of mercury into the mass of the pulp, followed by a condensation of the same, the amalgam being led into settling vats. It was proposed to use the tailing residues for the manufacture of red paint. The scheme, as might have been predicted, was a failure. A similar process, known as the *Phelps process*, had already been unsuccessfully tried on North Carolina ores, in (about) 1877, in an experimental plant situated at Philadelphia.

Attempts at *pyritic smelting* were made as early as 1847 at the Vaucluse mine in Virginia by Commodore Stockton, but resulted in failure.

Matte smelting, followed by refining in reverberatory furnaces, was practiced (about 1881-1882) on the copper ores of the Conrad Hill and the North State mines in North Carolina.

Experiments on matting auriferous sulphurets from the Haile mine, S. C., were made in 1886 by Mr. E. G. Spilsbury,[2] but proved unsuccessful.

Regarding smelting processes in the South, probably most has been done in the attempted treatment of the complex galena-blende ores, carrying silver and gold, of the Silver Hill and Silver Valley mines, Davidson county, N. C.

The process in use at Silver Hill, as early as 1853, was heap-roasting, followed by wet-crushing in a stamp battery, the zinc oxide being dis-

[1] *Trans. Amer. Inst. Min. Engs.*, vol. xv, p. 771.
[2] *Trans. Amer. Inst. Min. Engs.*, vol. xv, pp. 767-775.

solved and recovered separately, after which the residues were smelted in the old-fashioned Scotch open-hearth lead furnace, and the precious metals were recovered from the pig lead by refining in a cupellation furnace.[1]

During the past twelve years a number of patent processes have been experimentally tried on the Silver Valley ores in a plant situated at Thomasville, N. C., but it was not until 1895 that a successful process was introduced by Mr. Nininger, of Newark, N. J. It consists of a down-draught jacket furnace, through which the fumes of lead and zinc are carried downward into condensers, where they are met by a spray of water, the liquor being led to vats where the lead oxide is deposited, while the zinc remains in solution and is subsequently precipitated as zinc oxide. The matte, carrying copper, gold and most of the silver, is tapped from the well of the furnace and cast into pigs.

PRODUCTION OF GOLD AND SILVER IN NORTH CAROLINA AND OTHER SOUTHERN STATES.

The following table, compiled from the production reports of the United States Mint, gives an estimate of the gold and silver production of the Southern States down to the present time. The figures represent not only the amounts deposited at the United States Mint and Assay Offices, but also such amounts that were produced and not turned into the mint and of which records could be obtained:

TABLE I.—*Estimate of the Production of Gold and Silver in each of the Southern States from* 1799 *to* 1879 *and Annually Since.*

Year.	Md.	Va.	N. C.	S. C.	Ga.	Ala.	Tenn.	Total.
1799-1879	$2,500	$3,091,700	$19,659,600	$2,587,900	$14,180,500	$365,300	$155,300	$40,042,800
1880...	250	11,500	95,000	15,000	120,000	1,000	1,500	244,250
1881....	500	10,000	115,000	40,000	125,000	1,000	1,750	293,250
1882....	1,000	15,000	215,000	25,000	250,000	3,500	250	509,750
1883....	500	7,000	170,000	57,000	200,000	6,000	750	441,250
1884....	500	2,500	160,500	57,500	137,000	5,000	300	363,300
1885....	2,000	3,500	155,000	43,000	136,000	6,000	300	345,800
1886....	1,000	4,000	178,000	38,000	153,500	4,000	500	379,000
1887...	500	14,600	230,000	50,500	110,500	2,500	500	409,100
1888 ...	3,500	7,500	139,500	39,200	104,500	5,600	1,100	300,900
1889....	3,500	4,113	150,174	47,085	108,069	2,639	750	316,330
1890....	16,962	6,496	126,397	100,294	101,318	2,170	1,001	354,638
1891...	11,264	6,699	101,477	130,149	80,622	2,245	519	332,975
1892....	1,000	5,002	90,198	123,881	95,251	2,419	1,006	318,755
1893....	114	6,190	70,505	127,991	100,375	6,362	250	311,787
1894 ..	978	7,643	52,927	98,763	99,095	4,092	329	263,827
1895...	501	6,325	69,196	128,303	128,403	4,708	335	337,771
1896....	1,037	4,466	52,056	100,711	150,085	6,695	582	315,632
Total..	$47,606	$3,214,234	$21,830,528	$3,810,277	$16,380,218	431,230	$167,022	$45,881,115

In order to give an idea of the fluctuation from 1799 to 1896, Table No. 2 is given. These figures, however, comprise only the actual

[1] *Mining Magazine*, vol. I, 1853, p. 367 *et seq.*

United States Mint and Assay Office receipts, and do not include such bullion as went abroad, was sold directly to local jewellers, or was coined by the Bechlters[1] at Rutherfordton, N. C.

TABLE II.—*Statement of Gold and Silver produced in all of the Southern States; Deposited at the United States Assay Offices from* 1793 *to* 1896 *inclusive.*

Year.	Amount.	Year.	Amount.	Year.	Amount.
1793-1823	$47,000	1848	$850,692	1873	$158,952
1824	5,000	1849	891,968	1874	141,647
1825	17,000	1850	658,605	1875	150,612
1826	20,000	1851	500,539	1876	138,256
1827	21,000	1852	711,449	1877	159,009
1828	46,000	1853	486,184	1878	162,925
1829	140,000	1854	323,489	1879	186,123
1830	466,000	1855	362,349	1880	203,770
1831	519,000	1856	325,820	1881	197,084
1832	678,000	1857	141,810	1882	229,459
1833	868,000	1858	349,323	1883	272,475
1834	898,000	1859	379,677	1884	255,259
1835	686,300	1860	231,398	1885	239,963
1836	667,000	1861	141,778	1886	272,414
1837	282,000	1862	6,298	1887	390,531
1838[2]	358,750	1863	1,624	1888	234,947
1839	429,648	1864	6,093	1889	224,323
1840	427,311	1865	33,345	1890	269,997
1841	544,661	1866	202,000	1891	254,707
1842	723,761	1867	106,903	1892	262,023
1843	1,050,100	1868	155,660	1893	261,904
1844	928,095	1869	191,738	1894	263,827
1845	986,849	1870	168,057	1895	319,496
1846	992,792	1871	138,791	1896	270,210
1847	1,018,079	1872	164,461		
				Total,	25,870,310

The following note concerning this local coinage by the Bechtlers is added by Mr. Geo. B. Hanna of the U. S. Assay Office at Charlotte, N. C.:

"Gold was coined at Rutherfordton by three Bechtlers: Christian Bechtler, A. Bechtler and Christian Bechtler, Jr. A. Bechtler came in between C. Bechtler and C. Bechtler, Jr. I have in hand a 5-dollar gold piece stamped 'A.'

[1] Christian Bechtler, jeweller by trade, who resided near Rutherfordton, N. C., was urged by residents in Rutherford and adjoining counties to coin the gold of that neighborhood, as transportation to the only mint then existing (Philadelphia, Pa.) was hazardous and difficult. He commenced coining in 1831, and continued until his death, in 1843, when his nephew, C. Bechtler, Jr., continued the minting until 1857. No regular entries of the quantity of gold minted were made; sometimes as much as $4000 to $5000 were coined in a week; and for a period of ten years the annual quantity was fairly equal. See *Second Annual Report Survey of South Carolina*, 1857, O. M. Lieber, p. 135.

[2] The years 1838 to 1847 exclude the amounts deposited at the New Orleans Mint, which were not available for each year. The total amount at New Orleans in those years from the Southern States was only $116,086.

Bechtler, and it is the most artistic of all the 5-dollar coins. C. Bechtler also coined 5-dollar gold pieces stamped 'Georgia Gold'; a very few pieces are stamped 'August 1, 1834,' which date marked a change in the U. S. standard gold coin. The presumption is that all the Bechtler gold coins prior to this date were bought up at a premium, and recoined at a profit of nearly 7 per cent. The denominations coined were $1.00, of quite various patterns, and 2½ and 5-dollar pieces; the dollar pieces ranged from 27 to 30 grains. The coins were generally stamped with the carat, 20 c. being the lowest observed. The character of the stamping varied greatly, that of the dollar pieces being very poor, and these were extensively counterfeited. The alloy was silver and the coin had a pale brassy look. Some coins were specifically stamped 'North Carolina' gold; others merely 'Carolina Gold' or 'Georgia Gold.'"

In Table No. 3 the totals found in Table No. 2, from the years 1880 to 1896, are distributed among the various States.

TABLE III.—*Statement of Gold and Silver Produced in each of the Southern States; Deposited at the United States Mint and Assay Offices from* 1880 *to* 1896 *inclusive.*

	Md.	Va.	N. C.	S. C.	Ga.	Ala.	Tenn.	Total.
1880....	$191	$11,071	$77,405	$10,071	$103,066	$696	$1,270	$203,770
1881....	253	9,147	55,990	23,093	106,548	700	1,353	197,084
1882....	754	13,540	82,473	16,268	114,507	1,690	227	229,459
1883....	310	6,343	100,294	48,428	116,401	147	552	272,475
1884....	...	2,024	88,861	48,511	115,000	740	123	255,259
1885....	1,539	2,954	64,826	39,766	128,148	2,611	119	239,963
1886....	559	2,873	83,400	36,187	146,027	3,051	317	272,414
1887....	199	12,613	216,788	52,142	107,537	1,021	231	390,531
1888....	2,174	6,514	88,641	37,408	97,824	1,478	908	234,947
1889....	558	2,608	81,196	44,923	92,307	2,332	399	224,323
1890....	7,852	2,601	75,192	97,646	85,715	626	365	269,997
1891....	4,244	4,197	53,993	127,161	63,722	1,222	168	254,707
1892....	249	4,473	50,336	120,582	83,616	2,286	481	262,023
1893....	203	4,300	36,454	122,964	92,859	4,895	229	261,904
1894....	978	7,643	52,927	98,763	99,095	4,092	329	263,827
1895....	500	3,674	54,649	128,904	128,487	2,947	335	319,496
1896....	300	3,500	44,946	63,688	151,776	5,700	300	270,210

In the Census Report for 1880, vol. xiii, can be found statistics concerning gold mining in the Southern States tabulated under the following headings: Directory of deep mines; Means of handling water in deep mines; Cost of supplies in deep mines; Directory of ditches; Cost of ditch plants; Grades and dimensions of ditches; Length of water season; Placer directory; Tunnels in placer mines; Stamp batteries; Amalgamating mills; Arrastras; and Roasting furnaces.

CHAPTER III.

DISTRIBUTION OF GOLD MINES IN NORTH CAROLINA, WITH MINING NOTES.[1]

The North Carolina mines are distributed in three main belts—the Eastern Carolina, the Carolina, and the South Mountain belts (see pp. 14, 15–18).

The distribution of gold deposits and geological formations in North Carolina is indicated in a general way by the accompanying map (fig. 3, p. 44); but this is shown in greater detail and accuracy on the larger map which accompanies Bulletin 3 of the Survey reports.

The mining districts of North Carolina have been more extensively developed than those in any other portion of the South; although to-day a comparatively small number of the mines are in operation. Of these, very few can be said to be steady producers, most of the work being prospecting and preliminary development, with irregular and spasmodic output. Petty mining, chiefly in the placer ground, is carried on by tributors in various parts of the State.

THE EASTERN CAROLINA BELT.

The principal mines are situated in Warren, Halifax, Franklin and Nash counties, in an area covering about 300 square miles, and extending in a southwesterly direction from a point near the Thomas mine, 1½ miles northeast of Ransoms bridge, to and across Tar river.

Among the mines in this belt are the Thomas, Kearney, Taylor, Mann, Davis, Nick-Arrington, Mann-Arrington, and Portis. Of these the two latter are, perhaps, of most importance.

The MANN-ARRINGTON mine is situated in the northwest corner of Nash county, at Argo P. O. The country-rock is chlorite-schist, in part porphyritic, striking N. 60° E. and dipping 40° S.E. The ore-body consists of quartz lenses from minute size up to 12 inches in thickness,

[1] For fuller description of some of the mines, the reader is referred to:
Geological Report of the Midland Counties of North Carolina, by Ebenezer Emmons, New York, 1856.
"The Ores of North Carolina," by W. C. Kerr and George B. Hanna, *North Carolina Geological Survey*, 1887.
"The Gold Deposits of North Carolina," by H. B. C. Nitze and G. B. Hanna. *North Carolina Geological Survey*, 1896. Bull. No. 3.
Unless otherwise stated, the mines are not at present working. The values of the ores are not given on our authority; the same is true of the dimensions of the ore bodies in abandoned mines and in such as could not be examined.

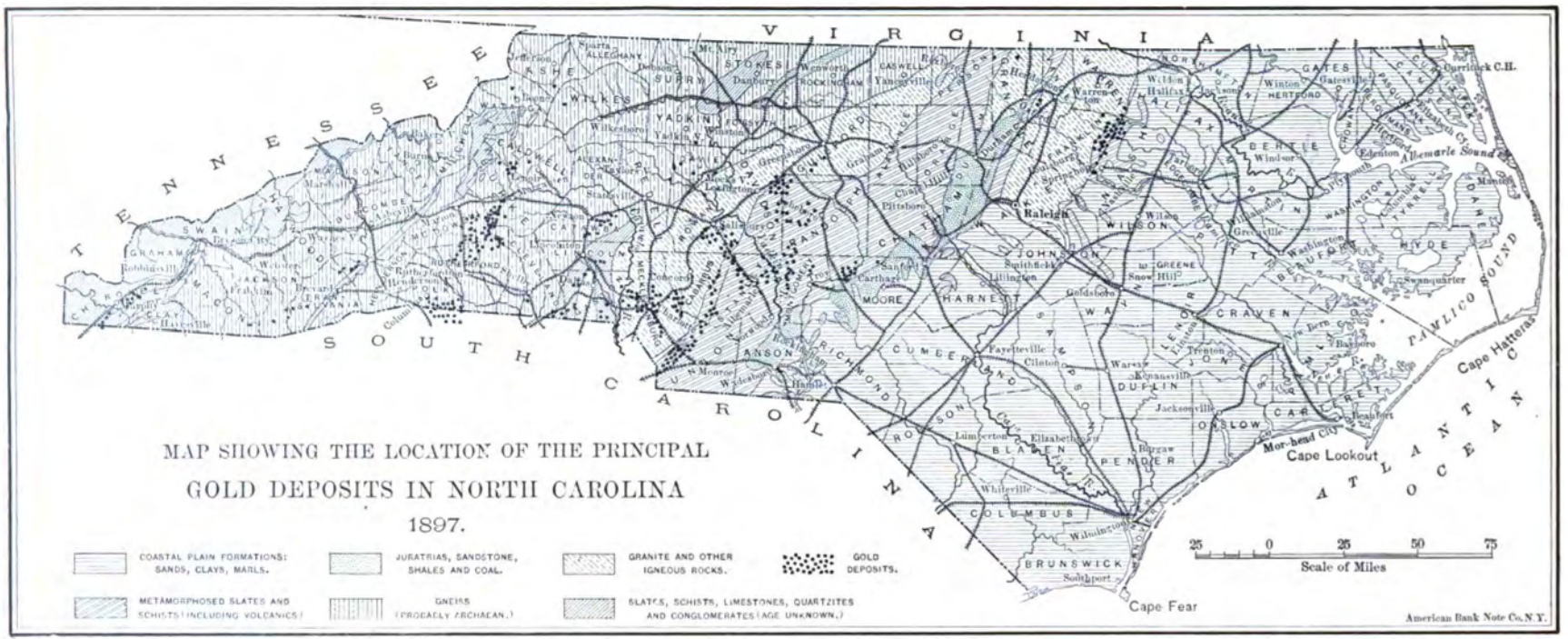


Fig. 3. Outline map of North Carolina. Distribution of gold deposits.

imperfectly interlaminated in the schists and often cutting the same at low angles. The quartz is usually saccharoidal. The mine has been opened to a depth of about 108 feet and, so far as is known, was last worked early in 1894.

The PORTIS mine is situated near Ransoms bridge in the northeastern corner of Franklin county. The country-rock is diorite. The ore-bodies lie in two intersecting belts of reticulated quartz-veins, each about 9 feet in total width. No work further than prospecting has been done on these. Small irregular quartz-stringers occur promiscuously throughout the country-rock, and the saprolites in general are stated to be auriferous. The only work of any consequence done here was surface sluicing and hydraulicking to a depth of 15 to 30 feet. Sufficient water supply and head are difficult to obtain. It is stated that 1000 cubic yards, washed in one of the sluice lines, yielded 1018 pennyweights of gold, the loose vein-rock obtained in this mass assaying about $8 per ton.

THE CAROLINA BELT.

Granville, Person, Alamance, Orange, and Chatham counties are included in this belt, being at its northern extremity; but little work of consequence has been done here. A newly discovered belt of veins has been recently opened three or four miles east of Oxford (Chatham mine); another in the northern part of Granville county, near Adoniram and Venable; and still another near the northwest border of the county, in the copper belt (Holloway mine).

MINES IN GUILFORD COUNTY.

Among the principal mines are the Fisher Hill, Millis Hill, Hodges Hill (Hodgins), Fentress (North Carolina), Twin, Gardner Hill, Jacks Hill, North State (McCullough), Lindsay, Deep River, Beason, Harland and Beard, situated from 3 to 10 miles south and southwest from Greensboro in a general direction towards Jamestown. The country-rock is granitic.

The FISHER HILL and MILLIS HILL mines are five to six miles south of Greensboro. There are two systems of parallel veins, the first running north and south and the second northeast and southwest. The aggregate length of the veins on this property is stated to be 8 or 10 miles. The vein which has been most extensively worked varies from 10 inches to 4 feet in thickness and has been successfully operated at several points. The mill consists of ten stamps and was running in 1886 and 1887.

The HODGES HILL (Hodgins) mine is two miles east of the Fisher Hill. The ore is quartz and chalcopyrite, in a flat vein from 6 inches to 12 feet thick.

The NORTH CAROLINA (Fentress) mine is 9 to 10 miles south of Greensboro. The general strike of the vein is N. 25° E.; its dip ranges from 38° to 60°. The quartz outcrop has been traced for three miles. The ore is chalcopyrite in quartz and siderite, containing gold. It was formerly worked for copper. The mine has been opened to a depth of 310 feet, where the ore-shoot was 80 to 90 feet long and 34 inches wide. The thickness of the vein varies from this to as high as 13 feet. It was last worked in 1856, and the ores which were shipped ranged from 14 to 23 per cent. copper.

The TWIN mine is six miles southwest of Greensboro. There are two parallel veins separated by 4 feet of slate. The strike is N. 40° E. and the dip S.E. The thickness of the vein is about 18 inches, the ore being auriferous quartz, carrying chalcopyrite.

The GARDNER HILL mine is three miles northeast of Jamestown. There are supposed to be three veins on the property. The main vein strikes N. 20° E. and dips westward. Its thickness is from a few inches to 3 feet. The vein-matter is auriferous quartz, carrying chalcopyrite and some pyrite. The wall-rock is granite, with a slaty gouge on each side of the veins. The mine has been opened to a depth of 110 feet. It is stated[1] that the ore ran from $10 to $20 per ton and that the mine yielded $100,000. It is estimated that the present dumps contain 25,000 tons of ore. Tentative assays show $3 to $10 per ton.

The NORTH STATE (McCullough) mine is situated about two miles west of south from Jamestown. The vein strikes northeast and dips 45° to 80° S.E. The mine was opened to a depth of 325 feet, where the vein was 4 to 8 feet thick. At the surface it was 2 feet; at the 60-foot level, 4 feet; at the 90-foot level, 10 feet; and at the 130-foot level, 24 feet in thickness. The ore is quartz carrying gold and sulphurets (pyrite and chalcopyrite). The brown ores extend to a depth of 130 feet and are said to have yielded from $1.50 to $5 per bushel ($15 to $50 per ton).

The last work was done at the depth of 325 feet, where the vein varied from 4 to 8 feet in width. The equipment consisted of 20 stamps and other machinery, which were last operated in 1884.

The JACKS HILL is on the northern, and the LINDSAY on the southern extension of the North State vein.

MINES IN RANDOLPH COUNTY.

The mines are in the central and western part of the county. The country-rock is argillaceous and chloritic schist, probably in large part sheared eruptives. At the Hoover Hill the rock is a massive porphyrite.

[1] Emmons, *Geol. Rept. Midland counties of N. C.*, 1856, pp. 174, etc.

The Sawyer mine is 5 miles northwest and the Winningham, Slack, Winslow and Davis Mountain mines are from 2 to 5 miles southwest of Asheboro.

During 1895 the application of the cyanide process to the ores of the Sawyer was experimented with, but finally abandoned

The HOOVER HILL mine is situated about 10 miles west of Asheboro and 17 miles east of south from High Point. The country-rock is a basic eruptive which is partially brecciated, the included fragments being hornstone. In part the rock is slightly schistose. The ore-bodies consist of belts in this porphyrite, which are pyritic and filled with reticulated quartz-veins from less than 1 inch to 12 inches in thickness. The strike of the belts is N.E. and the dip 30°–60° S.E. The ore-bodies are intersected by pyroxenic dikes. The mine has been opened to a depth exceeding 300 feet. The so-called Briols shoot at this depth furnished ore worth $8 to $10 per ton. The mine was working in June, 1895. It was equipped with a 20-stamp mill in 1882.

The Wilson-Kindley mine is one-half mile southwest from the Hoover Hill, and the formation is similar.

The JONES (Keystone) mine is 18 miles east-southeast from Lexington. The country-rock is a very schistose phase of the brecciated porphyrite described at Hoover Hill. The strike is N. 45° E. and the dip 80° N.W. The ore-bodies consist of separate belts, 12 to 15 feet wide, of the schists, impregnated with auriferous pyrites and quartz-stringers. The entire width of the ore-bearing ground is stated to be 50 to 110 feet. The ore is cheaply mined in open cuts by quarrying. A 40-stamp mill stands on the property. The ore is stated to mill $2. Assay value $2 to $7 per ton. Pan concentrates run $22 per ton. Cyanide experiments have been made in a small temporary plant, and it is stated that several tests of sulphureted ores gave an extraction of 70 to 80 per cent. The mine is at present in operation. The Uharie river, 2 miles distant, is the nearest supply from which water could be furnished by pumping, for hydraulicking and sluicing purposes.

The Herring (or Laughlin), Delft and Parish mines are in the vicinity of the Jones. At the last-mentioned mine free gold is found in association with actinolite.

The UHARIE mine is near the Montgomery county line on the Uharie river. The ore-bodies are similar to those of the Russell, which is a short distance southwest (see p. 52); but unlike that at the Russell, the work here has been underground, the depth of the shaft being 170 feet. A 10-stamp mill was erected in 1887.

MINES IN DAVIDSON COUNTY.

The LALOR (or Allen), LOFTIN, EUREKA and BLACK mines are situated from 2 to 3 miles southeast of Thomasville in the granite. The ores

contain gold, silver and copper. At the Lalor mine the depth of the workings is 140 feet. It was last operated in 1882 by the Campbell Mining and Reduction Company of New York. The mill contains 10 stamps and concentrating machinery. The concentrates contained sufficient copper sulphurets to make a smelting ore.

Two of the more important mines in this county are the Silver Hill and the Silver Valley.

The SILVER HILL (Washington) mine is 10 miles southeast from Lexington. The country is chloritic schist striking N. 35° E. and dipping 57° N.W.; it is accompanied by an eruptive porphyrite similar to that of Hoover Hill. The ore is schist and quartz, carrying a complex mixture of pyrite, galena, zinc-blende and chalcopyrite. The galena is rich in silver. A general average of 200 tests of Silver Hill ore shows:[1]

	Per Cent.
Galena	21.9
Pyrite	17.1
Chalcopyrite	1.8
Zinc-blende	59.2
Silver and gold	0.025
	100.025

The difficulty of successfully treating this complex combination of sulphurets has repeatedly been felt here. A mechanical separation of the galena and blende by buddles and similar machinery was perhaps the most successful of the vast number of concentrating processes tried, but even here the assays of the tailings and slimes showed great loss. The ore was for a time treated with some success, without any separation, for the combined oxides of lead and zinc used in paint manufacture. This class of ore is best adapted to a smelting process in combination with copper ores, such as has been successfully done on the similar ores of the Silver Valley mine. (See p. 49.)

As far as the 200-foot level certain portions of the vein were filled with argentiferous galena, which presented no difficulty in treatment. But below that level the blende gradually increases and finally predominates over the galena.

Various assays of the Silver Hill ores show:

	Carbonate Ores.		Pyritic Ores.	
	(1)	(2)	(3)	(4)
Gold, per ton	$8.27	$2.07	$3.10	$10.34
Silver, "	20.36	4.65	4.01	2.97
	$28.63	$6.72	$7.11	$13.31
Lead, per cent	3.80	31.94	0.67	....
Zinc, "	....	27.28	2.08	....

[1] *Ores of North Carolina*, by W. C. Kerr and G. B. Hanna, 1887, p. 197.

	Galena and Blende Ores.				
	(5)	(6)	(7)	(8)	(9)
Gold, per ton.....	$4.13	$6.20	$4.13	$....	$....
Silver "	3.23	10.73	11.25	25.86	103.44
	$7.36	$16.93	$15.38	$25.86	$103.44
Lead, per cent.....	22.94	56.72	12.57	49.00	52.00
Zinc, "	7.14	....	34.29	....	....

The mine has been worked to a depth of 660 feet by numerous and extensive levels. There are two parallel veins or lodes, known as the East and West, about 28 feet apart. The strike is N.E. and the dip 45° N.W. At the 60-foot level they come together, making 20 feet in width; at the 160-foot level the distance between the veins again widens to 32 feet, and the dip approaches the vertical. At the 200-foot level the width of the west lode is 10 to 15 feet. This mine was discovered in 1838; it was last worked 12 years ago.

The SILVER VALLEY mine is situated 5 miles northeast of the Silver Hill. The character of the country and the ore are similar to those at Silver Hill. The strike of the lode is N.E. with a dip of 45° N.W. The hanging is siliceous argillaceous schist, and the foot-wall, a hard hornstone (devitrified quartz-porphyry). The outcrop is a barren milky quartz, 20 feet wide; the sulphurets appear at a depth of 60 feet. The mine has been opened to a depth of 120 feet. The lode is from 5 to 12 feet in width and consists of alternate bands of slate, quartz and sulphurets, the latter seams being from 3 to 18 inches thick. A 20-stamp mill stands on the property.

Some assays of the Silver Valley ores show:

	Galena and Blende Ores.		
	(1)	(2)	(3)
Gold, per ton.....	$....	$4.13	$....
Silver, "	17.19	176.49	38.14
	$17.19	$180.62	$38.14
Lead, per cent.....	15.54	55.25	38.80
Zinc, "	31.43	11.24	32.00

	Concentrates.			
	(4)	(5)	(6)	(7)
Gold, per ton.....	$4.13	$4.13	$1.03	$1.65
Silver, "	23.01	44.74	13.08	14.34
	$27.14	$48.87	$14.11	$15.99
Lead, per cent.....	11.18	47.62	9.63	8.13
Zinc, "	27.70	12.68	27.84	33.54

The mine was last operated in the latter part of 1893, and the ores were smelted in a furnace at Thomasville (North Carolina Smelting Co.). Many attempts have been made at various times to treat these

complex ores, but unsuccessfully until this last time. A description of this smelting process, by Dr. G. W. Lehmann, of Baltimore, Md., is therefore deemed of interest and is given here in his words:

"The smelting plant situated at Thomasville, N. C., on the line of the Southern Railroad and within 13 miles of the mines of the Silver Valley Mining Company, was erected especially for the treatment of the refractory ores from this mine.

"The composition of the ore is zinc-blende, galena, iron sulphides, together with some little copper, silver and gold. An average analysis representing a large lot delivered at the smelter gave: Zn., 28 per cent.; Pb., 12 per cent.; Cu., 0.5 per cent.; Ag., 21 ounces per ton; Au., 0.06 ounces per ton. Quite a number of patent processes have been in operation since the last 10 years at the works in order to profitably reduce the several metals, but none of these processes have gone beyond the experimental stage, since none of them proved a commercial success, until about two years ago. At that time Mr. Robert Nininger, of Newark, N. J., erected a plant which deals with the subject of treating refractory ores successfully. The plant consists essentially of:

"1. Down-draft jacket furnace connected with two horizontal jackets, one on each side of the furnace;

"2. Two condensers connecting with the horizontal jackets;

"3. Vat house with a series of large vats to receive the flow of liquor from the condensers and to collect the lead and zinc residues;

"4. A separate plant for the treatment of the lead residues;

"5. A separate plant for the treatment of the zinc residues.

"The down-draft furnace, as far as charging and general construction is concerned, is operated in a similar manner as any ordinary jacket-furnace, but the arrangement of the tuyeres is different and the current of air from the blowers necessary for the complete combustion of the refractory ore is carried down through the charge; thence through the horizontal jackets, the condensers, through two powerful suction blowers along a series of dust chambers, and out through the stack. A constant spray of water meeting the volatile metallic fumes of lead and zinc (together with what silver the zinc fumes carry along) in the two condensers, deposits all the metallic products and carries them with the liquor into a series of vats where the lead sulphite or sulphate is deposited on the bottom of the vats, carrying the silver with it, whilst the zinc remains in solution and is precipitated out of this solution as zinc oxide.

"During the operation the slag is drawn off from openings near the bottom of the horizontal jackets near the furnace proper, whilst the matte is collected in the well of the furnace and tapped. This matte carries the copper, gold, and most of the silver. It is necessary to prepare the charges to the furnace so as to have not less than 5 per cent. of copper in your charge; otherwise the resulting matte would be too low in copper and would have to be treated over and over again. Gold concentrates and even dry ores can be used with advantage as fluxes and will help to make the process more profitable."

The cause of closing down the furnace was the difficulty of obtaining sufficient copper ores for fluxing.

During the summer of 1896 some testing work was done on the placer deposits forming the bottom land along a small creek that traverses the property. The plant consisted of an iron washer operated by a hydraulic stream, riffled sluices, amalgamating tables and rockers.

Its capacity is from 40 to 50 tons per day. It was estimated that the minimum yield of the ground was $2 per ton, and from that up to $4.

Some prospecting was also done on a gold-bearing quartz-vein situated on the west side of the creek. A 40-foot shaft exposed 7 feet of vein matter, consisting of quartz and schists carrying pyritic sulphurets. An assay of an average sample is stated to have given a value of $9.55 per ton. Assays of the more highly pyritic portion (about 4 feet in width) showed $19.06 per ton, and it is supposed that this material can be concentrated to $60.

The WELBORN (or Smith) mine, which is 2 miles west of the Silver Hill, carries similar ores.

The CONRAD HILL mine is situated 6 miles east of Lexington. The country-rocks are silicified chloritic and argillaceous schists, striking N. 10°–20° E., and dipping 80° N.W. There are two systems of veins, one parallel to the strike of the schists, and the other cutting the same at various angles. The vein-matter is quartz and siderite, carrying chalcopyrite and gold.

A number of these veins have been opened and worked by three different shafts, the deepest of which, the main or engine shaft, is 400 feet deep.

The thickness of the ore-bodies varies in different portions of the mines from less than 1 to as much as 20 feet.

The method of preparing and treating the ores at the time the mine was in operation, was to partially sort underground, and then still further hand-cobb and pick on the surface, which product went to the copper works; the remainder was crushed and jigged and the heads added to the hand-picked ore above; the tails were counted as waste, and the middlings were sent to the stamp-mill and amalgamated, where the tailings from the battery were again partly concentrated by buddles and blankets, and the concentrates sent to the copper works.

The treatment for the extraction of copper at first was to smelt the roasted ore in a shaft furnace for matte, from which, after re-smelting, black copper was obtained and refined. Smelting was superseded by the Hunt and Douglas wet process. The crushed roasted ore was subjected to a bath of protochloride of iron, for the conversion of the insoluble copper minerals to the soluble chloride; after leaching, the copper was precipitated by metallic iron and then refined. The residues were milled and amalgamated in order to obtain the gold.

MINES IN MONTGOMERY COUNTY.

The mines of this county are situated in the northern-central and northwestern parts, along the range of the Uharie mountains.

The CARTER and REYNOLDS mines are some 6 miles northeast of Troy. They have been worked to a depth of 100 and 80 feet, respectively. Telluride of gold is stated to occur here.

On the nortwest side of the Uharie mountains is a series of gravel mines situated in a line between the mountains and the Uharie river. Among others may be mentioned the Bright, Ophir [1] (Davis), Spanish Oak Gap, Dry Hollow, Island Creek, Deep Flat, Pear Tree Hill, Toms Creek, Bunnell Mountain, Dutchmans Creek, and the Worth. The available portions of these placers have been exhausted so far as the present supply of water will answer. The Beaver Dam placer is located about 5 miles west of Eldorado.

The SAM CHRISTIAN mine is situated on the west side of the Uharie mountains about 9 miles southwest of Troy.

The property contains 1350 acres. It was at one time extensively worked as a gravel mine by the Sam Christian Company, of London, England (the last operations were in 1893), the water being obtained by pumping from the Yadkin river, about 2½ miles distant. The plant consisted of two Worthington pumps and five 100 horse-power boilers, with a capacity of delivering to the mine 5,500,000 gallons in 24 hours, through a 20-inch steel flanged pipe. The elevation of the point of discharge above the point of supply was 416 feet.

The two principal channels were the Dry Hollow and the Sam Christian cut. The thickness of the gravel varied between 1 and 3 feet. The gold was coarse, mostly in nuggets from 5 to 1000 dwts. The country-rock is the Monroe slate, accompanied by large masses of volcanic breccias and cherty felsites (devitrified quartz-porphyry) which contain many small quartz-veins from ½ to 3 inches in thickness, striking N. 70° W. and dipping 60° N.E. Several shafts have been sunk on some of these narrow veins; but the attempts at deep mining were failures.

Most of the deep mines are situated in the extreme northwestern corner of the county, with Eldorado in their center.

The RUSSELL mine (Glenbrook Mining Company), is about 3 miles northeast from Eldorado and but a short distance from the Randolph county line. The country-rocks are argillaceous slates, both of soft and silicified types. Calcite occurs as a coating and in veinlets. In part at least, if not altogether, these slates are sedimentary; the bedding and cleavage planes usually coincide, though not always. The strike and dip is very variable. Diabase dikes occur in the country, but not in close proximity to the mine. The ore-bodies consist of parallel belts in the slates, impregnated with iron sulphurets (2 to 4 per cent.) and free gold, together with quartz-stringers. There are at least six of

[1] The saprolites have been explored here, and a belt 30 feet wide was found to mill $3 per ton.

BIG CUT, RUSSELL MINE, GLEN BROOK, N. C.

FORTY-STAMP MILL AND CYANIDE PLANT, RUSSELL MINE, GLEN BROOK, N. C.

these belts within a distance of 2000 feet across the strike. One of the largest is opened by the Big Cut, an open pit about 300 feet long by 150 feet wide by 60 feet deep (Plate II). On the eastern edge of this cut is a shaft 150 feet deep, from the bottom of which the ore has been stoped upward. It is stated that the entire material from the cut averaged about $2 per ton, mill-yield. There were some rich streaks from 4 to 5 feet wide which went much higher. Two stamp-mills are situated on the property; the new mill contains 40 stamps (Plate III) and the old one (now in ruins) 30 stamps. It was proposed in 1895 to treat the Russell ores by the cyanide process; and the American Cyanide Gold and Silver Recovery Company, of Denver, Col., erected a 30-ton plant in the following year, and it is stated that experimental tests and calculations demonstrated the ability to treat the ore for $1 per ton, on a 100 ton scale, with an extraction of 85 to 90 per cent.

The APPALACHIAN (or Coggins) mine is located near Eldorado. It is quite similar in character to the Russell, showing large bodies of low-grade ore. The depth of the last workings was 160 feet. A 40-stamp mill was erected in 1887, and was moved to the Jones mine, Randolph county, in 1896.

The MORRIS MOUNTAIN (Davis or Dutton) mine is one mile west of the Appalachian, and the ore-bodies are similar to those of the Russell and the Appalachian.

The RIGGON HILL mine is located 3 miles east of Eldorado. The ore-body consists of a quartz-vein, 2½ feet in thickness, lying in and with the slate country. It has been opened by a shaft 100 feet in depth. Some very high-grade ores (both in gold and silver) are reported from here. Prospecting work was being done during the past summer.

The STEEL mine is situated about 2 miles southeast of Eldorado. The country is silicified schist, striking N. 25° E. and dipping 70° N.W. The ore-bodies (9 to 12 feet in thickness) consist of the schists impregnated with sulphurets (galena, blende, chalcopyrite and pyrite) and intercalated with quartz-stringers or seams from less than one up to twelve inches in thickness. The combined thickness of these ore-seams is rarely less than 15 inches, and is sometimes more than 3 feet. The ore contains gold and silver in galena, blende, chalcopyrite and pyrite. Occasional bunches of the ore have been extremely rich, and assays of the entire mass of the vein-matter have shown values from $20 to $160 per ton. The depth of the mine is 220 feet. It was last operated by the Genesee Gold Mining Company, the ores being treated in a 40-stamp mill.

The Saunders mine is an extension of the Steel.

The MORATOCK mine is situated 8 miles south of Eldorado. The country-rock is a massive, devitrified quartz-porphyry and volcanic

breccia. It is very sparingly impregnated with sulphurets (pyrite and some chalcopyrite). Several small quartz-veins (less than 1 inch in thickness) intersect the mass. The mine consists of a small quarry opening in the quartz-porphyry. A 10-stamp mill, equipped with a cyanide plant, stands on the property and was last in operation in July, 1893. The ore was reported to be of too low grade to be profitably treated.

MINES IN STANLY COUNTY.

The mines are located in the northeastern portion of the county, more or less on the line of the Southern Railroad branch running from Salisbury to Norwood. Among the more important properties are the Haithcock, Hearne, Crawford, Lowder, Parker, Crowell and Barringer.

The HAITHCOCK and HEARNE mines are about two miles northwest of Albemarle. The country-rock is clay-slate, striking N.E., and associated with eruptives. The quartz-veins are stated to be from 2 to 6 feet in thickness.

The CRAWFORD mine, situated 4 miles northeast from Albemarle, is a newly discovered placer, and is described in detail on p. 91.

The LOWDER mine is situated 4 miles west of Albemarle. It was opened in 1835, but has not been operated since the war. Previous to that time it was worked along the outcrop and to a depth of 65 feet. The quartz-vein is stated to be 3½ feet in thickness, lying approximately with the slates in strike and dip. During the summer of 1895 the mine was unwatered, and some prospecting work was carried on.

The PARKER mine (the New London Estates Company, L'td.) is situated at New London, 9 miles northwest of Albemarle. The property comprises about 1200 acres. It is now in litigation. The country slates resemble those of the Monroe type (see p. 16); they are intruded by successive flows of greenstone porphyry and more basic eruptives, in part brecciated. The mine shafts have disclosed at least two volcanic sheets, from 2 to 3 feet thick each, lying horizontally and separated by sedimentary slates. In places the greenstone is squeezed into nearly vertical schistose masses. The country is intersected by numberless quartz-stringers and several larger quartz-veins, which are auriferous. The principal work at the Parker consisted of hydraulicking (see Plate IV) in several old gravel channels, which are stated to have yielded over $200,000. The gold was coarse, usually in nuggets from a few pennyweights up to 3 pounds. The fineness of the gold is 950 to 970.

The value of the gravel is stated to vary from 44 cents to $2.40 per cubic yard.

In one of the hydraulic cuts the bed-rock underlying the grit was decomposed greenstone. Test-pits have shown that this bed-rock is but

HYDRAULIC MINING, PARKER MINE, STANLY COUNTY, N. C.

STAND-PIPE, PARKER MINE.

SLUICES, PARKER MINE, STANLY COUNTY, N. C.

a sheet of greenstone about 3 feet thick, and that it is underlain by another auriferous gravel deposit, which may be considered virgin ground, as no attempt has yet been made to work it. There would be no great difficulty in getting a sluice on the bed-rock beneath this lower grit, with sufficient fall to carry off the tailings.

The hydraulicking plant is very extensive. It consists of a Worthington compound duplex condensing pump, with two 100 H. P. boilers (using 7 cords of wood per day, at $1 per cord), situated on the Yadkin river, 4¼ miles from the stand-pipe at the mine, and 340 feet below the same. The pipe-line on the lower lift is 20 inches in diameter, flange-riveted, made of $\frac{3}{16}$-inch steel; on the upper lift is a similar steel pipe 12 inches in diameter. Expansion-joints are placed every quarter of a mile, and the full length of sleeve (8 inches) is necessary to take up the maximum expansion and contraction of the pipe caused by changes of temperature. The capacity of the pump is 1,500,000 gallons in 12 hours; the head furnished from the top of the stand-pipe to the mine-workings is about 90 feet. (Plate V.)

Besides the gravel channels at the Parker, the saprolites are, in general, auriferous; and a combination sluicing and milling process (Dahlonega method, see p. 107) was at one time attempted here. The bank was undercut with powder and the shattered mass moved with the giants. The material ran about 50 cents a ton in the mill; but only a small percentage of it was quartz, and an attempt to select the latter proved unsuccessful. The tailings in the mill were reasonably low; but the loss of fine gold in the overflow from the mill-tank, in connection with the exhaustion of the richer available saprolites, led to the abandonment of the process.

The mill is a 10-stamp one, built by the Mecklenburg Iron Works of Charlotte, N. C. The weight of the stamps is 650 pounds. In the Dahlonega practice 4 drops were given 80 times per minute, and round punched screens were used; there were no inside plates. About 50 per cent. of the gold was saved in the mortars between the dies. The total cost of milling (including 1 cord of wood at $1), with 1 hand on each shift at $1, was $4 per 24 hours.

The last work done at the Parker (fall and winter of 1895) was that of prospecting some of the larger quartz-veins on the property. The Ross shaft was sunk to a depth of 130 feet and a vein was opened by a crosscut, showing sulphurets of iron and copper in white quartz, which gave assay values ranging from $3 to $12 per ton. The same vein had been exposed in a 130-foot shaft to the west of the Ross, where assays of the quartz showed values of $3 at the 85-foot and $7 at the 130-foot level.

The dimensions of the Ross shaft are 5 feet 6 inches by 11 feet inside

measurements, with three compartments, the ladder-way being in the center. The timbers (10 by 12 inches, white oak) are placed in square sets, with 5 feet centers. The cost of timber is $7 per thousand. The cost of the shaft (including timbering) was estimated at $10 per foot for the first hundred feet, $12 for the next hundred, and $15 for the last fifty feet.

Cost of labor:

Mine foreman (who also does the framing)	12-hr. shift,	$1.50
Helper to same	" "	1.00
Blacksmith	10-hr. "	1.00
Underground men	12-hr. shift,	75 to 85 cents.

The CROWELL mine is situated near the Parker. The ore-body is a pyritic belt in the country slate, from 4 to 7 feet in thickness, with a narrow pay-streak. The strike is N. 10° W., and the dip 45° N.W. The mine has been worked to a depth of 125 feet.

The LITTLE FRITZ (formerly the Culp) mine is situated near Gladstone. Some prospecting work has lately been in progress here, and an Elspass frictional roller quartz-mill was erected.

The BARRINGER mine is situated 4 miles southeast of Gold Hill. The gold is associated with limestone, and very rich ores are stated to have been mined here.

MINES IN MOORE COUNTY.

The mines are situated in the northern and northwestern parts of the county. The Jura-trias sandstone, the eastern limit of the Carolina belt, passes in a southwesterly direction through the central part of the county, near Carthage.

The BELL mine is situated 8 miles north-northwest from Carthage. The country-rock is a garnetiferous chlorite-schist, striking N. 55° E., and dipping 75° N.W. The ore-body consists of a 4-foot belt in the schists, containing a small percentage of finely disseminated pyrite and intercalations of siliceous seams from $\frac{1}{8}$ to 4 inches in thickness. The entire vein-matter is said to run $12 a ton. It is stated that the pay-streak, 4 to 8 inches thick, lay against the foot-wall, and that about 2 feet of the material on the foot-wall side was mined and milled, yielding as much as $30 a ton. The mine has been worked to a depth of 110 feet and for a length of 800 feet.

The Grampusville mine is 3 miles southwest of the Bell.

The BURNS mine[1] is situated 11 miles west-northwest from Carthage, on Cabin creek. The country is sericitic and chloritic schist, in part silicified. The strike is N. 20° E., and the dip 55° N.W. The ore-

[1] See article by H. M. Chance, *Eng. and Min. Jour.* vol. lxi, p. 132, 1896.

bodies consist of certain belts of the country, impregnated with pyrite and quartz in lenticular stringers. The ore is mined in large open cuts, 20 to 100 feet wide and 50 feet deep. The average ore is stated to run from $2.50 to $3 per ton in free gold. In 1894 the ores were being treated in five Crawford mills by the Columbia Mining Company, but the operations did not apparently prove successful. In 1895 the Cabin Creek Mining Company built a 10-stamp mill, with bumping-tables for the concentration of the sulphurets, for the treatment of which it has been proposed to introduce the cyanide process.

The Clegg, Cagle, Bat Roost, Shields, and Brown mines are situated from ½ to 3 miles west and north of the Burns. The character of the country-rock and of the ore-bodies at these is similar to that of the Burns.

MINES IN ANSON COUNTY.

A small patch of crystalline rocks, lying on the south side of the Jura-trias sandstone, is gold-bearing. Two mines, the Hamilton (Bailey) and the Jesse Cox, are situated about 2 miles southwest of Wadesboro. They are not working at present.

MINES IN ROWAN COUNTY.

The mines are located in the southeastern portion of the county in three general groups:

1. In a line extending from 2 to 9 miles southwest of Salisbury, and 1 to 3 miles east of the Southern Railroad, including the Hartman, Yadkin, Negus, Harrison, Hill, Southern Belle, Goodman, Randleman, and Roseman mines. Not enough is known of these to admit of an intelligent description.

2. Two to seven miles east and southeast of Salisbury, in the Dunns Mt. granite area, including the Dunns Mt., New Discovery, Bullion, and Reimer mines. Of these, the Reimer is fully described on page 117, and will serve as a type for the others.

3. Nine to ten miles southeast of Salisbury in the metamorphic schists, including the Gold Hill, Dutch Creek, Gold Knob, Holtshauser, Atlas, and Bame mines.

The GOLD HILL district was at one time one of the most important mining centers in North Carolina, if not in the whole South; although at present no work of consequence is being carried on there. It is situated about 14 miles southeast of Salisbury, in the southeast corner of Rowan county, extending into Cabarrus county on the south and Stanly county on the east. The country-rocks are chloritic and argillaceous schists, striking N. 25° to 30° E. and dipping 75° to 85° N.W. A diabase dike cuts the schists near the village of Gold Hill. The char-

acter of the ore-bodies is that common to these schists elsewhere, consisting of certain belts in the schists filled with pyritic impregnations and imperfectly conformable lenticular veins and stringers of quartz. The principal part of the gold-bearing zone is 1½ miles long from northeast to southwest and ⅔ of a mile wide. There are well-defined veins in the district, among which the more prominent ones are the Randolph, Barnhardt, Honeycut, Standard, Trautman and the McMackin. Some of these, such as the Trautman and McMackin, are heavy in argentiferous galena.[1] (See fig. 4, p. 59.)

The first gold was discovered here in 1842, and it is stated that in the next 14 years the total production of the various mines was $2,000,000. In 1853 there was a population of about 2000 in the Gold Hill camp, at which time the Gold Hill Mining Company operated 5 Chilean mills and 40 to 50 rockers, working 300 hands. Between 1845 and 1850 the Randolph shaft was put down to a depth of 750 feet. This is the deepest gold-mine shaft in the South. The Randolph vein was worked in three principal lenticular ore-shoots, pitching to the northeast, and varying from 50 to 200 feet in length and from a few inches to 6 feet in width. It is stated that remarkably rich ores were obtained in those days, large quantities yielding from $100 to $500 per ton in the mill. In 1881 the Randolph shaft was unwatered to the depth of 400 feet.

The method of working the Gold Hill ores in the earlier days is described on p. 34.

According to Emmons,[2] the amount of gold produced from December, 1853, to June, 1855 (inclusive), as derived from the company's books, was $136,636.76, and the expenses were $76,429, leaving a net profit of $60,207.76 for 19 months. During the time which includes the foregoing record, however, only the ore taken from the poor pockets was worked.

It is estimated by some that up to 1874 $3,000,000 worth of free gold in the ore was produced. In 1871, Mr. Amos Howes, the owner at that time, worked 3 Chilean mills, treating 7 tons of ore per day. The total daily expenses were $95.51, or $13.64 per ton. Of 8400 tons treated by Mr. Howes he produced $200,000, or an average yield of $23.81 per ton. It is estimated that only 33 per cent. of the gold was saved by this method of amalgamation, 67 per cent. going off in the tailings.

The first stamp-mill (20 stamps) was erected in 1881. The last regular work was done in 1893 by the New Gold Hill Company, Mr. Richard Eames, manager, when the ores from the Barnhardt vein, which are high in copper, were milled in a 10-stamp mill. (See p. 60.)

[1] For more detailed description of the structure of the region see Bull. 3; *Gold Deposits of N. C.*, 1896. pp. 83-91.

[2] *Geological Report of the Midland Counties of North Carolina*, 1856. E. Emmons, pp. 160 *et seq.*

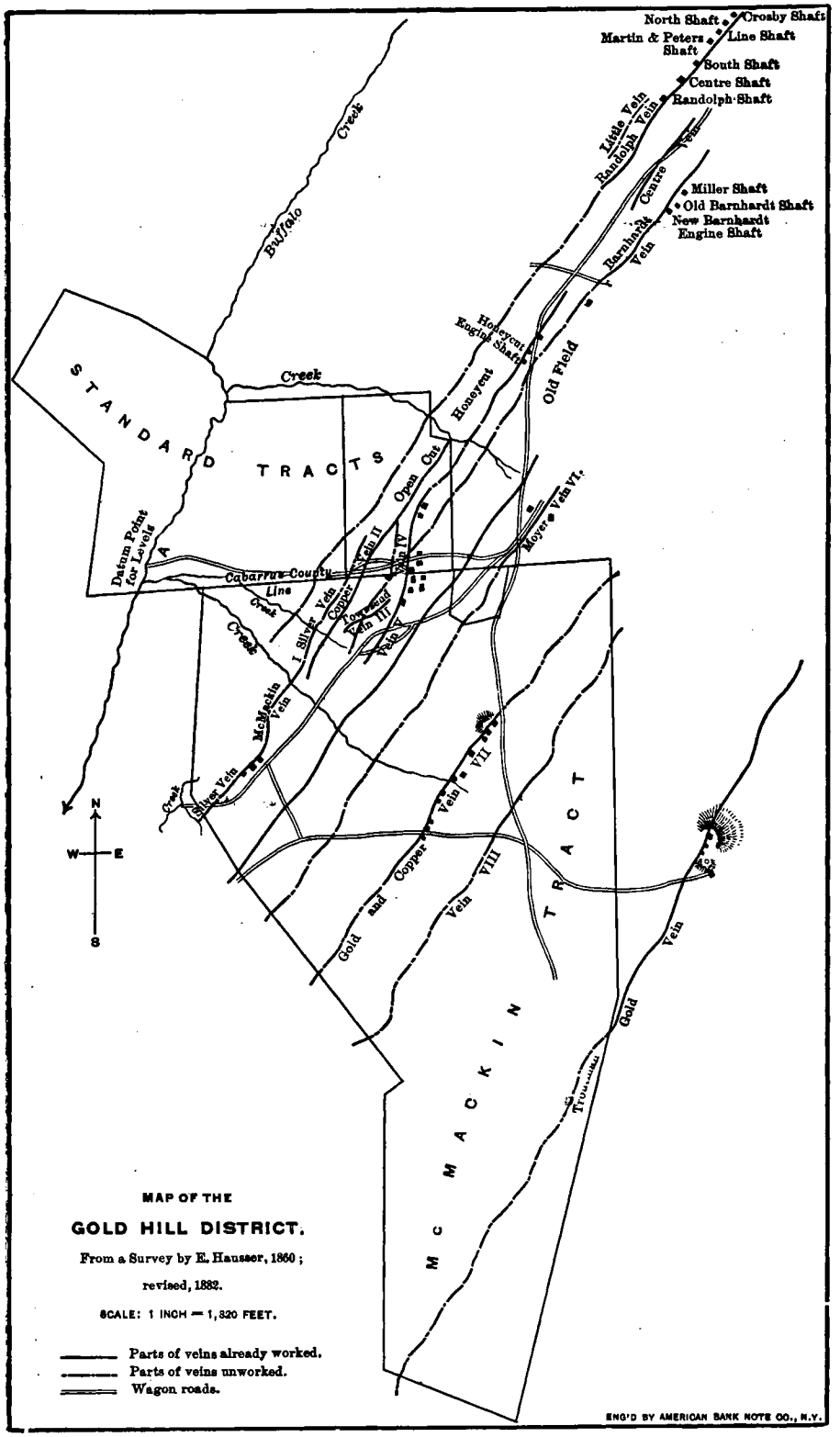


Fig. 4. Map showing distribution of the Gold Hill veins.

Mr. Eames carried on some laboratory experiments in 1892 for a cyanide treatment of the Gold Hill ores, and obtained an extraction of 60 per cent. on 100 pounds treated. During the summer of 1895 Mr. Bloomer, of London, experimented with cyanide, but with what result is not known. Chlorination of the Gold Hill ores has been advised but never carried out. No earnest attempts have been made to treat the sulphurets on a working scale. Plate VI shows the Eames stamp-mill.

For the past number of years the only work at Gold Hill has been done by tributors, who cart the decomposed material from the old mine dumps to the Barnhardt mill, receiving 50 per cent. of the yield. This material mills about $1.50 per ton. The pulp from the stamps flows directly over a line of blankets 24 inches wide, which are washed every 20 minutes in a tank; and the concentrates are treated in a series of hollowed log-rockers, 12 to 14 feet long, provided with quicksilver riffles (see Plate I, p. 30), the tailings flowing off into the creek.

At the ISENHOUR mine (Cabarrus county), 1½ miles southwest from Gold Hill, the ores from a 3-foot vein were ground (during the summer of 1895) in a Howland pulverizer of 6 tons capacity per 24 hours. The pulp was run over blankets, the washings from which were treated in rockers, as at the Barnhardt mill, with a yield of about $2 from ores that assayed from $5 to $7 per ton.

The GOLD KNOB mine is some 5 miles northwest of Gold Hill in the same general zone of schists. As many as 11 separate parallel ore-leads have been explored. Of these, the Holtshauser vein was again opened during the summer of 1895.

The DUTCH CREEK mines are in the vicinity of Gold Knob. It is stated that there are 20 veins on the property, some of which are copper-bearing. The strike of the veins is generally northeast; but there is a second system striking more northerly and intersecting the first. The more or less oxidized surface ores have been largely worked out down to the water-level, below which point the sulphurets remain practically unchanged.

The Atlas and Bame mines are on the southwest extension of the Dutch Creek veins.

MINES IN CABARRUS COUNTY.

The metamorphic schists occupy a narrow strip along the eastern edge of the county, in which are located a series of mines which might be considered an extension of the Gold Hill zone. Such are the Widenhouse, Nugget (Biggers), Eva Furr, Allen Furr, Rocky River, Buffalo, Reed and Phœnix.

The other mines of the county are situated in the granitic rocks near Concord and to the southeast and south of Concord. Such are the Joel Reed, Montgomery, Quaker City, Tucker and Pioneer Mills mines.

GOLD HILL MINE: BARNHARDT SHAFT AND EAMES STAMP-MILL.

The NUGGET (Biggers) mine is situated 12 miles southeast of Concord, near Georgeville. The principal operations during the past three years have been hydraulicking on a gravel channel, similar to that at the Crawford mine in Stanly county. The gold is coarse, usually in nuggets. Quartz-veins carrying argentiferous galena have also been superficially explored.

The ROCKY RIVER mine is 10 miles southeast of Concord. The country is chloritic schist striking N. 20° E. and dipping 70° N. W. Several lenticular quartz-veins, lying more or less with the schists, have been explored. The quartz contains pyrite, galena, blende and chalcopyrite. During 1895 Mr. Wayne Darlington, M. E., carried on some prospecting work on one of these in a shaft 130 feet deep, the total length of the drifts being about 200 feet. In the 80-foot level the quartz was 2½ to 3 feet thick; but it pinched out at 130 feet. Some of the ore was heavy in sulphurets and rich in gold. Crosscuts have exposed parallel quartz-bodies. However, it appears that no regular quartz-vein can be depended on. The more or less silicified schists enclosing the quartz are impregnated with sulphurets and intercalated with small quartz-stringers, which, taken together, will make large bodies of low-grade ores. It is in such that the possible value of the mine must be looked for.

The Buffalo mine, 1 mile northeast of the Rocky river, presents similar conditions.

The REED mine is 1½ miles southeast of the Rocky river. It is the site of the first discovery of gold in North Carolina. In 1799, a 17-pound nugget was found, and in 1803 one weighing 28 pounds. The placer ground was worked vigorously in former years and much nugget-gold taken out. The estimated yield from 1804 to 1846 is $1,000,000. During the year 1895 work at this mine was revived, but it appears to have been simply of a prospecting character and short-lived. On April 11, 1896, a nugget weighing 246.83 ounces Troy was found. It contained 120.87 ounces (10.072 pounds) fine gold, and 5.99 ounces fine silver. During the latter part of 1896 placer work was being carried on in a small way. The chloritic schists are accompanied by a large body of greenstone, intersected by numerous quartz-veins varying in thickness from 4 inches to 3 feet. Some of these are gold-bearing, and were formerly worked by a shaft 120 feet in depth.

The PHŒNIX mine is situated 7 miles southeast of Concord. The country schists are accompanied by a large mass of diabase, in which the auriferous quartz-veins are confined. The main vein is the Phœnix, which was extensively and successfully worked under the management of Captain A. Thies, now of the Haile mine, S. C. Operations ceased here about 1889. The Phœnix vein strikes N. 70° E. and dips 80°

N.W. It varies from 12 inches to 3 feet in thickness. The ore-shoot, which is 300 feet long and pitches to the northeast, has been worked out from the 100 to the 425-foot level. The shaft was sunk to 485 feet on the dip of the vein, but not drifted from. The vein in the shaft averages 30 inches; but the rich pay-streak, lying on the hanging wall, is only from 2 to 3 inches thick. It is believed, however, that if the vein were drifted on at the 425-foot level the 300-foot ore-shoot just referred to would be reached again. Another ore-shoot, the Big Sulphur, is situated 300 feet southwest of the above, and has been worked to the 180-foot level. The ore in the bottom of this shaft (the pump shaft, 213 feet deep) is stated to be 14 inches thick.

Captain Thies's work was confined to the 300-foot shoot. The ore was quartz, carrying 3 to 60 per cent. of sulphurets (pyrite, chalcopyrite and traces of galena). Barite and calcite occur in the gangue. The cost of mining was $4 per ton. Assays show from 1½ per cent. to 3 per cent. of copper. The mill yield was $10 per ton, besides which the sulphurets contained $7.50. The concentrates ran $30. Chlorination was first introduced here in 1880. This was the Mears process, later developed into the Thies process. A full description of this, with costs of working at the Phœnix mine, has been given in a paper by Dr. William B. Phillips.[1]

The mill and chlorination plants are now dismantled.

The Barrier, Furness, and Gibb mines adjoin the Phœnix. The Faggart is 3 miles to the northeast, and the Barnhardt is 1½ miles east of the Faggart.

The TUCKER (or California) mine is 1 mile south of the Phœnix. It was last worked in 1884, by a shaft 175 feet deep, and levels 117 feet in total length. The quartz-vein was 15 inches wide, and showed values of $15 per ton. In 1882 the Plattner chlorination process was introduced here; but this was later superseded by the Mears process.

The QUAKER CITY mine, which is 3 miles north of the Tucker, has not been worked for the past ten years. There are three shafts on the property, the deepest one being 80 feet. The vein is stated to be from 2 to 5 feet wide.

The Pioneer Mills group of mines is situated 13 miles south of Concord. No work has been done here since the war. The granite is accompanied by large masses of basic eruptive rocks.

MINES IN UNION COUNTY.

The mines are situated in the metamorphic slates in the western part of the county. Among the more important may be mentioned the

[1] "The Chlorination of Low-grade Auriferous Sulphides," *Trans. Am. Inst. Min. Engs.*, xvii, pp. 313-322.

Crowell, Long, Moore, Stewart, Smart, Hemby, Lewis, Phifer, Davis, Bonnie Belle, and Howie mines.

The Long, Moore, Stewart and Smart are characterized by the presence of complex sulphurets (pyrite, galena, blende and sometimes chalcopyrite). At the Moore mine the gold is associated with calcite, which exists in a pay-streak 4 inches thick on the hanging wall of a 5-foot quartz-vein.

The BONNIE BELLE (Washington) mine is situated 8 miles west of Monroe. The country is argillaceous schist silicified in varying degrees, striking N. 55° E. and dipping steeply N.W. The ore-deposit consists of pyrite and quartz impregnations in the schists. The width of the ore-bearing belt is stated to be 14 feet. It is intersected by a diabase dike. The mine was in operation during the fall of 1894. Ores assaying from $4 to $5 per ton were treated in a Chilean mill and four drag-mills, of 10 tons capacity per 24 hours; the pulp was discharged on amalgamated copper plates and thence to a Gilpin county bumping-table. The concentrates assayed $22, and the tailings 50 cents per ton.

The HOWIE mine is 1 mile southwest of the Bonnie Belle. The ore-bearing slates are said to have a total width of 400 feet, within which there are as many as 8 so-called parallel veins, varying from 18 inches to 16 feet in thickness. Sulphurets are rare, the gold occurring mainly as fine films on the cleavage planes of the more or less silicified slates. It is stated that the ore, when last mined, yielded $13 to $14 in the mill. The mine has been opened to a depth of 350 feet. Numerous diabase dikes intersect the ore-bodies, which are said to be richer in the vicinity of the dikes.

The Monroe slates in the vicinity of Monroe contain some narrow auriferous quartz-veins, but they are scarcely of economical importance, at least so far as present explorations have gone.

MINES IN MECKLENBURG COUNTY.

This has been one of the most important and active gold-mining counties of the State.

The mines are distributed over the entire county, around Charlotte as a center. Among the more important are the Davidson Hill (1 mile west of Charlotte), St. Catherine, Rudisil, Clark (2½ miles west of Charlotte), Stephen Wilson (9 miles west of Charlotte), Smith and Palmer, Howell, Parks (1 mile northeast of Charlotte), Taylor and Trotter (3 miles southwest of Charlotte), Brawley (4 miles west of Charlotte), Arlington (6 miles west of Charlotte), Capps, McGinn, Alexander (8 miles northwest of Charlotte), Dunn (7 miles northwest of Charlotte),

Henderson (7 miles northeast of Charlotte), Ferris, Tredinick (7 miles southeast of Charlotte), Ray (9 miles southeast of Charlotte), Simpson (10 miles southeast of Charlotte), and Surface Hill (10 miles east of Charlotte).

The RUDISIL mine is 1 mile south of Charlotte. In the upper part of the mine the country is a silicified, chloritic and argillaceous slate. At a depth of 200 feet this gives place to a crystalline eruptive rock. The ore-body consists of two parallel veins close together and separated by slate; they are said to vary in thickness from 2 to 6 feet. The strike is N. 30° E. and the dip 45° N.W. The mine has been worked to a maximum depth of 300 feet in three principal shoots, some of which furnished very rich though highly sulphuretted ores. The largest of these shoots had a maximum length of 100 feet and a maximum thickness of 15 feet; it pitched towards the south, and was followed down to below the 300-foot, but never found in the 350-foot level. No attempt at concentration and treatment of sulphurets was made.

The Smith and Palmer and the Howell mines are supposed to be on the southwestern extension of the Rudisil.

The ST. CATHERINE mine is on the northeastern extension of the Rudisil, and the general features are the same. The deepest workings are at the 370-foot level. It is reported that no large chimneys of solid high-grade ore were found below the 250-foot level; but between the 200 and 370 a large shoot, 4 to 60 feet wide, of low-grade ore has been worked. The ores were treated by battery amalgamation, and the sulphurets were concentrated; these were probably shipped north or elsewhere for smelting.

The CAPPS mine is 5½ miles northwest of Charlotte. There are two convergent veins, the Capps striking N. 30° W. and dipping 40° W., and the Jane striking N. 40°–60° E., and dipping steeply eastward (see Fig. 5). The actual intersection of the veins has not been found. The Capps was worked to a maximum depth of 130 feet in the Bissell shaft. The filling of the vein is quartz. Its thickness, as explored in the mine workings, was not less than 20 feet; definite walls were only found at a few points. The pay-ore was not uniformly distributed in the quartz, but generally occurred in layers. Four ore-shoots have been explored. The brown ores extend to a depth of 130 feet. The sulphurets are pyrite, with some chalcopyrite. The past production of the Capps has been estimated at over $1,250,000.

In the summer of 1895, Mr. Wilkes, the owner of the Capps, made at his test plant in Charlotte, a trial run of 50 tons of Capps ore (sulphurets) from the old dumps, and the result of this milling and chlorination test was a yield of $27 per ton.

Between January and April, 1895, four diamond drill-holes (1-inch

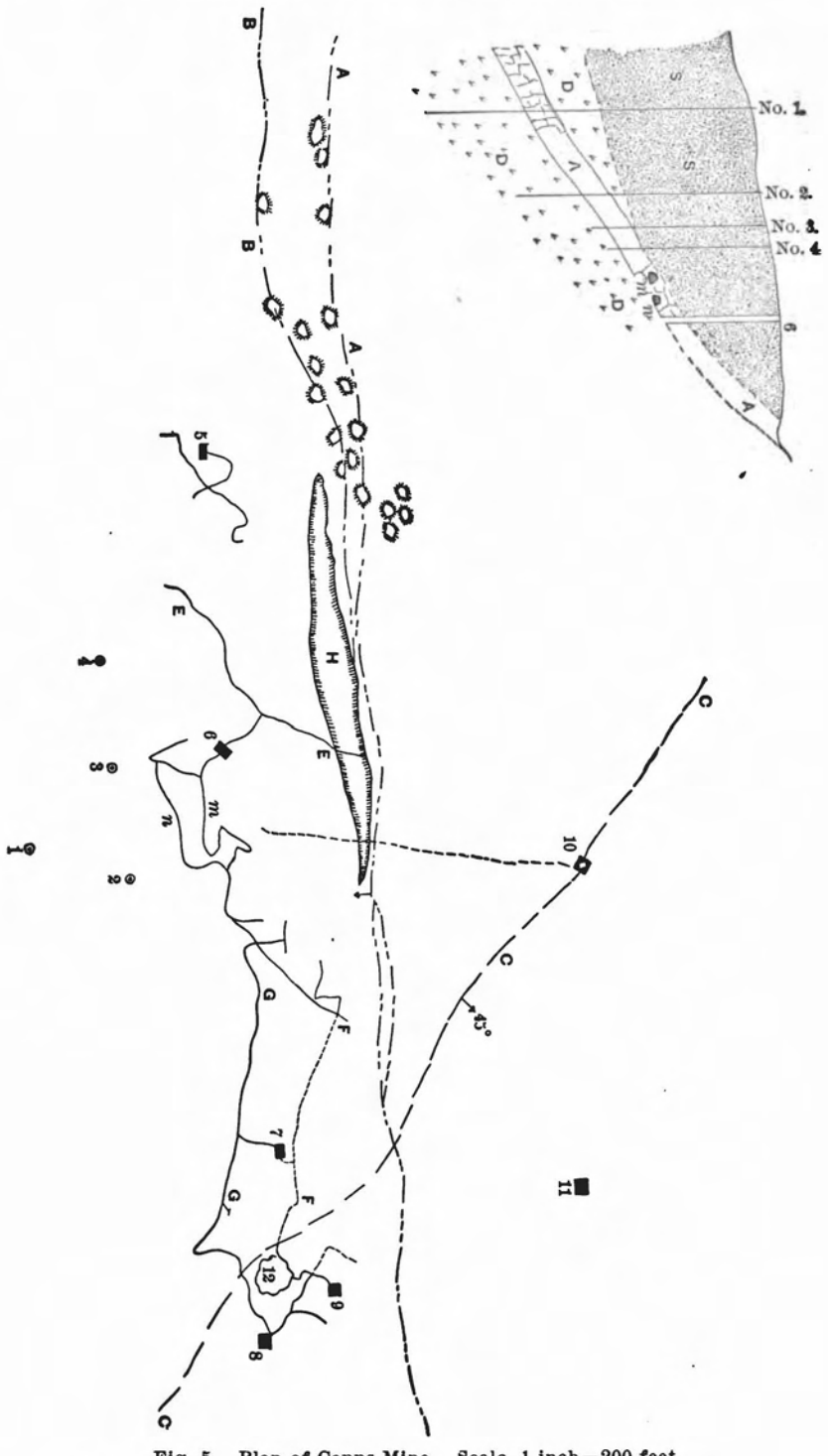


Fig. 5. Plan of Capps Mine. Scale, 1 inch=200 feet.

core) were bored on the Capps vein. Fig. 5 shows their position relative to the mine-workings in plan, as well as a vertical section of the ground which they explored.

A, Capps vein; B, parallel vein; C, Jane vein; D, diorite; E, 90-foot level; F, 78-foot level; G, 130-foot level; H, open cut; S, saprolites; m, drift; n, drift; 1, borehole, 350 feet deep; 2, borehole, 250 feet deep; 3, borehole, 220 feet deep; 4, borehole, 200 feet deep; 5, Penman shaft, 80 feet deep; 6, Bissell shaft, 125 feet deep; 7, Mauney shaft, 130 feet deep; 8, Baldwin shaft, 120 feet deep; 9, Gooch shaft, 10, Old shaft; 11, Isabella shaft, 160 feet deep.

The Capps vein was penetrated by each borehole, and showed a regular thickness of about 20 feet, with walls of fine- and coarse-grained diorite, at times porphyritic. The dip is quite constant, about 30° S.W. The vein-matter is quartz, averaging $6 to $7 per ton, as shown by assays of the drill cores. The drill-holes are certainly very satisfactory, in so far as they prove the continuity in depth, and regularity in thickness of the Capps vein; and, on a large body of ore, such as this is, the assays of the drill cores are of value as showing at least the presence of mineable ores.

The McGinn mine comprises the Jane vein, worked to a depth of 160 feet in the Isabella shaft, and a cross-vein on the northern extension of the Jane, known as the Copper vein, which has been worked to the depth of 110 feet as a copper mine.

The Ferris mine is situated 5½ miles northeast of Charlotte. The character of the vein-matter is milky quartz, carrying free gold and pyrite. It lies with the schists, striking N. 25° E. and dipping 70° N.W. The quartz is broken up into stringers, the widest solid portion being 12 inches. The vein, as a whole, is stated to vary from 2½ to 5 feet in thickness. In the fall of 1894 the mine was being worked by two shafts, respectively 56 and 95 feet deep. The ore was treated in a Chilean mill of 3 tons capacity. It is stated that the concentrates assay from $45 to $60 per ton.

MINES IN GASTON COUNTY.

Among the mines of this county are the Oliver and Farrar (12 miles northwest of Charlotte), the former being situated on the Catawba river near the "big bend," and reported to have been worked by one of the early German settlers prior to the Revolutionary war; the Rhyne and Derr (17 miles west of Charlotte), the Duffie and Robinson (16 miles west of Charlotte), the Smith and Sam Beattie (13 miles west of Charlotte), the McLean (15 miles southwest of Charlotte), the Long Creek and the Kings Mountain.

The Long Creek mine is situated in the northern part of the county,

THE THIRTY-STAMP MILL AT THE CATAWBA MINE, KING'S MOUNTAIN.

about 6 miles northwest of Dallas. The property contains 600 acres. The country-rock is chloritic schist, striking northeast and dipping 85° northwest. There are three veins lying with the schists, and consisting of lenticular quartz-bodies. The Asbury vein was 6 to 8 feet thick, and contained rich ore-shoots carrying sulphurets (pyrite, chalcopyrite, galena, blende and mispickel). A 10-stamp mill was running here in 1891, and in the following year a Crawford mill was put in, which was, however, soon abandoned, and the mine has since been practically idle.

The KINGS MOUNTAIN (Catawba) mine is situated about 1½ miles south of Kings Mountain, a station on the Southern Railroad, in the southwestern corner of the county. The country-rock is mica-schist, striking N. 50° E. and dipping 70° N.W., intercalated with lenticular masses of siliceous magnesian limestone. These rocks appear to be of sedimentary origin. The ore-bodies consist of large lenticular chimneys or shoots of this limestone, containing auriferous quartz and sulphurets (pyrite, chalcopyrite and galena up to 3 per cent.). Tellurides also occur in very small quantity. Five such lenses have been opened in the mine.

In length these lenses reach about 100 feet and in thickness 20 feet, being separated by a black graphitic slate carrying coarse pyrite, which is, however, barren. The mine has been opened to a depth of 320 feet. At the time of our visit 40 tons of ore were being raised per 24 hours by a total force of 20 men. (Cost of mine labor, 75 to 85 cents per day). The rock is very tough, and 60 per cent. dynamite is used for blasting. The mill house is equipped with a well-constructed 30-stamp mill built by the Mecklenburg Iron Works, of Charlotte (Plate VII), and 5 Frue vanners (6x14 feet). Weight of stamp, 750 pounds. Twenty stamps were dropping 71 times per minute—the height of drop being 5 inches. The ore was crushed through a 40-mesh brass wire screen. The mill yield is stated to be $3 per ton, with a loss of $3 in tailings. Great difficulty was found in saving free gold, and the quicksilver gave trouble by flouring; this is ascribed to the graphitic slates which occur with the ore. The concentrates run $35 to $40. The total cost of mining and milling is $1.75. Two men are employed in the mill at $1 per day. The cost of wood is $1.35 per cord.

A plant for washing the surface brown ores and saprolites is situated at the mine, and was in successful operation until lately. It consists of 2 sets of 12-foot log-washers. The slimes flowed over amalgamated copper plates (12 feet by 5 feet), while the material carried up in the washer was screened through a ½-inch perforated revolving screen, and then through a 20-mesh brass wire revolving screen, from whence it passed over copper amalgamating plates. The coarse material was taken to the stamp-mill. A large proportion of the

gold remained in the log-washers; much was caught on the plates below the fine screens; and the smallest amount, which was all fine gold, was caught on the slime plates. Trouble was also experienced here by the flouring of the quicksilver. The bottom land lying directly to the east of the mine is being worked in shallow pits by tributors, who wash the grit and soft bed-rock slates in sluice boxes. Panning showed up very well here, and the ground might pay for hydraulic working on a large scale.

MINES IN LINCOLN, CATAWBA, DAVIE, ALEXANDER AND YADKIN COUNTIES.

Gold has been found in these counties in isolated localities; but with few exceptions no mining work of any consequence has been done.

The DIXON mine, in Yadkin county, is a new discovery (1895). The vein is reported to be several feet in thickness, of high-grade sugary quartz, containing some copper. Only prospecting work has been carried on. The developments consist of a 40-foot shaft and 140 feet of levels on the vein. A hundred tons of ore taken out had a reported value of $5 per ton.

THE SOUTH MOUNTAIN BELT.

MINES IN CALDWELL COUNTY.

The Miller, Scott Hill, Pax Hill and Baker mines are situated within a distance of 1½ miles from Johns river, and near the southwestern boundary line of the county. The mines are located in each instance in close proximity to a wide dike of olivine diabase, which strikes through the country for many miles in a direction N. 20° W.

The Miller, Scott Hill, and Pax Hill veins strike N. 50°–60° E. and dip N.W.; as far as observed they are from 8 to 12 inches in thickness.

At the Baker mine the strike of the veins is N. 35°–45° W., and the dip is 60°–70° N.E. The thickness is from 2 to 5 feet; the ores contain auriferous and argentiferous galena.

The Bee Mountain mine is about 4 miles northeast of the Baker mine, and the ores contain zinc-blende, galena and chalcopyrite.

MINES IN BURKE, MCDOWELL AND RUTHERFORD COUNTIES.

By far the greater proportion of gold coming from these counties has been won by placer mining. With few exceptions, the quartz-veins are too narrow to justify deep mining. But even in the cases where the veins are of sufficient width, mining operations have been very spasmodic and of limited extent. Placer mining on a larger scale has been carried on during the past years only at a few points. Such

are the Mills property and Hancock mines in Burke; Cane creek, Brackettown, Huntsville and Vein Mountain in McDowell, and Golden Valley in Rutherford county.

The Mills place is fully described elsewhere (p. 95), and will serve as a type for the other mines of the district. Petty mining is almost constantly in progress in the above counties, as well as in certain parts of Cleveland and Polk counties to the south.

Of the quartz-mines, those worthy of mention are the Idler, Elwood and Vein Mountain.

The IDLER (Alta or Monarch) mine is situated about 5 miles north of Rutherfordton, in Rutherford county. As many as 13 parallel quartz-veins have been explored here within a distance of ½ mile. The country is gneiss, striking about N. 60° W., and dipping 25° to 30° N.E. The veins strike N. 65° E. The vein-matter is quartz, containing sulphurets (pyrite and some chalcopyrite). The Alta vein has been explored to the depth of 105 feet; its thickness is from 10 to 22 inches; the ore is stated to yield $10 per ton. The mine has been worked in a desultory way, but is now under water.

The ELWOOD mine is 1½ miles southwest of the Idler. The character of the country and of the veins is similar to that of the Idler. The ore is reported to yield $5 in free gold. The mine was last operated in 1893.

The VEIN MOUNTAIN mine is situated in McDowell county on the Second Broad river. A series of as many as 33 parallel auriferous quartz-veins crosses Vein mountain in a belt not over ¼ of a mile wide. The principal and largest one of these is the Nichols, which has been prospected in four shafts within a distance of 1200 feet, the deepest one being 117 feet. The strike of the vein is N. 80° E., and the dip 75° N.W. Its thickness is reported to vary from a few inches to 3 feet. The quartz is mineralized with pyrite, galena, blende and chalcopyrite. The value of the ores varies from $2.50 to $70 per ton. There is a 10-stamp mill on the property, but it has never been operated on any regular output.

At BRACKETTOWN, 5 miles northeast of Vein mountain, an expensive shaft has been sunk to a depth of 126 feet, on a parallel series of several narrow (1 to 6-inch) quartz-veins, with the fallacious hope that these would come together in depth. It is needless to say that these small veins will not justify working alone unless the intervening country (gneiss) is found to contain auriferous sulphurets of sufficient richness to make large bodies of low-grade ores.

An isolated belt of gold-bearing rocks has been mentioned in Henderson county, N. C. (see p. 20). The only mine situated here is the BOYLSTON, 12 miles west of Hendersonville. The country-rocks are

fine-grained, mica- and hornblende-gneisses and schists, in part much crumpled, striking N. 20°–30° E., and dipping 35°–60° N.W. The quartz-veins coincide, more or less, with the strike of the schists. The mine has been opened by a series of shallow shafts and short drifts on one of these veins, which is from 3 to 4 feet in thickness, with a pay-streak of 1 to 3 inches on the hanging; it is accompanied, in places, by a granitic dike. The ores are reported to average about $4 per ton (assay value); sulphurets occur, chiefly pyrite and some chalcopyrite. A 10-stamp mill (in bad repair) stands on the property. It has not been in use since 1889.

MINES IN THE MOUNTAIN COUNTIES.

In the northwestern corner of North Carolina, the copper ores of some of the Ashe county mines, and some small galena-bearing veins in Watauga and Wilkes counties, are auriferous.

In the southwestern corner of the State (in Jackson, Swain, and Cherokee counties) some placer-mining operations have been carried on from time to time, notably in Georgetown valley, Jackson county, and about the headwaters and other tributaries of Valley river, in Cherokee county, but nowhere successfully on a very large scale.

Gold is also stated to occur in Macon county, and this may be a northern extension of the Georgia belt (see p. 21).

In Horse Cove, Macon county, the Ammons Branch mine has recently been explored, with the showing of a 10-inch quartz-vein, from which very rich specimens have been taken.

In the southern part of Clay county the Warne mine is situated at the northeastern extremity of a small belt of auriferous quartz-veins which extends southwesterly into Towne county, Ga. (For description see p. 84).

CHAPTER IV.

DISTRIBUTION OF GOLD MINES IN THE SOUTH APPALACHIAN REGION OTHER THAN IN NORTH CAROLINA, WITH MINING NOTES.[1]

GOLD MINES IN MARYLAND.

The gold mines are situated within the belt of crystalline rocks extending from Washington to Great Falls, on the Potomac river, in Montgomery county, and also in the central and northern part of this county. Geologically, they are included in the Virginia belt (see p. 13).

The greatest development has been in the vicinity of Great Falls, about 15 miles west of Washington. Among the principal mines in this region are the Maryland, Montgomery, Harrison (or Sawyer), Irma, Huddleston, and Allerton-Ream, situated in a belt from 7 to 8 miles in width.[2] The greatest development was during the years 1888-93, in which time the various properties were worked. Since that time operations have been carried on in a limited way at the Allerton-Ream, Harrison, Miller and Bethesda.

During the winter and early spring of 1895 a considerable amount of exploratory work was carried on at the Bethesda mine, 7 miles northwest of Washington, by the Bethesda Mining Company. Some $20,000 to $30,000 had formerly been taken from a rich chimney in a 6-foot quartz-vein at this mine. The old shaft was continued to a depth of 102 feet, and the ore-shoot found to pinch out. Assays from the lower end of the chimney ran about $4 per ton. There are no sulphurets to speak of in the ore at this depth. The country-rock (micaceous schist) is slightly auriferous in places. It is stated that large areas of the saprolites will yield 18 cents per cubic yard. Sufficient water-supply for hydraulicking or sluicing is difficult to obtain.

GOLD MINES IN VIRGINIA.

The principal gold region of this State is comprised in the Virginia belt (see p. 13). A small, isolated area of placer deposits is situated on the west side of the Blue Ridge in Montgomery and Floyd counties.

[1] Unless otherwise stated, the mines are not at present working. The values of the ores are not given on our authority; the same is true of the dimensions of the ore bodies in abandoned mines, and in such as could not be examined.

[2] The best description of these mines has been given by Mr. S. F. Emmons, in a paper entitled "Notes on the Gold-Deposits of Montgomery County, Maryland," *Trans. Am. Inst. Min. Engs.*, xviii, 1890, pp. 391 to 412.

So far as is known, none of the Virginia mines are at present working on an actively producing scale, although considerable prospecting is in progress and apparent preparations for mining are being made.

The mines of Fauquier, Stafford, Culpeper, Orange and Spottsylvania counties are grouped around the junction of the Rappahannock and Rapidan rivers in a belt some 15 miles wide.

MINES IN FAUQUIER COUNTY.

The Franklin, Wycoff and Leopold mines are situated in the southern part of the county near Morrisville.

MINES IN STAFFORD COUNTY.

The principal localities are in the western part of the county near the Rappahannock river. The EAGLE mine, situated 12 miles northwest of Fredericksburg, was worked by the Rappahannock Gold Mining Company in 1894; greatest depth, 250 feet; length of workings, 600 feet.

The MONROE mine adjoins the Eagle on the northwest, and the Lee mine is situated in the same vicinity.

The RATTLESNAKE mine adjoins the Eagle on the northwest. It was worked as a gulch placer; large amounts of nuggets are reported, weighing from ½ to 5 dwts.; some as high as 125 dwts.

MINES IN CULPEPER COUNTY.

The CULPEPER mine is situated 18 miles west of Fredericksburg on the Rapidan river. Prof. Silliman (in a report made in 1836) stated the average value of this ore to be $25 per ton, and the mining and milling expenses at $7 per ton. Other mines in the district are the Richardville and the Ellis.

The Powhatan Land and Mining Company operated a mine in this county in 1894, treating the ore in Crawford mills and a ten-stamp mill (Fraser and Chalmers' make) in connection with Frue vanners.

MINES IN SPOTTSYLVANIA COUNTY.

The oldest mines worked in this county were those operated by the United States Mining Company near the Rappahannock river in the extreme northwest corner of the county. A description of the method of milling at these mines in 1835 is given on p. 33. At that time a 2-foot vein was operated by adits and several shafts, the deepest of which was 80 feet. The value of the ore is given in this early report at $25 per ton, and the cost of milling at 80 cents per ton. Other old mines near this property are the Marshall and the Gardiner.

In the central portion of the county there is a group of mines, most prominent among which is the Whitehall,[1] which was in active operation as late as 1884. Other properties in this group are the Kiggins, Johnston, Pullian and Grindstone Hill mines.

Still farther south are the Mitchell and the Goodwin mines. They are located on Pigeon run, along which considerable placer-work was done in the earlier days. Both have been worked within the past twelve years, but no paying vein was developed.

MINES IN ORANGE COUNTY.

The gold mines of this county are situated in the northeast corner near the Rapidan river. The most prominent one among them is the Vaucluse, which was discovered and opened in 1832. A description of the milling practice at this mine in 1847 is given on p. 34. Other mines in the vicinity are the Orange Grove, Greenwood and Melville.

MINES IN LOUISA COUNTY.

The gold-bearing rocks traverse the central portion of the county in a southwesterly direction, forming a narrow belt but a few miles in width. In this belt, near the centre of the county, and from 2 to 6 miles northeast of Mineral City (Tolersville), are the LOUISA COUNTY PYRITE MINES. These large bodies of sulphurets, occurring in lenses with a maximum thickness of 60 feet, and developed to a depth of over 600 feet, are probably of contemporaneous origin with the gold-veins. They show the same strike (N. 30° E.), dip (60° S.E.) and pitch of shoots or ore lenses (45° N.E.) as the quartz-veins in the vicinity. Traces of gold are found in the pyrite deposits, and small gold-bearing quartz-veins have been encountered in the mines. We quote from a letter written by Mr. W. H. Adams, manager of the Arminius Pyrite Mines, Mineral City, to whose kindness we are much indebted:

"It is true that in the pyrite vein, as now opened, there are traces of gold and silver, but I do not think the average so high as $1.00 per ton, and have found that gold carries only in certain lines, and that nearly all the vein matter is barren. There are, in all of the properties, easily traceable quartz-veins in the hanging- and foot-slates, which are gold-bearing to the extent of $4.00 to $15.00 per ton, but these veins are always narrow—about as you saw them in our No. 3 shaft (3 to 7 inches). They are, however, persistent, and I have no doubt that chimneys are to be found at points of contact of the veins and dikes, which chimneys will be found to be the source of much of the gold so prevalent in the streams of the neighborhood."

The scope of this report will not permit a detailed description of these interesting pyrite deposits or the methods of mining and concentration

[1] See *Am. Jour. Sci.*, i, xxxii, 1837, p. 101.

pursued here.[1] It may, however, be of value to give the cost of labor at these mines, as this would apply equally to auriferous mining. The daily wages paid are:

Carpenters	$1.25 to $1.75
Engineers	1.40
Blacksmiths	1.30 to 1.75
Drill-runners	1.35
Helpers	1.20
General labor (under ground)	1.00
" " (above ground)	0.90 to 1.00

The TINDER FLATS placer deposits[2] are situated at the northern end of the pyrite bodies on both banks of North Contrary creek.

This bottom was perhaps the best known and most productive source of placer-gold in the early days of Virginia gold-mining.

At present the problem is one of reworking shallow placer bottoms on a large scale, and at the time of our visit in 1895, Mr. W. H. Case, of Charlotte, N. C., was testing the ground with this object in view. Water under natural head cannot be obtained here, the surrounding country being a but slightly indented pene-plain it would probably have to be pumped from the North Anna river.

One-half mile southwest of the Arminius pyrite mine, on the same line of strike, is the WALTON gold mine. This mine has produced some very rich ore from a shoot or chimney developed to a depth of 150 feet. The property has been tied up in litigation for the past twelve years.

Near Mineral City (Tolersville) a vein, known as the FISHER LODE, striking parallel to the pyrite veins and about 2 miles to the east of them, has been opened by the Harris, Luce, Slate Hill, Louisa and Warren Hill mines. Two of these, the Luce and Slate Hill, were in operation at the time of our visit.

The LUCE mine had been developed to a depth of 200 feet, and the total length of drifting on the vein is over 1000 feet. The thickness of this vein is from 3 to 8 feet. The mine is equipped with a 20-stamp, hand-feed mill (Fraser and Chalmers' build).

The SLATE HILL mine was first opened in 1850, and for a time was extensively worked. It is the southwest extension of the Luce, which formerly constituted a portion of the property. Two veins are developed to a depth of 150 feet. In a report made in 1853, the average value of the ore is given at $4 per ton, and the cost of mining and milling at $1.40 per ton. The present company began operations in March, 1895. A Huntington mill has been erected, and the mine was being developed in the lower levels at the time of our visit.

[1] For a description of the deposits, see "Origin of the Iron Pyrites Deposits in Louisa County, Virginia," by Frank L. Nason; *Eng. and Min. Jour.*, lvii, 1894, pp. 414-16.

[2] See *Am. Jour. Sci.*, I, xxxii, 1837, pp. 101, 110.

MINES IN FLUVANNA AND GOOCHLAND COUNTIES.[1]

The same narrow belts traverse the boundary of Goochland and Fluvanna counties, crossing the James river at Bremo Bluffs into Buckingham county. No work but petty placer-mining and more or less active prospecting is carried on in these counties at present, although from 1830 to 1860 this region was the field of extensive operations.

Among the well known properties are the Tellurium, the Bowles, the Payne, the Page, the Hughes, the Moss, the Fisher, the Busby, the Tagus, the Gilmore, the Collins, Marks, Eades, Big Bird and the Belzora.

The TELLURIUM mine, embracing a property of 644 acres, lies partly in Fluvanna and partly in Goochland county, 6 miles from Columbia, and is at present owned by the Columbia Gold Mining Company. It was discovered in 1834 by George Fisher, and is reported to have yielded $1,000,000 during its various periods of activity. It was last operated in 1886. Three principal parallel veins, the "Sandstone," "Middle" and "Little," traverse the property in a southwesterly direction for a distance of about half a mile. None of the workings have extended below a depth of 60 feet.

The BOWLES mine adjoins the Tellurium, and the Payne mine is in the same vicinity.

Lying partly in Fluvanna and partly in Goochland county, and within ½ mile of the Tellurium and Bowles mines are the Fisher, the Moss and the Busby mines, all on the same lode.

The FISHER mine was opened in 1860 by James Fisher. The main developments consist of a 40-foot shaft with 175 feet of levels. The vein is narrow, from 3 to 15 inches, and the ore is stated to carry from $25 to $300 per ton.

The Moss mine is one mile northeast of the Fisher. It was discovered in 1835 by John Moss. It has been worked to a depth of 65 feet, and the vein, which is 2 feet wide in places, carries reported values of $15 to $65 per ton.

The BUSBY mine is one-half mile northeast of the Moss. Prof. Silliman, in an early report, gives ore values of $160 per ton from here. The work has been altogether of a superficial nature.

The PAGE mine is situated ½ mile west of Wilmington on Long Island creek in Fluvanna county. Work was begun on the quartz-veins in 1856, when an 8-stamp mill was erected. Considerable prospecting work has been carried on lately.

The HUGHES mine is 5 miles from Bremo Bluffs in Fluvanna county.

[1] We beg to acknowledge our indebtedness to Messrs. Wm. Bugbee and Scott Thurston of Palmyra, Va., for information concerning the mines of these counties.

It was opened in 1836. The last work was done about 4 years ago, when a 60-foot shaft was sunk, but without encouraging results.

The BELZORA mine is 7 miles from Columbia in Goochland county. It was discovered in 1832, and was worked by surface washing until 1849, and after that the veins were opened. The Marks, Collins, Eades and Big Bird mines adjoin the Belzora.

MINES IN BUCKINGHAM COUNTY.

This is the most southwesterly county of the Virginia gold belt in which mines have been actively operated. The occurrence of gold has, however, been reported still farther to the southwest, in Appomattox, Prince Edwards, Charlotte, and Halifax counties.

The BOOKER mine, near Whitehall Station, was worked prior to 1860 by an English company. The deepest shaft is 110 feet. The ore was crushed in a Howland mill and yielded $13 per ton.

Another English company operated the London mine, seven miles north of the Booker, for a number of years. Other mines of equal importance in their day are the Garnett and Mosely (3 miles west of Willis mountain), the Buckingham, the Morton, the Morrow, the Duncan, the Ford, and the Lightfoot.

MINES IN FLOYD AND MONTGOMERY COUNTIES.

A small placer-mining field was opened here (on the west side of the Blue Ridge) in 1879, along Brush and Laurel creeks and other small streams running from Pilot mountain. The area embraces about 80 square miles.

The Walters and Gardner mine in Montgomery county was operated in 1893.

Gold also occurs it Patrick, Carroll and Grayson counties, but probably only to a very limited extent, associated with copper ores.

GOLD MINES IN SOUTH CAROLINA.

The present gold output of South Carolina is derived almost entirely from the Haile mine.

To show the extent and distribution of the gold-mining industry in South Carolina before the war, the following table comprising the working mines in 1859 is given:[1]

Chesterfield and Lancaster counties	21	working	mines.
Spartanburg, Union and York counties	19	"	"
Abbeville and Edgefield counties	10	"	"
Greenville and Pickens counties	8	"	placers.
Total in State	58		

[1] *South Carolina. Resources, etc.*, published by the State Board of Agriculture, Charleston, 1883, p. 134.

Some of these were probably minor operations, as Lieber[1] in his reports, made a few years earlier, complained of the lack of interest taken in the South Carolina gold mines.

CAROLINA BELT.

CHESTERFIELD COUNTY.—The Brewer mine is the main point of interest in this county. It is fully described on p. 144.

In the same neighborhood are the old Kirkley, Leach and McInnis mines. Some gravel mining has been done near the northern boundary of this county.

LANCASTER COUNTY.—The Haile mine is fully described on p. 125. The Funderburk, 8 miles northeast of the Haile, and of the same character, was worked as late as 1887. The Clyburne property is situated 1½ miles southwest of the Haile. Some tributing is done here with rockers, on saprolite and gulch deposits. Adjoining this on the southwest is the Gay mine, which shows ore-bodies of the Haile type, but is little developed. The most southerly occurrence of gold in this district is at the Williams mine, 7 miles southwest of the Haile.

YORK COUNTY.—There is no active work at present in this county. Among the older mines of this district are the Wilson, Wallace and Palmetto.

UNION COUNTY.—About 3 miles south of Glen Springs are the West and the Thomson mines. Mr. Becker describes the veins as quartz lenses similar to the Dahlonega type, interlaminated with mica- and hornblende-schists. The Thomson mine was operated during the summer of 1895 on a small scale by the Dahlonega method of mining and milling.

ABBEVILLE AND EDGEFIELD COUNTIES.—Little information could be obtained regarding the mines of this district. The deposits are probably closely connected with, and of the same nature as those in McDuffie, Warren and Columbia counties, Ga. The Dorn mine, situated at the lower end of the Abbeville district, was opened in 1852. In the first year of its operation over $300,000 are said to have been taken from a rich pocket in this mine; a yield of $100 per ton was considered a poor one. The rich pockets were, however, soon exhausted; and the mine was abandoned until 1866, when it was reworked for a short time with some success, as reported.

SOUTH MOUNTAIN BELT.

SPARTANBURG, GREENVILLE AND PICKENS COUNTIES.—The gold district in these three Piedmont counties is probably a continuation of the

[1] For a full discussion of the occurrence of gold and a description of the older mines in South Carolina, see Tuomey (M.), *Report on the Geology of South Carolina*, 1848; and Lieber (O. M.), *Reports on the Survey of S. C.*, 1856, 1857, 1858 and 1859.

South Mountain belt in North Carolina (page 68), and, as in that district, the gold produced has been obtained almost entirely from placer-deposits. The present operations are purely of a desultory character. Among the more extensive deposits might be mentioned those of Wolfe creek and Tiger river, located on the boundary between Spartanburg and Greenville counties at the foot of Hogback mountain. The gold in these bottoms is derived from small quartz-veins having the same strike and dip, and being in other respects similar to those of the South Mountain district in North Carolina. The gravel in the bottom is from a few inches to 5 feet in thickness. It consists of white, saccharoidal and glassy, barren quartz. In 1892 the Wolfe creek bottom was worked by the Wolfe and Tiger Mining Company, with a 2-inch nozzle giant, supplied with 45 feet head of water by a 4-mile ditch.

Other mining properties in this vicinity are the Hammett, Knott, Golden Gate, Thompson, Hale and West Springs.

GOLD MINES IN GEORGIA.[1]

MINES IN RABUN COUNTY.

Some work has been done at the Smith mine near Burton, and at the Moore Girls' mine, 12 miles northwest of Clayton.

MINES IN HABERSHAM COUNTY.

Practically no work of importance has been done in this county, excepting perhaps some development work a few miles northeast of Clarkesville.

MINES IN WHITE COUNTY.

The chief mining district is located in the picturesque Nacoochee valley and its vicinity. Among the many Indian traditions of this neighborhood is that of extensive gold mining by the aborigines, but absolute proof of this is wanting.

The LUMSDEN mine is situated about 2 miles north of the Nacoochee valley on Bean creek. Several rich quartz-stringers were being worked in 1895 by tributors, using a combination of hydraulic and dry mining, the hard ore being hauled ¼ mile to a wooden 10-stamp mill, driven by a 20-foot over-shot water-wheel. Five hands are stated to extract 70 to 80 dwts. per week by this crude method.

The JARRET mine adjoins the Lumsden on the south; a 20-stamp-mill was operated here for some time by Mr. Childs, of Athens, Ga.,

[1] For a more complete statement concerning gold mines and mining in Georgia see *Bulletin No. 2 of the Georgia Geological Survey, Atlanta, Ga.*

using the Dahlonega method of sluicing and milling (see p. 107). It has been idle for the past eight or nine years.

The Yonah Land and Mining Company controls some 4800 acres of mining property situated mainly along the watershed of Dukes creek. This property is a consolidation of what was formerly known as the TONTON, the MERCER and the BUTT mines. The company has pursued extensive vein explorations on their land under the direction of Mr. E. T. Whatley. This prospecting work has disclosed a large number of auriferous quartz-veins, which have a general strike of N. 20° E. and a dip of about 85° S.E., while the dip of the country-rock is steeply to the N.W. Although of low grade ($3 to $7 per ton) and of small width (6 inches to 3 feet), some of these veins might, under close management, be mined and milled at a profit. The producing operations of this company are confined to placer work with hydraulic elevator in the bottom land of Dukes creek. The elevator used and the method of work in the pits is similar to that employed by the Chestatee Company (see p. 101). A 65-foot head of water is obtained from a 7-mile ditch line. The gravel bed averages about 3 feet in thickness, covered by 6 inches of peat and clay, and above this about 6 feet of soil overlay. The gold consists, to a large extent, of extremely rounded and waterworn nuggets, often aggregated in pockets, from one of which $1500 is reported to have been taken in one day.

The LOUD mine, situated near Pleasant Retreat P. O., and about 11 miles east of Dahlonega, is one of the famous placers of the district, and has produced a large amount of remarkably well crystallized and wiry nugget gold. It has been known as one of the most extensive and richest deposits in the Southern States. For the past few years the work has been confined to hydraulicking old gravel piles. Water, under a 75-foot head, is leased from the Hand-Barlow Company of Dahlonega and is supplied by a ditch 25 miles in length. Extensive cuts in the saprolites have been made here.

Other properties of importance in White county are the Longstreet placer, 2½ miles northwest of Cleveland, the Nacoochee Hills Gold Mining Company, the Martin Mining Company, the St. George property (also known as the Dean Mine), the Plattsburg (or Chattahoochee) Gold Mining and Milling Company, etc.

Besides these there are quite a number of petty operators, some washing gravel in sluice boxes, others mining rich, narrow seams in the saprolite and "beating" the ore in wooden stamp-mills, as, for instance, at the Thompson mine near the Yonah Land Company's property, where the mining operations were formerly carried on by a mother and son, the latter digging the quartz and carrying it on his back to the mill, while his mother attended to the beating.

MINES IN HALL COUNTY.

But little active work has been in progress for a number of years. The principal properties are the Potosi, 12 miles northeast of Gainesville, the Currahee, 6 miles northeast of Gainesville, the Elrod, the Merrick, the Mammoth and the Glades. The Currahee mine is equipped with a 20-stamp mill and a roasting furnace. The ore is quartz, containing pyrite and galena. A set of rolls and a cyanide plant are now being erected at this mine.

MINES IN LUMPKIN COUNTY.

The principal mining operations are in the vicinity of DAHLONEGA, extending from the Yahoola river, about 1 mile northeast of the town, in a continuous belt nearly 4 miles in width to the mining village of Auraria (Kunckelsville), a total length of about 6 miles. A general description of this belt and the method of mining and milling (which bears the name of the Dahlonega or Georgia method) pursued here is given on page 107.

This is by all means the most important mining district in Georgia. In 1838 a United States mint was established in Dahlonega, which continued in active operation until 1861, during which time $6,106,569 were coined. The nearest railroad point to Dahlonega is Gainesville (Southern R. R.), 20 miles to the southeast. A connecting branch between these two points is looked for in the near future, and will greatly benefit the mining interests of the district.

The following is a list of the prominent mines and their crushing equipment: Mary Henry (or Murray) (5 stamps); Hand (20 stamps); Singleton (10 stamps); Yahoola (20 stamps); Stanley (10 stamps); Findley (40 stamps); Preacher (10 stamps); Hedwig (40 stamps); Josephine (20 stamps); Lockhart (20 stamps); Barlow (40 stamps); Ralston (20 stamps); Turkey Hill (10 stamps); Woodward (5 stamps); Ivy (60 stamps); Calhoun (40 stamps); Garnet (20 stamps); Bigley (20 stamps); Fish Trap (20 stamps); Bast (10 stamps); Siloam (10 stamps); Lawrence (10 stamps); Horner (5 stamps); Betz (1 Huntington mill). In the summer and fall of 1896 240 stamps were being operated at the Findley, Hand, Yahoola, Murray, Lockhart, Singleton, Woodward, Preacher, Turkey Hill, Ralston, Barlow and Hedwig mines.

Of late years more attention is being paid to the deep-mining of hard ore in distinction to the usual method in this district of sluicing the soft saprolites. Thus, at the Lockhart mine, quartz from underground stopes is treated in a 20-stamp mill (for description of which see p. 115).

The special operations of the Chestatee Company, and of the dredge boats on the Chestatee river, are described on pages 101, 106.

Among the mines of this district there are some that are operated by lessees, and in those cases the usual royalty is 25 per cent. for properties on which a mill and water-power are furnished, and 10 per cent. where these are absent.

MINES IN DAWSON COUNTY.

At present no active work of any prominence is prosecuted. Among the mines formerly extensively operated by the Dahlonega method may be mentioned the Cincinnati Consolidated, the Etowah, the Kin-Mori and the McGuire, all situated in the vicinity of Dawsonville, the county seat.

At the Kin-Mori a ditch 34 miles in length, delivering 600 to 700 inches at a pressure of 286 feet, was completed in 1883, and placer-mining on an extensive scale was carried on in connection with a Hendy gravel elevator. A 30-stamp mill was erected during the winter of 1884-85. The mine has been idle since 1888.

MINES IN FORSYTHE COUNTY.

No mines of importance have been developed, the gold output having been derived almost solely from small placer-diggings. The Dr. Charles property, which is 6 miles southwest of Dawsonville, and not far from the Cherokee county line, has been prospected to some extent. The quartz-veins carry arsenical pyrites from the grass roots down, and very little ordinary pyrites. There is a 10-stamp mill at this mine.

Other properties that might warrant attention are the Little, Settles, Collins, Sawnee Mt., Parks, and Fowler.

MINES IN GWINNETT COUNTY.

The Piedmont mine, 2 miles northeast of Buford, has been worked in a small way until recently. The vein-quartz carries pyrite, galena, and free gold.

The Shelby mine is 4 miles west of Buford. It is equipped with a 5-stamp mill. The quartz-vein is 2 feet in width, and is stated to carry values approximating $6 per ton. The Simmons property adjoins the Shelby on the east.

MINES IN CHEROKEE COUNTY.

At Creighton, near the eastern boundary of this county, is located the Creighton (Franklin) mine, which, together with the Haile mine of South Carolina, and some smaller mines in North Carolina, shows the brighter side of Southern gold-mining. It is a continuously and systematically worked, dividend-paying property (for description

see p. 121). Stimulated by the success of this mine, developments are being pushed on several other properties in this county, mainly along the approximate strike of the Franklin vein. The properties extend from a point about 3 miles north of the Creighton, in a more or less continuous line to the Sixes, Wilkinson, Cherokee (10 stamps), Georgiana, Cox and Worley mines in the southwestern portion of the county. Near the center of this belt, south of the Creighton, the Chester (formerly Latham) and the Strickland properties have been prospected.

MINES IN BARTON, COBB, PAULDING AND DOUGLAS COUNTIES.

The same auriferous belt, described above as occurring in Cherokee county, extends through a portion of Barton, Cobb and Paulding counties. In the latter county a high-grade quartz-vein has been opened up in the Yorkville mines.

In Douglas county, lenses of auriferous quartz have been explored to some extent in former years, but no active mining is carried on at present.

The MINERAL HILL mine in this county has been developed by a double-compartment shaft 120 feet in depth, sunk on the vein. At the 80-foot level the width of the ore-body is estimated to be 15 feet. The ore is rich in sulphurets (pyrite and chalcopyrite), and is stated to have an average value of $8 per ton.

MINES IN CARROLL COUNTY.

The principal mining district is in the vicinity of Villa Rica, where prospecting and development work has been quite active during recent years. The principal properties are the Clopton mine, operated by the Boston Kennesaw Mining Company; the Mineral Farm mine, 3½ miles northwest from Villa Rica; the Pine Mountain mine, operated by the Southern States Exploration and Financial Syndicate, L't'd.

MINES IN HARALSON COUNTY.

Several mines have been opened in the southwestern portion of this county, lying in the belt which, to the southwest, is more extensively developed near Arbacoochee, Ala. The most important of these is the ROYAL (formerly known as the Camille) mine, 2½ miles southwest of Tallapoosa.

In past years the soft, semi-crystalline slates were sluiced, the loose free gold saved in the sluice boxes, the quartz milled, and the gold saved by amalgamation. In the washed-off portion, hundreds of quartz-stringers, from the size of a knife blade to 5, 6 and more feet in thickness, can be seen striking almost due east and west.

In 1887 a large amount of money was spent in developing the mine and in erecting a 20-stamp mill (Fraser and Chalmers), with 8 Frue vanners. A double-compartment inclined shaft was sunk to a depth of 186 feet. The ore was milled at the rate of 4 tons per stamp head. But little free gold was saved, the loss in the sulphurets being great, and after a short run the work was abandoned as unprofitable.

In December, 1895, Capt. A. Thies, of the Haile mine, S. C., made a thorough examination of this property, which resulted in reworking the mine and the erection of a chlorination plant.

The outcrop of the main vein, on which the 186-foot shaft is sunk, is exposed for 600 feet west of the shaft. The width of the ore-body is stated to be 6 feet. The ore in sight stands practically from the 186-foot level to the surface, and is developed by east and west drifts.

Later, a three-compartment vertical shaft was located south of the inclined shaft and sunk to a depth of 118 feet. It cut the ore-body at 105 feet and had not passed through it at 118. The ore is hard, white quartz, heavily sulphuretted.

In the original exploratory work done by Capt. Thies, 8 tons of ore, including a large amount of hanging wall slates broken from the east drift of the inclined shaft, were milled and yielded 55 dwts. free gold and ½ ton of concentrates. Later, 143 tons of ore from the east drift of the same shaft were milled, realizing 500 dwts. free gold, and 7 tons of concentrates, assaying $602 per ton. The percentage of sulphurets (iron pyrites) in the ore varies from 5 to 7 per cent.

There are over 2 acres of old tailing dumps, 8 feet deep, which material assays from $7 to $8 per ton.

Towards the end of 1896, the mill was increased to 40 stamps with 10 Frue vanners, and a 5-foot Huntington mill, with 2 Triumph concentrators were added. The milling capacity is 1¼ tons per stamp per day, and 12 tons per day in the Huntington mill.

Besides the above equipment, 2 reverberatory roasting furnaces, 50 x 9 feet hearth, and a chlorination plant with two 2-ton barrels, filters, etc., were built.

MINES IN MERIWEATHER COUNTY.

The only mine of importance is the WILKES, situated in the extreme northwest corner of the county. It is stated to have produced $50,000 from 1873 to 1878, during which years the vein (composed of quartz lenses 8 to 10 inches thick) was mined to a depth of 130 feet. The ore, consisting of quartz, with about 3 feet of the adjoining wall-rock, mills about $4 per ton.

In the spring of 1895 the mine was opened and operations conducted on a limited scale by Mr. John Cross.

MINES IN TOWNE COUNTY.

A zone of ore-bearing schists about 3 miles in length extends across the State line into Clay county, N. C. (see p. 70).

The WARNE mine, in Clay county, N. C., is situated on Brasstown creek, about 8 miles southwest of Haysville and not more than ¼ mile north of the Georgia line.

The developments consist of a 60-foot shaft, at the bottom of which the quartz-vein is stated to be 2 feet in width. There are no underground workings of consequence. The property is equipped with a 10-stamp mill driven by a turbine wheel with a 20-foot water-fall.

The OLD FIELD mine, in Towne county, Ga., adjoins the Warne on the southwest. Considerable exploratory work has been done, and a number of quartz-veins located. There appears to be a good opportunity here for hydraulicking the saprolitic material over a considerable area; with a ditch line 2 miles in length a head of 160 feet can be attained.

The NANCY BROWN mine adjoins the Old Field on the southwest, beyond which lies the HUNT mine property, where the main developments consist of a shaft 45 feet deep, and a tunnel 60 feet long. In the former, the vein, which is composed of vitreous quartz, is stated to vary from 18 to 36 inches in width, and various assays have shown values ranging from $10 to $17. In the tunnel the quartz-vein, which strikes nearly east and west and stands vertically, has a thickness of from 12 to 15 inches, which has given reported mill-test values of $13. The country is mica-gneiss and -schist, striking N. 70° W. These rocks are filled with quartz-stringers or veinlets, and in general the district is not unlike that of the Dahlonega region in Lumpkin county.

The JACK BROWN property adjoins the Hunt on the southwest. The main prospect is an 8-foot quartz-vein, which has a promising appearance and is stated to carry values from $9 to $125 per ton. The strike of the vein is N. 75° E., and the dip is nearly vertical.

The WELBORN HILL mine is situated about ½ mile west of the Jack Brown on a parallel zone of auriferous schists. It was last worked several years ago by two shafts respectively 125 and 70 feet deep, cutting two parallel quartz-veins respectively 36 and 30 inches wide. The strike is N. 40° E. and the dip steeply to the northwest. The property is equipped with a 10-stamp mill of the Hall type.

THE CAROLINA BELT (IN GEORGIA).

In the eastern part of the State an auriferous district, which probably represents the southwesterly extension of the Carolina belt, is developed to some extent in McDuffie, Warren, Wilkes, Lincoln, and Columbia counties.

The most prominent mine in this district is the SMITH mine, operated by Mrs. J. Belknap Smith. It is situated 14 miles northwest of Thomson in McDuffie county.

A 3-foot vein of white quartz, carrying free gold, pyrite, chalcopyrite and galena, and milling from $8 to $24 by simple amalgamation, has been developed by two shafts to a depth of 160 feet, and for a distance of about 300 feet along the strike (nearly north and south). The mill (10 stamps) is located three miles from the mine on Little river. No attempt is made to save the sulphurets, and the tailings are stated to carry as high as $12 per ton.

Other mines in this district are the Columbia, Egypt, Tatham, Williams, Warren, and Magruder.

GOLD MINES IN ALABAMA.[1]

MINES IN CLEBURNE COUNTY.

All of the more important mines of the county are located in the Arbacoochee district, situated 7 miles southeast of Heflin, the nearest railroad point. In the earlier days extensive placer mining was carried on about ¾ of a mile southwest of the mining village, Arbacoochee, principally in the Clear Creek valley. The auriferous deposit at this point covers nearly 100 acres in Sections 5, 6 and 7, T. 17, R. 11 E.

During the summer of 1895 a pocket of very rich quartz was opened up in one of the old placer pits on the boundary line between Sections 6 and 7. It is stated that between $1000 and $2000 of coarse gold was taken from about 400 pounds of ore and the immediately overlying gravel. This find created considerable local stir, and prospecting was being pushed along the strike of the quartz-vein as far as the direction could be determined from the very limited dimensions of the ore lens, the latter having a maximum width of 8 inches, a dip of about 30°, and pinching rapidly along the strike in a distance of about 6 feet. The ultimate value of this find will depend on the continuation of this shoot in length and depth, or the discovery of new ore-bodies along the strike of the veins. Prospecting along this ore-lead was still in progress during 1896.

The only hydraulic work in the State was carried on for a short time by the Arbacoochee Hydraulic Company on side-hill deposits, about ½ mile east of Arbacoochee. The limited supply of water and poor management are given as the reasons for failure.

The Anna Howe, the Anna Howe Extension, the Crutchfield and the Valdor are adjoining properties in the Arbacoochee district. These

[1] For a more complete statement concerning gold mines and mining in Alabama see *Bulletins 3 and 5 of Alabama Geological Survey*, referred to on p. 18.

mines are located on a series of narrow, irregular, lenticular quartz-veins having quite a flat dip. The Anna Howe was developed to a depth of about 100 feet when the vein pinched out and the mine was abandoned. The equipment consists of a Huntington mill and Frue vanner.

The Chulafinnee district is about 8 miles west of Arbacoochee, in Sections 14, 15, 16, 22, 23, 24, 25, T. 17, R. 9 E. As at Arbacoochee, extensive placer mining has been prosecuted here in the past, but has long since been abandoned. Recent prospecting has disclosed some rich quartz-stringers on the property of Mr. Burrell Higginbotham. The old King mine, at which a stamp mill was in operation over 20 years ago, is in the same vicinity.

The Turkey Heaven District comprises a series of mines situated along the base of the Turkey Heaven mountains. Among the more important properties are the Miller, the Crown Point, the Moss-Back, the Pritchard, the Lucky Joe, the Hicks-Wise, the Lee, the Crumpton, the Middlebrook, the Sutherland, the Bennifield, the Marion-White, and the James Moore.

The Crown Point mine is equipped with a 5-stamp mill. The Moss-Back is one of the early discoveries; it is equipped with a 10-stamp mill. The LUCKY JOE[1] is the most extensively developed mine in the district. It was opened in 1893, and a stamp-mill (Fraser and Chalmers make) erected. It is stated that the mill runs saved $2.27 a ton by amalgamation, the cost of mining and milling being $1.35 to $1.45 per ton. The capacity of the mill, using 30-mesh screens, was 30 tons per day. The pay-ore lies in chimneys and shoots from 3 to 4 feet thick, dipping about 30° eastward. The workings consist of about 300 feet of drifting and cross-cutting. Apparently the development of ore did not prove satisfactory, as the mine was abandoned during the summer of 1894.

The MOSS-BACK mine, near the Lucky Joe, was opened in the early seventies. A 10-stamp mill was erected in 1890.

The Hicks-Wise mine was developed by a vertical shaft 110 feet deep with levels at 20, 40, and 85 feet. Of 3000 tons of ore milled it is stated that a yield of $2 per ton was obtained by amalgamation. The ores are graphitic.

The LEE mine is developed by an inclined shaft sunk to a depth of 40 feet on the dip of the ore-body (45°), on which level a drift of 121 feet in length has been run in ore, which varies from 2 to 5 feet in thickness. The plant in operation in 1894 consisted of 3 arrastras and a Blake crusher. It is stated that the ore will mill $5 per ton.

The MIDDLEBROOK is opened by an inclined shaft 20 feet deep on an ore-body 5 feet in thickness. Panning tests have shown $5 per ton.

[1] For full description of this property ee *Engineering and Mining Journal*, vol. lvi, 1893, p. 79. by W. M. Brewer.

The SUTHERLAND ore-body closely resembles the Middlebrook. It has been but slightly developed to a depth of about 30 feet. An old-fashioned wooden stamp mill with iron shoes stands on the property.

The Kemp Mountain district is situated in T. 17, R. 10 E. and T. 17, R. 11 E. The two most important properties are the Eckels and the Golden Eagle. The ECKELS mine was opened in 1893 by an open-cut 8 feet deep and 50 feet long, exposing ore, thin seams of quartz in decomposed graphitic schist, the entire distance. A shaft was sunk from the floor of the open cut to a depth of 65 feet. The dip is vertical down to 36 feet, when it changes to 60° south. A cross-cut at the bottom of the shaft showed that the ore-body had narrowed down to 18 feet. In 1894 the shaft was deepened to 100 feet and the same conditions found to hold. No sytematic work of treating the ore has been done.

The GOLDEN EAGLE (formerly known as the Price) mine has been opened by a shaft 75 feet deep on the dip of the ore-body about 50° southeast. The vein-matter, quartz-stringers in hydromica-schist, is 10 feet thick at the bottom of the shaft and is highly sulphuretted, containing also arsenical pyrites. Some rich ore has been found here.

The DYNE-CREEK Company has recently made a number of openings in the vicinity of Kemp Mountain and south of Arbacoochee.

MINES IN RANDOLPH COUNTY.

The only mine of prominence is the Pinetucky. It might be classed as belonging to the Arbacoochee district, and is located about 2 miles south of Micaville and 14 miles from Heflin, near the northern boundary of the county.

The occurrence of gold-bearing quartz here was discovered by a Mr. Knight in the early days of gold digging. Numerous shallow workings, perhaps the most extensive at any one point in the South, extend in a continuous line for over a mile along the outcrop of the vein, and give evidence of the large amount of work done here in time past, as well as of the continuity of the vein. These old workings have been carried to a maximum depth of 70 feet, and a large amount of drifting has been done on the course of the vein, which is nearly north and south, the dip being about 20° east. The vein is a fissure of hard, bluish quartz in walls of garnetiferous hornblende-schist. It varies in thickness from the fraction of an inch to 12 inches. The values are concentrated in chimneys or shoots, and vary from a trace to $150 a ton. It is claimed that the ore will carry an average of $40 per ton. About one-half of the gold is free-milling, the other half being contained in the sulphurets (pyrites). The percentage of pyrite in the

ore is less than 1 per cent. Assays of concentrates have shown from $90 to over $600 per ton.

A few years ago a complete and well-constructed 10-stamp mill of Western pattern (Fraser and Chalmers) was erected on the property about 700 feet east of the outcrop. A vertical shaft was started in the mill house with the object of cutting the vein in depth and hoisting the ore direct to the grizzly and crusher, situated at the top of the building. This shaft was sunk to a depth of 50 feet and then abandoned for lack of funds. In the spring of 1895 the property was leased to the Fair Mining and Milling Company of Chicago, which began operations by sinking three (3) vertical diamond drill-holes. The first of these was driven to a depth of 205 feet without cutting ore. The cores showed granite at a depth of 55 feet, which alternated with the garnetiferous country schists to the bottom of the hole. The second hole, bored about 150 feet east of the old workings to a depth of 130 feet, also failed to reach the vein. The country schists were passed through at 60 feet, below which they alternated with granite. The third hole, only 80 feet east of the old workings, was drilled to a depth of 70 feet. After passing through the country schists, granite was encountered at a depth of 47 feet, immediately below which the quartz-vein was found 12 inches in thickness; below that a layer of soft gouge, and below that garnet-schist and granite. A working shaft was started at this point.

In gold quartz-veins of this size the result obtained by diamond drill borings might often be misleading, as the gold-bearing vein can at times be distinguished from other quartz only by its gold contents; about this the drill-core, and still more the cuttings used as assay samples, can give no reliable information. However, such explorations may disclose other facts of interest, as, for instance, in this case the discovery of granite overlying the vein in depth, which may give a clue to the formation of the vein and more intelligently direct search for it.

The prospecting work at this mine was done with a small Sullivan drill ($\frac{7}{8}$-inch core). The drill runner furnished by the Sullivan Diamond Drill Company, of Chicago, received $90 per month. The cost of underground labor in this district is $1 per day and for top labor 80 cents to $1; cord wood, 75 cents per cord; freight to Heflin (by wagon), 14 miles, 20 cents per 100 pounds.

Near the center of this county, at Wedowee, some placers have been operated.

The Goldberg district lies in the extreme western part of the county, running partially into Clay county near Abner. Attention has been paid in this direction almost entirely to placer mining along the bottom of Crooked creek. A very considerable amount of prospecting has also been done on the vein formations, but no regularly producing mines

have yet been developed. Arsenical pyrite is of common occurrence in the district.

MINES IN CLAY COUNTY.

The more important mining operations have been carried on in the Idaho district, which embraces an area of about 3 miles square. The country-rocks are graphitic mica- and hornblende-schists, often garnetiferous. The principal properties are the Idaho, Hobbs, Laurel, Chincapina, California, and Horns Peak.

The IDAHO (or Franklin) mine is situated in Sec. 3, T. 20, R. 7 E., on the northwestern side of Shinbone ridge. The main ore-body consists of a large mass of the country schists interlaminated with quartz-seams and largely stained with manganese oxide. The schistosity stands almost vertical. This ore-body, which has a thickness of 50 feet, is opened by cuts which extend for over 300 feet along the line of strike and to a maximum depth of 60 feet.

The second ore-body is about 150 feet northwest of the above. It is locally called the "Little Sampson vein." But little work has been done here.

The Idaho ore is stated to carry $2 per ton in free gold. The milling plant, which was in operation in the winter of 1896, consists of a 5-stamp mill (crushing capacity 10 tons in 24 hours), and a 5-foot Huntington mill (crushing capacity 20 tons in 24 hours), the former crushing through round punched 2 mm. screens, and the latter through 1 mm. slotted screens. The pulp from both mills goes over shaking coppers and thence over stationary coppers, which are barred with riffles. From here it flows over blanket sluices 8 feet wide at the Huntington and 4 feet wide at the stamp-mill. The cost of mining and milling is stated to be 50 cents per ton, and the cost of delivering from mine to mill 15 cents per ton.

The following rates of wages are paid: Miners, 75 cents per day (10 hours); foremen, millmen, and engineers, $1 per day; millwright, $1.25 per day. The cost of fuel is $2 per day.

The Laurel mine is supposed to be an extension of the Little Sampson ore-body, and the character of the ores is very similar.

The CHINCAPINA mine is situated on a ridge to the north of the Laurel and Idaho mines. The character of the ore-body is similar to that of the Idaho, though the dip is more inclined, about 30° southeast. No work of consequence has been done.

At the California mine a 10-stamp mill was erected and operated several years ago.

The HORNS PEAK mine is situated about 1 mile west of the Idaho. The ore-body, which resembles the others in this district, has been

opened by a cross-cut tunnel, determining its thickness to be about 30 feet. Tests made in a small 5-stamp mill located in the vicinity have demonstrated a saving of $2 per ton by amalgamation.

MINES IN TALLADEGA COUNTY.

The occurrence of gold in this county is limited to the extreme eastern portion, in the Blue Ridge mountain range. The Riddle and Story mines have been worked to some extent.

The ore-body at the RIDDLE mine is a highly sulphuretted quartz-vein, having a very flat dip towards the southeast. It has been opened by an inclined shaft on the dip to a depth of 100 feet. The thickness of the quartz lenses is about 4 inches, pinching to a mere seam in places. Assays have shown values varying from $20 to $150 per ton. The prospect pits extend for over half a mile on the course of the vein.

The STORY mine lies in the adjoining section to the Riddle. The ore was mined some years ago from an incline on the vein to a depth of 60 feet. It is similar to that of the Riddle mine.

The occurrence of gold in Coosa, Chilton, Chambers and Tallapoosa counties has been fully described by Dr. W. B. Phillips in Bulletin No. 3, *Geological Survey of Alabama.*

The latter county was at one time the seat of extensive mining operations in the Goldville, Hog Mountain,[1] Silver Hill, Gregory Hill, Blue Hill, and Farrow Mountain districts.[2]

GOLD MINES IN TENNESSEE.

The gold produced in this State has been obtained entirely from petty placer workings in Monroe, Polk, McMinn, and Blount counties. The most prolific sources have been the deposits along Coco creek, a tributary of the Hiawassee river in Monroe county. Other gold-bearing streams in this county are the Citico and Cane creeks, and the headwaters of the Tellico river. Along Whippoorwill branch, a tributary of the Tellico, small gold quartz-veins have been discovered, but they have never been worked.

In the latter part of 1896 a company known as the Cooper Gold Mining Company was organized for the purpose of developing the Coco creek gold fields.[3]

[1] Extensive prospecting work has recently been done at Hog Mountain with the result of showing the existence there of a number of thick veins of low grade ore, averaging perhaps $4 or $5 a ton.

So also in the vicinity of the old Ulrich mines, and across the river at the Bonner, Terrell, and Gunn mines, much work has been done within the past twelve months.

[2] See Bulls. Nos. 3 and 5, *Geolog. Survey of Alabama.*

[3] *Eng. and Min. Jour.*, vol. lxii, p. 374.

CHAPTER V

THE MINING AND MILLING PRACTICE AT SOME OF THE CHARACTERISTIC PLACER AND FREE-MILLING MINES.

THE CRAWFORD (OR INGRAM) MINE, STANLY COUNTY, N. C.

This mine is situated 4 miles southeast of Albemarle, in the Carolina belt. It represents a type of working in virgin placer ground, the gold being coarse, usually in nuggets. The mining tract (180 acres) comprises a flat hollow or depression, averaging 250 feet in width, which is drained by a small branch. The country-rock is the dark greenish Monroe slate (sedimentary), lying in a flat synclinal trough. The auriferous grit, lying on the slate floor, is composed of angular fragments of quartz and country-rock bound in a clay matrix; the cement is often hard and stained a brownish or black color. The quartz is of a milky, vitreous variety, seldom showing ferruginous stains; some pieces show parallel walls (vein structure) from a few inches up to 1 foot in thickness. No free gold has been found in this quartz. The thickness of the grit in the center of the synclinal basin is from $1\frac{1}{2}$ to 2 feet, and of the over-lay 2 to 4 feet, thinning out towards the edges. The length of the deposit on the company's property is about a quarter of a mile. The adjoining property on the north is owned by Mr. F. A. Fesperman, whose place has been worked by tributors. The gold found at the Crawford is altogether coarse, from the size of a pin's head to nuggets of considerable weight. The largest nugget was found on August 22, 1895, and weighed 10 pounds. The so-called De Berry nugget, found April 8, 1895, weighed 8 pounds 5 ounces. These nuggets are scarcely at all water-worn, being rough and irregular in shape. The fineness of the gold varies from 850 to 900.

On the hillside to the west of the placer mine several quartz-veins have been explored by shallow openings along the outcrop. One of these is from 2 to 3 feet thick, and dips steeply to the east, cutting the slates both in strike and dip. The quartz, so far as explored, has been found generally barren, though in several places gold has been panned from the crushed rock; but no larger pieces have been found giving any possible clue as to the origin of the nuggets of the placer deposits.

Gold was first discovered in this bottom in August, 1892, the prop-

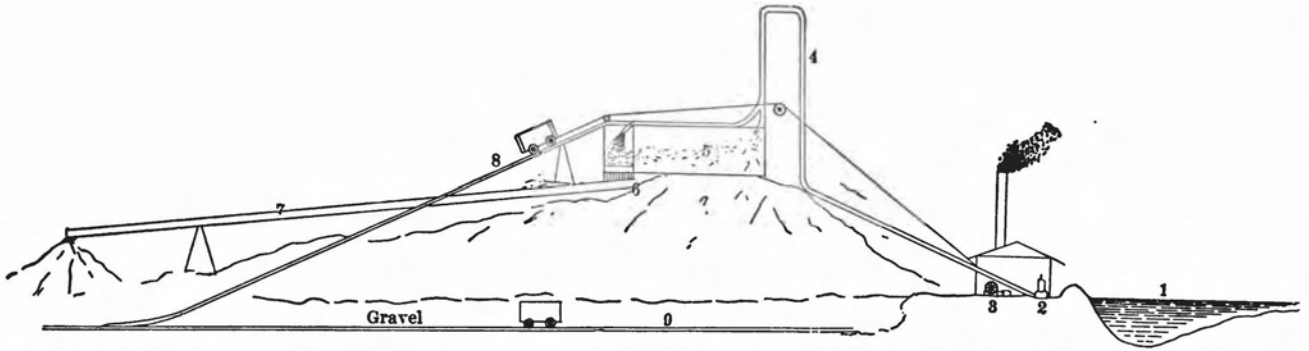


Fig. 6.—Sketch of method of working gravel at Crawford mine, Stanly county, N. C. (Not drawn to scale.) 1, reservoir; 2, pump; 3, hoisting engine; 4, stand-pipe; 5, washing-box; 6, grizzly; 7, sluices; 8, inclined plane; 9, track on bedrock.

erty being at that time a portion of the W. S. Ingram farm. For two years it was worked spasmodically by tributors, and 16 to 17 pounds of nuggets were obtained. In 1894 the property was bought by the Crawford Mining Company of New York, and was put under the able management of Mr. Richard Eames, Jr., of Salisbury, N. C. A sketch of the method of working which was being pursued in 1895 is given in fig. 6.

The bottom having insufficient grade to carry off the tailings with the limited amount of water at hand, a washing tank and sluice were put up on the side hill at an elevation of about 30 feet above the creek. The deposit was mined by a system of parallel trenches 12 feet wide, worked from the lower end of the deposit upward. Track was laid in these as they advanced. The upper 6 to 18 inches of the over-lay were thrown off, the remaining 1½ to 2 feet, together with the true grit (gravel) and 6 to 12 inches of the bed-rock, were shovelled into cars holding about half a cubic yard. These were trammed to the foot of the inclined plane (8), and hoisted to the top of the washing plant by a small friction-drum engine (3) (see fig. 6). This tank was built of plank and is about 50 feet long, 18 feet wide and 6 feet high. On one of the sides there is a door or opening 4 feet wide, reaching to within 4 inches of the bottom to a sill. The grit was dumped into the tank and a constant stream of water kept flowing over it. The action of this stream was reinforced by water played on the material from a hose nozzle under a head of 30 feet. This head was obtained from a stand-pipe (4) to which water was pumped from a reservoir (1) by means of a Hall duplex pump (2) with a 4-inch discharge. Excepting at the time of the clean-up, the tank was kept nearly full of gravel, and under the combined action of the two streams of water, closely imitating natural agencies, a very good concentration of the coarser nuggets was attained in the tank. The material, partly assisted with a rake, flowed over a grizzly (6), the bars of which were set 1½ inches apart. The coarser pebbles and boulders were forked off, while the finer gravel and sand were carried down into a sluice (7) situated below the grizzly. The sluice was 400 feet long, 12 inches wide and 10 inches deep, and had an inclination of 6 inches in 10 feet. It contained only about 20 feet of riffles, and these were situated about 100 feet below the grizzly. Originally, the whole sluice was filled with riffles, but these were removed when it was recognized that they were superfluous for saving gold. The first hundred feet of the sluice were found to aid in thoroughly washing and disintegrating the material before it reached the riffles, and gold was seldom found below the first four or five feet of the riffles. The upper riffles consisted of diagonal slots cut in 2-inch plank, which was laid in the bottom of the sluice. The lower riffles were of the longitudinal variety (see fig. 8).

The upper riffles, as well as the surface of the material in the tank, were examined every evening for larger nuggets. A complete clean-up was made at odd intervals, depending upon the richness of the material worked on, etc. The gravel in the tank was entirely worked down by means of the hose, the coarser nuggets picked out by hand, and the heavy sand, together with similar material found in the bottom of the sluice, after taking up the riffles, was washed in a rocker. No quicksilver was used, there being no fine gold whatever. A loss of gold would more likely be in the form of larger nuggets, which might be overlooked in forking out the coarser material, or which, on account of their round form and size, might roll over the riffles to the tailing heap. One large nugget, of the shape and size of a hen's egg, was found on the latter. Clay balls (sluice-robbers) also cause considerable loss.

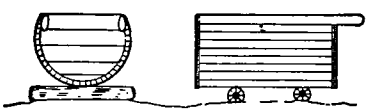


Fig. 7.—Rocker used by tributors; Crawford Mine.

Upper End. Lower End.

Fig. 8.—Riffles in sluice-box; Crawford Mine. Scale, ¼ inch=1 foot.

When working to full capacity, 25 men were employed at these mines—5 men at the tank and sluice, 1 playing the hose and dumping cars, 1 raking gravel out of the tank, and 3 helping the material down the sluice and over the riffles, forking out the coarser pebbles. The latter force was necessitated by the limited supply of water and the desire to work as large quantities as possible. Their work might perhaps have been assisted by the use of a much shorter sluice, and a somewhat steeper inclination of the same, without endangering loss in gold of such a coarse character. The remainder of the force, excepting foreman and engineer, were employed in digging gravel, taking up bed-rock, etc. An average day's output consisted of 80 carloads, about 45 cubic yards of loose gravel. Two and one-half to three cords of wood were burnt a day, at 65 cents per cord. Labor was paid at the rate of 60 to 65 cents per day. These figures, with reasonable additions for superintendence, supplies, etc., placed the cost of mining gravel by this method at about 50 cents per loose cubic yard. From June until November, when the water-supply is very limited, the right of mining the gravel was let out to tributors, who turned in as royalty ¼ of the finer gold, including

pieces up to 1 ounce in weight, and ½ of the larger nuggets (above 1 ounce). The tributors worked in pairs, one pitting and taking out the bed-rock while the other one manipulated the rocker (cradle), shown in fig. 7. It is made up like a barrel, with half-inch staves, smoothed on the inside, with solid heads, the latter being a little more than half a circle. One wheelbarrow-load is put in the rocker at a time. After the gravel is thoroughly disintegrated by vigorous motion of the rocker, the pebbles, etc., are thrown out, and finally, by a light movement, the finer and heavier portions are examined closely by eye. It is practically a panning process on a larger scale. Fifteen minutes are occupied in cleaning up one charge.

THE MILLS PROPERTY, BURKE COUNTY, N. C.

This property is situated near Brindletown, about 14 miles southwest from Morganton. It comprises an area of 2460 acres, including the eastern portion of Pilot Knob and the western flanks of the South mountains, being drained by the waters of Silver creek. The problem here presented is the reworking of old gravel deposits by a simple hydraulicking process where the grade is sufficient, or, where this is not the case, by raising the material to the surface by hydraulic elevators.

Geologically, the locality is in the South mountain belt. The general strike of the crystalline schists is N. 20° W. and the dip 20° N.E. The rocks are decomposed to a considerable depth, reaching often 50 feet and at times 100 feet. The strike of the auriferous quartz-veins is N. 60° to 70° E. and the dip 70° to 80° N.W. These veins are usually from a knife edge to several inches in thickness, and are too small to work individually. One vein from 12 to 18 inches in thickness has been explored, but was found to be almost barren. The gravel deposits occupy the present stream beds and adjoining bottoms, and the ancient channels now covered with deep over-burden and extending into the hillsides which flank the mountain. From Pilot Knob and along its lower slopes, a number of these deep channels radiate in all directions.

The facilities for obtaining water for mining purposes are good, though beset with difficulties. The numerous streams which have their rise in the South mountains are small though of good flow throughout most seasons, and it is practicable to collect their water and lead it to the larger part of the mining ground in ditch and flume-lines and reservoirs with sufficient head for sluicing and hydraulicking purposes. However, the summer months cannot be depended upon for steady work, as the water-supply is apt to be cut short by droughts. The chief impediment is in the loss of grade before the mining ground in the lower country is reached, owing to the deep and numerous indentations of the mountains which it is necessary to circumvent. It is impossible to

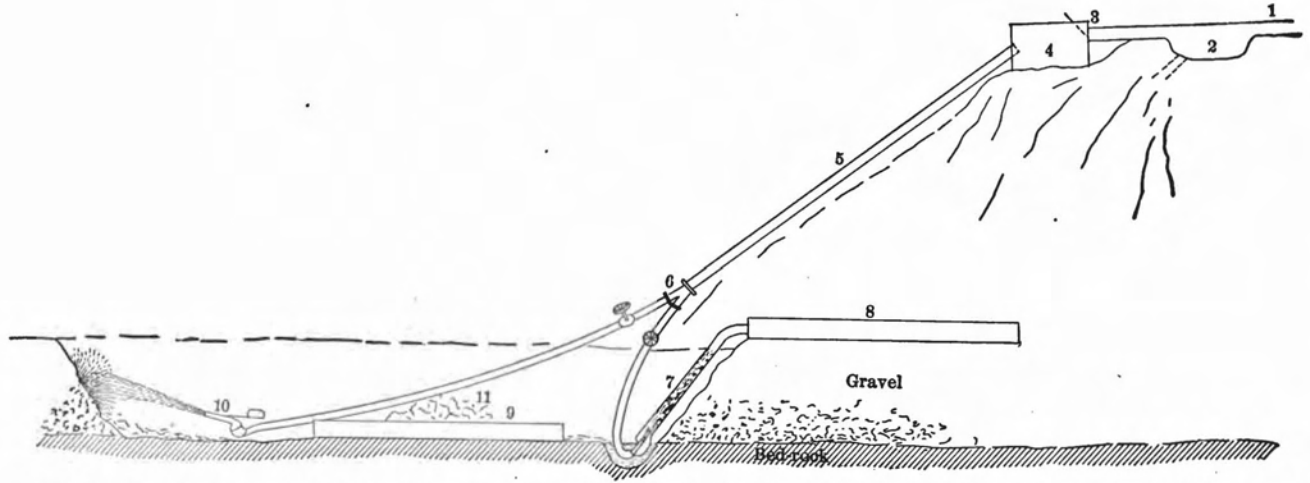


Fig. 9.—Sketch of proposed Hydraulic work on Mills Property, Burke County, N. C. (Not drawn to scale.) 1, ditch; 2, sand pit with drain; 3, screen at head of penstock; 4, penstock; 5, pipe (10 and 8-inch); 6, Y branching into two 7-inch pipes; 7, hydraulic elevator; 8, top sluice-boxes; 9, pit sluice-boxes; 10, giant; 11, bowlder and pebble heaps.

water some portions of the sidehills except by pumping into reservoirs or by constructing expensive syphon-lines.

Brindle creek on the Mills property was the site of the first discovery of gold in this part of North Carolina, in 1828. With few exceptions, most of the virgin placer ground above alluded to has, by more or less continuous mining operations since then, been worked as high as water could be obtained with the present ditch lines. Much of the gravel has been washed over as many as three times. As no regular records have ever been kept, it is impossible to speak intelligently of the value of these gravel deposits. Small channels yielding as high as $20 per cubic yard have been worked, but in general the gravel will yield from 4 to 50 cents. At present, the available mining ground may be divided into two general classes: first, the bottom and ancient channel gravel deposits; second, the decomposed country-rock in place, containing belts of small auriferous quartz-veins. Not much attention has been paid to the latter, excepting by tributors who in a spasmodic way have worked some deposits on the flanks of Brindle ridge, gouging out the small rich quartz-veins, and extracting the gold by crushing in hand-mortars and panning; they pay a royalty of 16⅔ per cent. to the owner. Captain J. C. Mills at one time successfully worked one of these small quartz-belts by sluicing to a small stamp-mill (Dahlonega method), but the mill was destroyed by fire and never rebuilt.

In 1894 an English company was formed with the object of again reworking the principal gravel deposits and obtaining as a by-product the monazite, which occurs concentrated with the gold and is derived from the adjacent country-rocks by disintegration. Over a year was spent in preparing the mining ground, building and repairing ditches, flumes, etc. It was proposed to concentrate the work at two points, the first in the bottom land of Silver creek, using a giant and hydraulic elevator; the second in the bed of Magazine or Parker branch, using a giant and continuous sluice-box system.

PLACER DEPOSITS ON SILVER CREEK.

Silver creek forms one of the main drainages of the South mountains. The placer deposits which it was proposed to rework on the Mills property are situated near its headwaters. They are about 1 mile in length and are located mainly upon the west bank, on which the gravel often extends out a distance of 500 to 600 yards. The main difficulty encountered was the want of fall in the bed, a feature common to many Southern placers. It amounts in this case to less than 1 foot in 100. To overcome this obstacle for hydraulicking with continuous sluice, the use of the hydraulic gravel elevator was decided upon. Fig. 9 gives a

rough sketch of the plant and method proposed. Twelve miles of ditch and flume line (1) carry the water from a reservoir, through the Dan Sisk gap in the South mountains, to a penstock (4), situated 200 feet above the level of the creek bed. The ditch is cut about 8 inches deep by 20 inches wide, at a cost of about 25 cents per rod, and is given a grade of from 1½ to 3 inches in 100 feet. The flumes are, at ordinary grade, 18 inches wide by 12 inches deep (see fig. 10).

A sill, bent, top and side brace are erected every 6 feet at the jointing point and middle of each box. The bents are made of rough lagging seldom more than 6 inches in diameter, the greatest height of trestle being less than 30 feet. The sill of the flume acts as a cap for the posts. Wherever a small grade becomes necessary, the width of the flume is doubled. The cost of erecting these flumes is small, equal to about the cost of the material in them. Lumber is worth $6 to $7 per thousand.

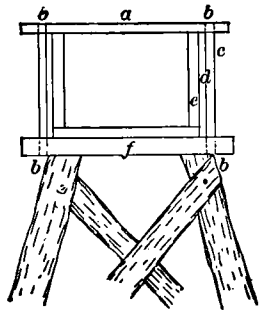


Fig. 10.—Flume, Mills Property, N. C. Scale, ⅛ inch=1 foot. *a*, 1x3-inch board; *b*, 1-inch holes; *c*, 1x3-inch board; *d*, wedging; *e*, 1½-inch plank (sides and bottom); *f*, 2x4-inch sills and cap for bent.

The water, before reaching the penstock, flows through a sand pit (2, fig. 9), to catch sand, etc., washed into the ditch line from the side. It then enters the penstock after passing through a screen (3) for removing leaves, sticks, etc. The pipe (5) leading from penstock is 10-inch spiral riveted sheet-steel (with No. 16 Birmingham gauge), coated with coal-tar and connected with flanges. Smaller curves are made by placing cast-iron bevelled wings between the gaskets of the flanges, larger ones by suitable elbows. Near the gravel pit the 10-inch pipe branches out through a Y (6) into two 7-inch pipes, supplied each with a gate-valve, one leading to the giant pen and the other to the hydraulic elevator (7). These are both of California type and manufacture.[1] An illustration of the latter in detail is given in fig. 11. The principle of this device is too well-known to require a description. It

[1] Joshua Hendey Machine Works, San Francisco, Cal.

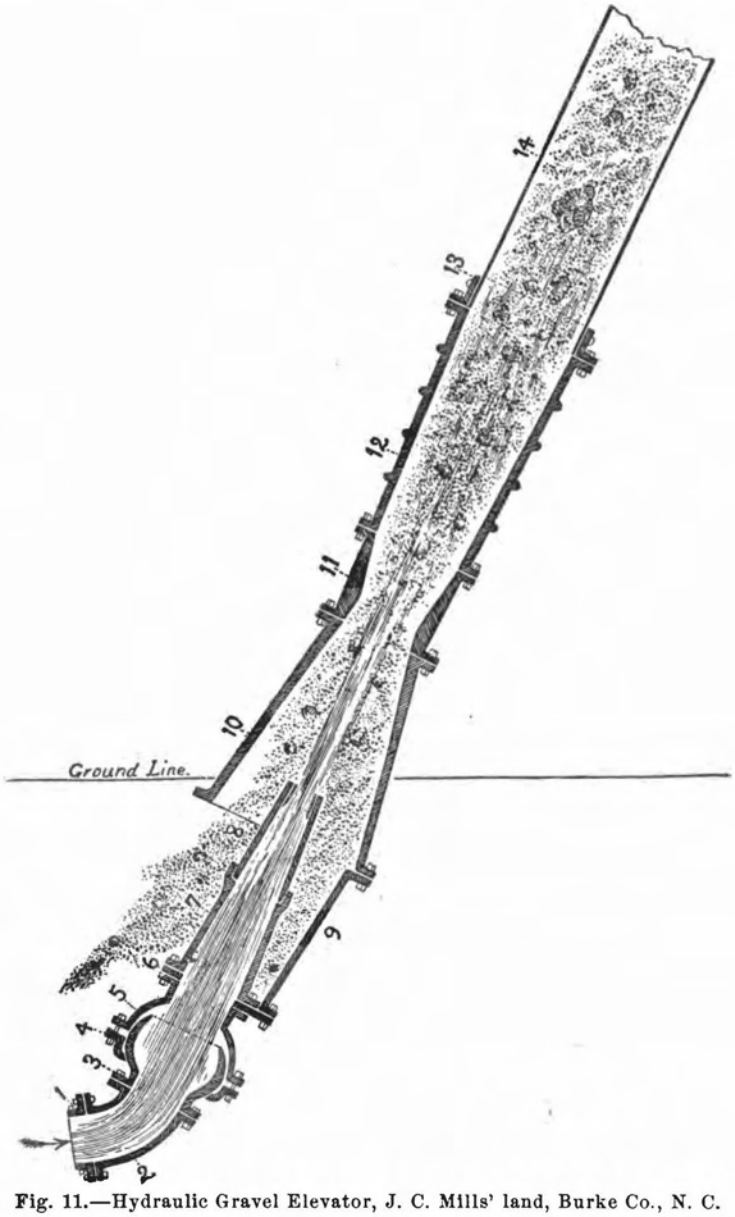


Fig. 11.—Hydraulic Gravel Elevator, J. C. Mills' land, Burke Co., N. C.

is intended to keep the elevator stationary as long as possible, as its installation consumes considerable time. A pit must be sunk in the bed-rock, and as the elevator must also drain the workings (a drain on the top of bed-rock to the initial point of working was considered too expensive), the water would gain too much headway while the elevator is moved. The work in the main pit will be carried diagonally up the banks of the stream, so as to gain as much grade as possible. As soon as there is room, a sluice-box (9) will be placed between the working bank and the elevator-pit. A cross-section of this is given in fig. 12.

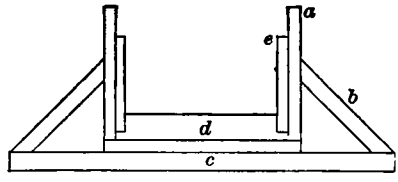


Fig. 12.—Section of Sluice-box, J. C. Mills land, Burke Co., N. C. Scale, ½ inch=1 foot. *a*, 1½-inch surfaced pine plank (sides and bottom); *b*, 2x4-inch brace; *c*, 2x4-inch sill; *d*, 1x4-inch riffle; *e*, 1x8-inch sand-board.

The upper part of this sluice will be filled with 3-inch by 4-inch blocks and the remainder with 1-inch by 3-inch cross-riffles, placed 11 inches apart and held down by a sand-board, which is halved down on them. Both will help to protect the sluice-box against wear. All pebbles, etc., more than ½ inch in diameter will be forked out of the sluices and left in the pit (11). After being raised by the elevator, the material will pass through another sluice (8), the tailings from which will be worked for monazite. It is expected that by far the largest part of the gold will be saved in the first sluice.

Active work was commenced in July, 1895, and after three months' washing with the giant and hydraulic elevator the undertaking was abandoned. So far as the working of the machinery was concerned, the operations were entirely successful, but the yield in gold and monazite did not meet the expectations.

The ¾-acre of ground (chiefly tailing dumps, which had already been worked over in an irregular and imperfect manner several times) that was worked to an average depth of 9 feet, yielded $350 in gold, and the monazite was so full of magnetite, rutile, etc., that its saving was not warranted.

It is by no means intended by this to condemn the property, for it is of course unjust to judge its value from this single test; and while it is undoubtedly true that the resources are insufficient to support a company organized on so large a capitalization as this English company was, there is no reason why smaller operations should not be entirely successful.

PLACER DEPOSITS ON PARKER BRANCH.

The Magazine or Parker branch is a tributary of South Muddy creek. Its source is at the foot of Pilot Knob, and from the latter several gravel channels run towards it, sometimes entirely covered with soil, so as to make their location unrecognizable at the surface. One of these, the Magazine channel, has been extensively worked, first by open hydraulic work, and afterwards at the upper end, where the over-burden grew too heavy, by a tunnel, subsequently connected with the shaft. The former had a total length of 600 feet, and the latter a depth of 50 feet. The creek bed has also been worked, mainly with rockers. It was proposed to work this bottom, besides any side-hill channels that might be found, by giant, sufficient fall being available to carry off the tailings in a continuous sluice-box below. Water for this work was brought a distance of 5 miles to a large reservoir on the divide between South Muddy and Silver creeks, and from here in 2 miles of ditch and flume, along the foot of Pilot Knob, to a reservoir situated 100 feet above the creek bottom. This reservoir was designed to hold the water contained in the ditch after the gate at the large reservoir had been closed in the evening; and this was to be the first water to be used in the morning before that from the large reservoir had time to reach this point. The placer deposit in the creek bed has a total width of 400 feet. The old gravel banks, etc., were to be broken down and the material run into sluices similar to those described above, the tailings being carried down the branch to South Muddy creek.

These operations were, however, never undertaken, owing to the liquidation of the company before that point was reached.

THE CHESTATEE COMPANY, LUMPKIN COUNTY, GA.

The work pursued here, and its ultimate object, present special features of interest, and might warrant a greater application in the Southern gold-fields. The plant and property of this company are situated 2½ miles from Dahlonega, on the Chestatee river, about ½ mile above the entrance of Yahoola creek. The property comprises about 250 acres of placer ground on the banks of the river, together with about 1 mile of the stream bed. The main object in view was to turn the river into a new channel and to work the stream-gravel, as well as that in the adjacent bottoms.

At the lower end of the property a dam was thrown across the river and a substantial and well-constructed power station erected, supplying the power, by means of two 66-inch Leffel wheels, for a Blake duplex 12-inch by 24-inch pump and a 50 horse-power dynamo. The Leffel wheels were originally installed to furnish motor-power to a centrifugal

sand-pump for raising gravel from the channel excavation, but this was later on abandoned in favor of a hydraulic gravel elevator. The substitution was made for economic reasons as well as for the fact that the latter had in its favor greater simplicity, more constant work, and easier portability, as well as greater facility of installation.

This elevator is the design of Mr. W. R. Crandall, the general manager of the Chestatee Company. It combines cheapness and compactness of construction, and a novel feature is the introduction of air at the nozzle whenever the inlet of the suction-pipe is entirely submerged. Its mechanism and operation have been admirably described and illustrated in a paper by Mr. Crandall, presented at the Pittsburgh meeting of the American Institute of Mining Engineers in February, 1896. We believe that this form of elevator may have quite an extended and useful application in many parts of the Southern field, and in order to intelligently bring it before those of our readers to whom the Transactions of the American Institute of Mining Engineers may be inaccessible, we cannot do better than to repeat the descriptive portions of Mr. Crandall's paper,[1] changing the numbers of the figures to suit this report:

"Fig. 13 shows the elevator in detail; Fig. 14, the manner in which it is set; Fig. 15 the details of the flume, etc. In all the figures the parts are lettered respectively as follows:

A. Cast-iron elbow at the base of the elevator.
B. Wings or vanes, to straighten the water before it enters the nozzle.
C. Nozzle.
D. Air-cap.
E. Air-inlet pipe, to furnish air when the bottom of the discharge-pipe is submerged.
F. Studs to support the discharge-pipe and to keep it and the nozzle in line.
G. Cast-iron flanged throat.
H. Discharge-pipe.
I. Discharge-box.
K. Hood for discharge-box.
L. Adjustable wood-packing around discharge-pipe.
M. Discharge-flume.
N. Adjustable flume-supports.

This elevator, as used at the Chestatee mine, near Dahlonega, Ga., where it has been gradually developed and perfected under the needs of practice, consists essentially of an elbow, A, longer at one side than the other, and coupling by means of a flange to a 5-inch pipe. At the other extremity are a flange, into which the nozzle screws, and three studs, F, which support the throat into which the gravel and water enter to be elevated. The throat slips inside the 6-in. lap-welded pipe, H, for discharging into the flume on the bank, from which it may be conveyed wherever desired.

The whole apparatus, except the discharge-pipe, may be readily carried by two men. If it be necessary to move the elevator often, to keep up with the drainage, the portable character of the outfit is a great advantage.

At the Chestatee mine the practice is about as follows: The water-supply is conducted to the mine through a 9-inch pipe. At a suitable point the water is divided, and a 5-inch pipe conveys that used by the lift, while a 7-inch pipe conducts to the giant. Valves are provided at the Tee, so that one or both

[1] *Trans. Am. Inst. Engs.*, xxvi, 1897, pp. 62-68.

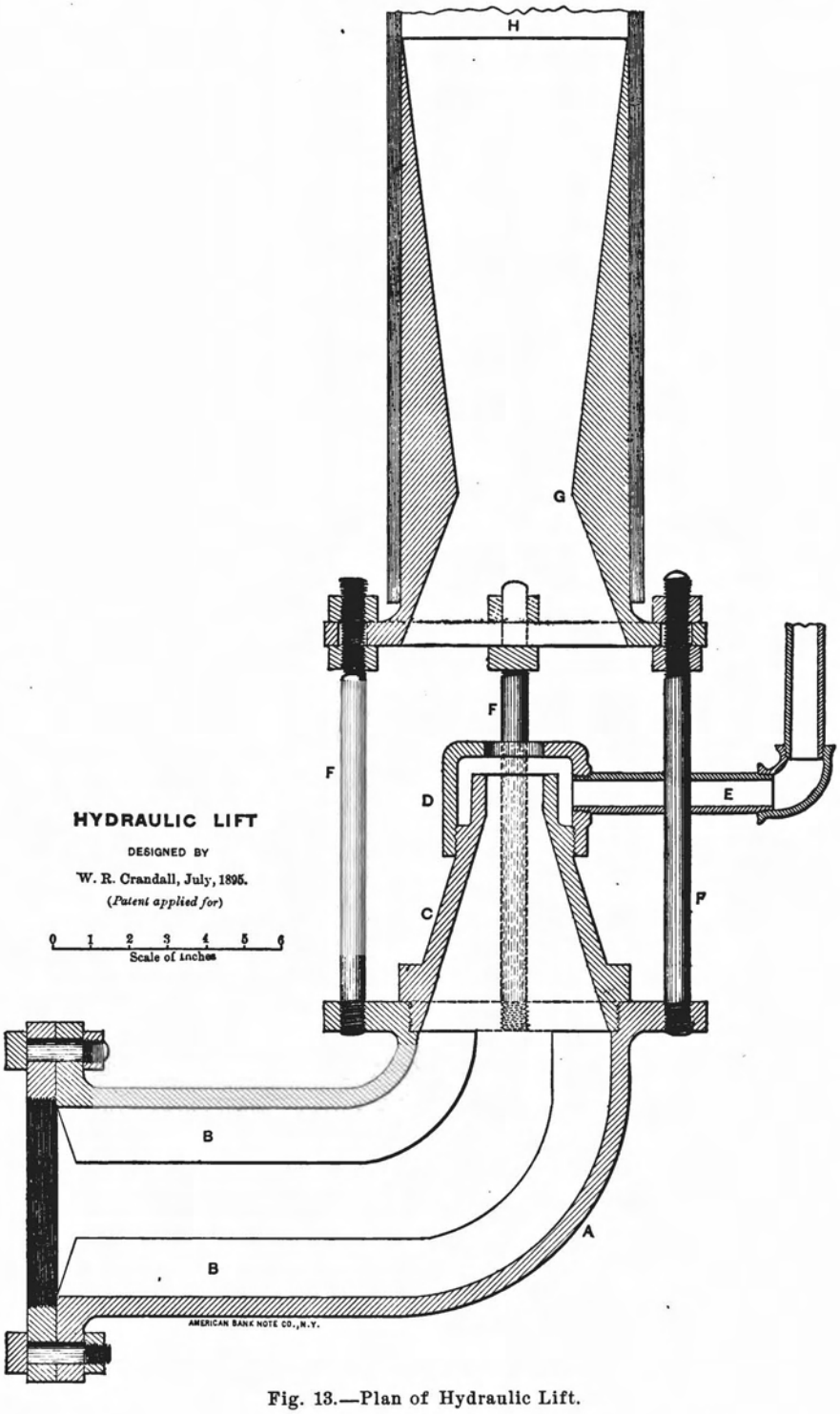


Fig. 13.—Plan of Hydraulic Lift.

may be shut off as necessity requires. The lift is set into the slate to such depth as may be desired, and connection is made with the water-supply pipe. The discharge-pipe is then slipped over the throat and the discharge-flume is put in place, the discharge-pipe being set at such an angle of inclination as may be necessary to give proper grade to the tailings-flume and allow the pipe to extend a few inches through the bottom of the hooded box.

The air-pipe, E, is then screwed into place, and the lift is ready for operation. We govern the depth to which we set the lift into the bed-rock slate by the hardness or softness of the latter. If it be hard, frequent moving is cheaper than cutting slate-drains. If soft, we go as deep as the slate will stand without timbering. This we find to be about 7 feet.

A main drain is then started in the general direction of our work, from which laterals are afterwards cut as required; and, at some suitable place near the lift-pit, a box about 6 feet long by 32 inches wide is set into the drain at grade, and in this is placed a cast-iron "grizzly" having round holes 2½ inches in diameter. This catches any rocks which may escape the forkers, and insures that nothing will get to the lift which will not readily pass through the throat, which has, when new, an opening of three inches.

We use straight-bar riffles in the discharge-flume to catch any gold that may pass through the lift. This we find in practice to be about 5 per cent. of the total amount recovered, a result largely due to the fact that, when work is started at a new pit, the ground-sluices are not long enough to settle the gold thoroughly.

Whenever the drainage afforded by a pit is exhausted the pipe-line is extended, a new pit is sunk near the gravel-breast, and the work is continued as before.

As the work follows the general course of the river, the tailings are discharged into the river at the nearest point, the portable tailing-flume being extended far enough to insure the safety of the immediate bank. The tailings finally flow through a ditch into the river.

We usually use about 200 feet of 5-inch pipe in the lift water-supply before extending the 9-inch pipe-line; and we often move up 100 feet, dig the pit, re-set the lift and get ready for work again in one 12-hour shift with 5 men.

As to the work which the lift will accomplish, I may say that we are using a lift with 1½-inch nozzle, discharging through a 3-inch throat into a 6-inch pipe, and lifting an average of 18 feet vertically, with water at about 60 pounds pressure per square inch.

As we are quite near the river, and have the drainage of a side-hill, the surface-water is considerable, probably fifty gallons per minute. We use a 1¼-inch nozzle on the giant, and the lift readily handles all this and all the dirt and gravel we are able to wash to it. The latter we estimate, from measurements taken at different times, to be about ½ cubic yard per minute of 'topping.' The quantity of gravel is hard to determine, owing to varying conditions; but it is safe to say that it is all that the amount of water employed will wash."

Water is supplied to both the elevator and the giant by direct pressure (about 60 pounds to the square inch) from the Blake pump. This direct appliance of pressure, without intermediate stand-pipe or reservoir, has proved very successful, the only precaution necessary being to shut off the pump before closing the feed of the giant or elevator. It

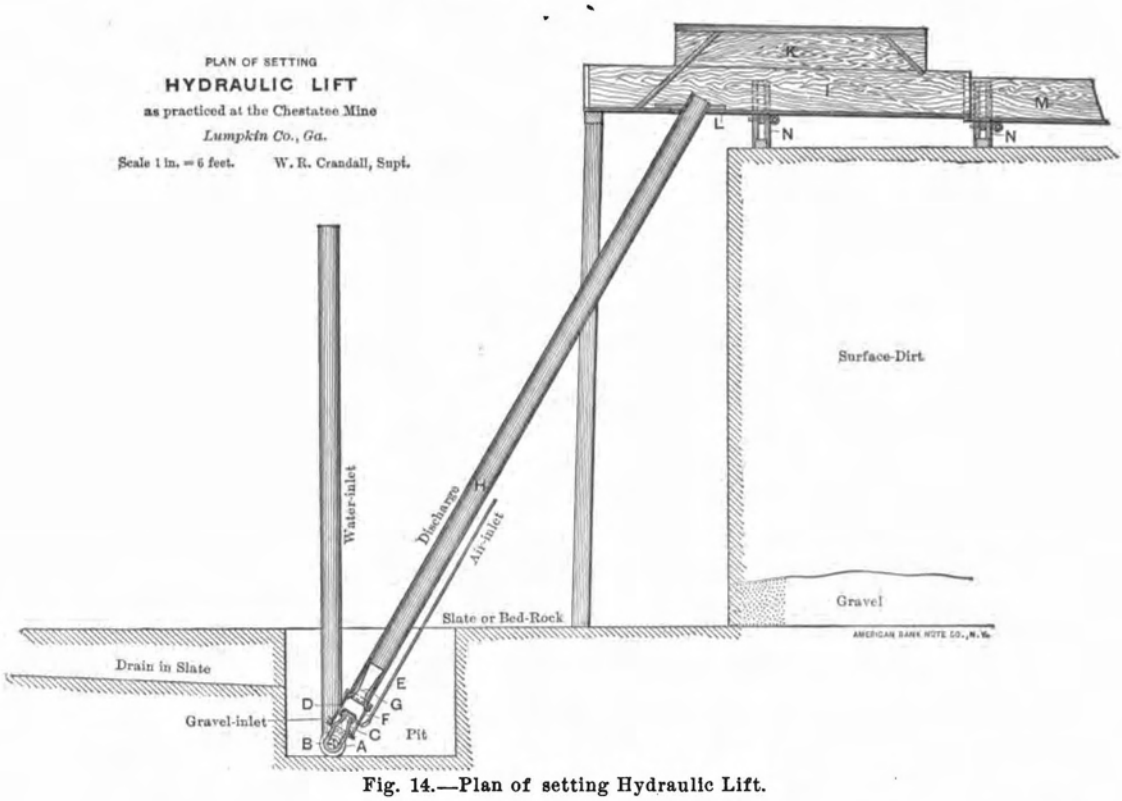


Fig. 14.—Plan of setting Hydraulic Lift.

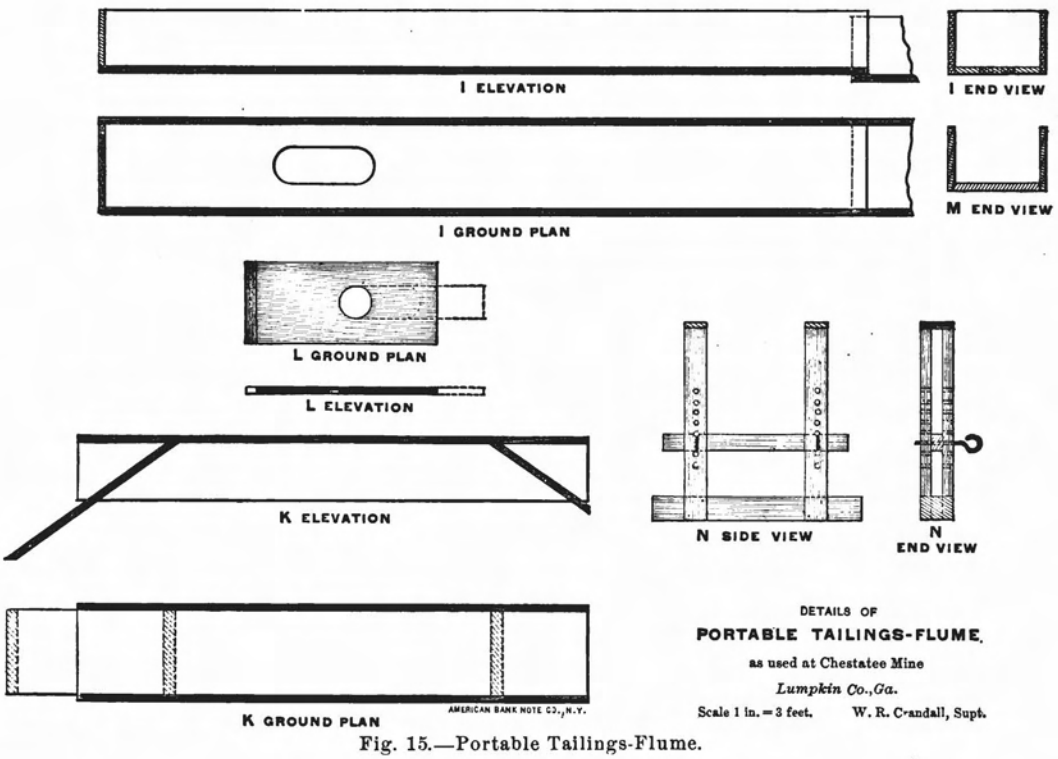


Fig. 15.—Portable Tailings-Flume.

has also this advantage, that when occasion demands it, smaller nozzles can be used and the pressure thus increased.

The channel is cut 30 to 35 feet wide, down to bed-rock in depth, and has a total length of about half a mile. It runs almost parallel to the river, and from 50 to 200 yards from the north bank of the same. When completed, the waters of the river will be turned into it by means of a wing-dam.

The gravel above the bed-rock in this channel is auriferous and has paid the expenses of the preliminary excavations. It averages 1 foot in thickness, with 6 to 10 feet of over-lay. The latter was worked off during the night shift (using electric light illumination), and the gravel thus exposed, as well as about 2 inches of bed-rock, taken up during the succeeding day.

CHESTATEE RIVER DREDGE-BOATS, LUMPKIN COUNTY, GA.

Dredge-boats of various descriptions have been at work on the Chestatee river for a number of years. The work has been spasmodic, and failures are more often recorded than successes. The river, where operated on, is about 100 feet in width and of variable depth. Numerous shoals make dredging difficult.

A steam vacuum dredge [1] was operated for a time on this river; it did good work, especially in cleaning up the bed-rock. The main difficulty, and the reason for abandonment, was the banking up of the tailings around the boat, finally hemming it in.

The Roy Stone method,[2] using the principle of the hydraulic elevator, was attempted as early as 1883, but proved unsuccessful. In the summer of 1895 there were two dredge-boats on the river, one above and the other below New Bridge. The former of these, operated by Mr. Frye, is on the principle of a continuous bucket elevator. So far it has not been operated successfully, the buckets and continuous link-chain proving entirely too light for the work. The other boat was operated at a small profit by Mr. Jacquish. It was erected seven years ago by the Bucyrus Steam Shovel Company at an initial cost of about $15,000. After being worked for two years it lay idle until the summer of 1895.

The machinery is installed on a scow, 26 by 70 feet, drawing 3½ feet of water. It consists of a Bucyrus shovel (scoop) of 1¼ tons capacity, derrick and hoisting-drums for operating the same, a small horizontal engine and a centrifugal-pump for supplying fresh water to wash the gravel, and a 60 horse-power locomotive boiler. A barge, 100 by 20 feet, lying alongside of the dredge-boat, carries the sluices. There are

[1] See *Gold*, by A. G. Locke, 1882, p. 890.
[2] See R. W. Raymond, in *Trans. Am. Inst. Min. Eng.*, vol. viii, p. 254.

two lines of sluice-boxes, each 3 feet wide and 18 inches high, running the full length of the barge, and filled with longitudinal riffles, made up in five-foot racks, composed of 1 by 3-inch slats set 1 inch apart. The gravel is discharged from the shovel on an iron-shod platform at the head of these boxes, where the boulders and larger pebbles are removed. The gold is caught almost entirely in the upper two racks; the tailings run off into the river in the back of the boat. When in favorable ground, the dredge will scoop and deliver an average of 1 bucket every 2 minutes. When examined there were 3 men on the dredge-boat, engineer, fireman and craneman, and 6 men at the sluice-boxes. Work is carried forward up stream, the scow being moved against the current by anchoring the scoop and pulling the scow towards it by means of the crane engine. The main wear and tear are on the lip of the scoop, and on the chains. A steel lip 12 inches in length wears out in about six months. The river ground is leased on a royalty of from 5 to 10 per cent. by the property owners. It is said that gravel as low as 5 cents per cubic yard can be worked at a profit.

In the spring of 1896 a boat, equipped with a Marion Steam Shovel Company's dredging outfit, was in operation under the management of Messrs. Benham and Helmer. A pontoon alongside of the dredge carried a line of sluice-boxes. The material from the dredge was dumped on a grizzly at the head of the sluice line and washed down by a stream of water from a No. 8 Held and Cisco centrifugal pump having a capacity of 4500 gallons per minute. The sluice-boxes were 70 feet in length, 64 inches wide and 12 inches deep, and provided with riffles. There was a device for carrying back the tailings and depositing them in the excavation behind the machine. The efficiency of the dredge was stated to be 800 to 1200 cubic yards per 10 hours. The expenses were estimated at about $18 per day, and the gross returns at $40 to $120 per day.

THE DAHLONEGA METHOD, WITH SPECIAL DESCRIPTION OF THE HEDWIG MINE.

The Dahlonega method of mining and milling is one which is particularly adapted to the large bodies of low-grade auriferous saprolitic schists, such as exist in the Dahlonega district of Georgia. It consists in cutting down the soft, decomposed ore-bodies by means of a hydraulic giant, the water from which carries the material through a line of sluices to the mill situated some distance below the workings, usually on the banks of a stream from which it derives its water-power. In the mill the coarser and heavier portions are retained by means of a screen, and are fed to the battery by hand, the mud and fine silt being carried through into the river. Generally, a third of the gold saved is caught

in the riffles of the mine-sluices, the remainder being obtained in the mill.

HISTORICAL NOTES.

The Dahlonega method first originated in 1868 by sluicing the material from the mines to platforms near the mill, from where it was hauled to the mill in carts. This was improved by placing bins, with perforated bottoms, in the stamp-mills, from 4 to 5 feet above and back of the mortars; underneath this bin was a settling-box, in which the sandy material settled and the slimes overflowed. At the Child's mill, near Nacoochee, a plant was erected, consisting of a series of washing and sizing plate-screens, in which three sizes, coarse, medium and sand, were made and milled separately. It is stated that all the millable ore was saved in this way, in a clean shape, free from mud.

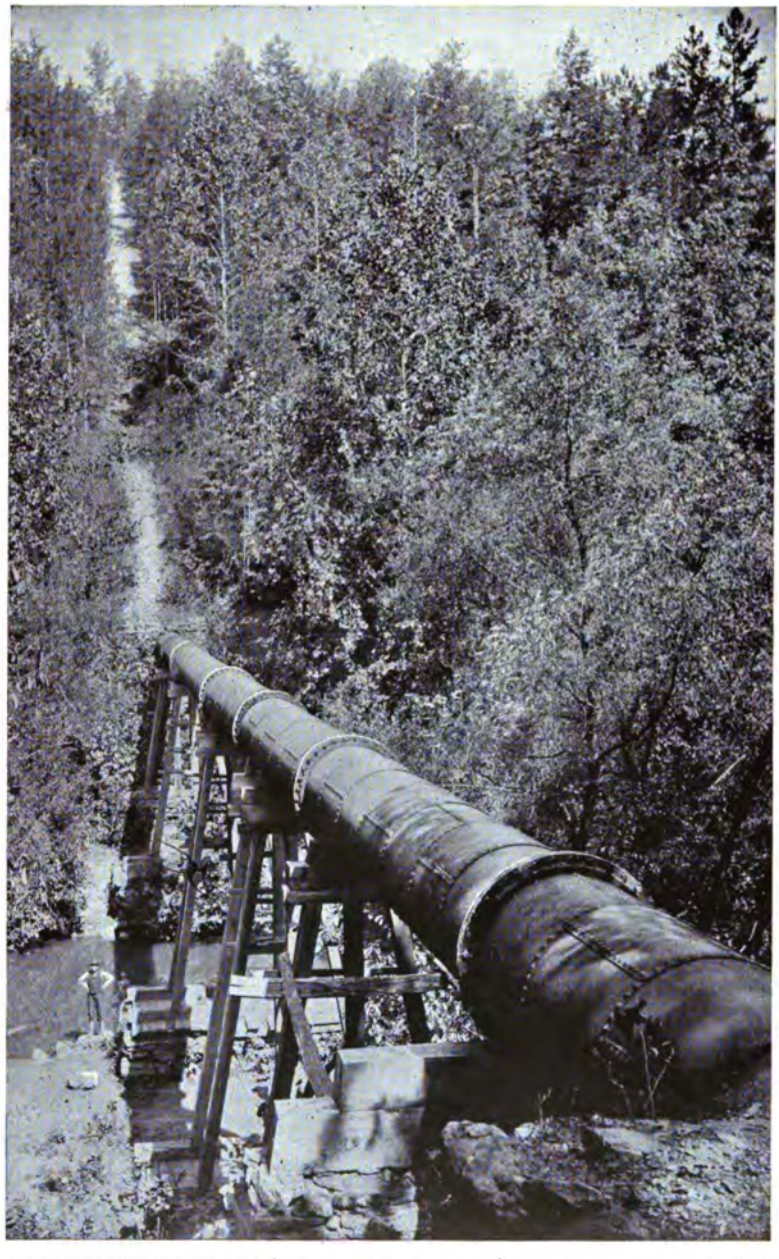
The present practice is to flush the material on to the mill floor back of the batteries, this space in the mill-house being practically arranged as a large bin with a slat screen (distance between slats about $\frac{1}{2}$ inch) at one end. Frequently a V-shaped storage-tank is situated outside of the mill, where the material is collected and flushed into the mill as occasion requires.

THE WATER-SUPPLY.

The system of reservoirs, ditches, etc., in this district is by far the most extensive and best equipped in the Southern gold-belt. The principal water-line is known as the Hand and Barlow ditch, having a total length of 34 miles, the main canal being 20 miles long, 6 feet wide and 3 feet deep, and furnishing 800 miners' inches. The grade averages 5 feet to the mile, being $4\frac{1}{2}$ feet on straight lengths, with slightly steeper grades on bends. The cost of digging this canal was about $1 per rod; the total cost, including trestling, etc. (excluding syphon-line), was $1000 per mile. The canal crosses the Yahoola valley about 1 mile northeast of Dahlonega, in a wrought-iron syphon-tube (see Plate VIII) 2000 feet in length. The difference in level of the two ends is about 6 feet, and the pressure at the lowest point is 90 pounds per square inch. The inside diameter is 3 feet, the thickness of the pipe being $\frac{8}{16}$ inch in the upper and $\frac{3}{8}$ inch in the lower part. It was built in 1869.

Four miles from Dahlonega the water is carried across a similar depression in a wooden tube which is $\frac{7}{8}$ of a mile in length and 3 feet in outside diameter. It is made of 3 by 5-inch staves, trimmed so as to make a tight fit. These staves are laid in wrought-iron hoops, forming alternate joints; the last stave is driven in with a maul. This tube was built in 1868, and is still in good condition.

Auxiliary ditches run off from the main canal to the various mines. A portion of this water was formerly leased out at the rate of 12 cents per miner's inch for 24 hours. The present owners, The Hand &



WROUGHT-IRON SIPHON PIPE (3 FEET INSIDE DIAMETER), 2000 FEET LONG, ON THE HAND BARLOW DITCH LINE, CROSSING THE YAHOOLAH RIVER. ONE MILE FROM DAHLONEGA, GA.

DAHLONEGA METHOD OF MINING, SHOWING GIANT AND GROUND SLUICE.

Barlow United Gold Mines and Hydraulic Works of Georgia, have, however, been lately using the whole amount in working their own mines. Besides this system there are several smaller ones, bringing the total length of ditch-lines up to about 80 miles.

A unique feature of the water-supply at the Findley mine is the elevation of the water from the ditch-line to a reservoir situated 152 feet above it, by means of a hydraulic pumping engine made by the Filer & Stowell Company, of Milwaukee, Mich. This pump is situated near the stamp-mill, 285 feet below the ditch-line. The water is led to it from the above ditch in a 16-inch straight-riveted feed-pipe 456 feet in length, and is discharged by it into a reservoir of 88,000 cubic feet capacity, a total vertical height of 437 feet, through a 12-inch steel pipe 1141 feet in length. The principle involved is that of the hydraulic ram, inasmuch as a large quantity of water under a lower head raises a certain portion of itself to a higher head, the remainder being waste. The machine, however, is of entirely different and, so far as known, novel construction. It is of the duplex pattern, the two engines being connected by gearing and with an 8-foot fly-wheel. Each engine has 3 cylinders in tandem, to which the water under the feed-head (123 pounds) is admitted and discharged by valves of the Riedler type. In one of these cylinders the water is raised to the greater head (190 pounds) at the expense of the feed-water, under head, going to waste in the other two. A snifting-valve is attached to the latter to give relief to the valves. The stroke is 18 inches, and at a high piston-speed of 250 feet per minute the pump works very smoothly. Tests had not been made, and no figures of efficiency could be obtained at the time of our visit. Such figures, as well as a more detailed description than could be made after a hasty examination, would be of great interest. The present working capacity of the pump is 600 gallons per minute.

MINING METHODS.

The general character of the ore-bodies has already been described (pp. 22 and 23). The depth of the saprolites (decomposed schists) in the Dahlonega region reaches often to 50 and sometimes 100 feet. Enormous openings have been made in these by the hydraulic giant, whole sides of the mountain being torn off in places (see Plate IX). The head employed in hydraulicking varies from 50 to 150 feet, dependent on the height from which water can be obtained. Where harder rock is torn loose, it is broken by hand-sledges and thrown into the ground-sluices. Powder is sometimes resorted to for breaking down the more resistant ledges. In order to shorten the distance in sluicing to the mill, tunnels are often run through the intervening hills (as at the Hand and Findley mines). The wooden sluice-line is supplied with longitudinal riffles throughout its entire extent.

In the pursuance of this method a large proportion of the material carried to the mill is perfectly barren, for the reason that the entire mass is not gold-bearing, but only certain streaks of it, which cannot be mined separately by this method.

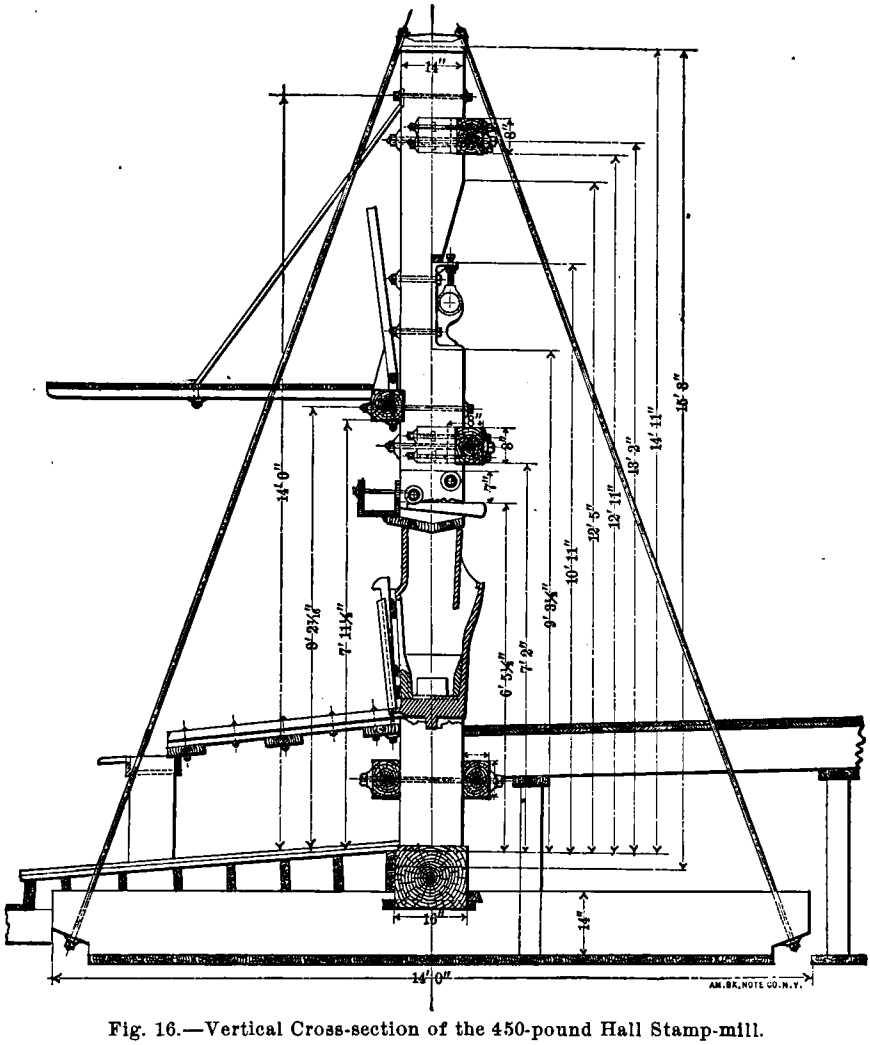


Fig. 16.—Vertical Cross-section of the 450-pound Hall Stamp-mill.

MILLING METHODS.

The Dahlonega method of mining and the milling material resulting from the same have developed a milling practice particularly characteristic of this district. The material floated to the mill is of necessity of small size, the larger pieces of rock being sledged before entering the flume. Thus crushing is dispensed with. Automatic feeders at the

mill have been tried, but were found impracticable, the variable hardness of the ore (only a small proportion being hard quartz and rock) making hand-feeding imperative.

The battery which is almost universally in use is that of the Hall type, invented and patented by Mr. Frank W. Hall, of Dahlonega. The usual weight of the stamp is 450 pounds. Figs. 16 and 17 give the two vertical sections of this mill. It represents novel features both in the battery and in the setting. The long battery blocks and a bed-rock foundation have been entirely dispensed with. The mill can be set upon any level piece of ground, a 2-inch plank platform forming practically the only foundation. The plan of construction (well shown in the drawing) makes the frame self-contained, the blow of the stamp and the reaction being absorbed and neutralized in the setting. Elasticity is maintained by the guy-rods. A suspended platform gives access to the props, cams, etc. The mortar is held in place by a rib on the bottom fitted in a corresponding gain in the mortar block. It is held down on the latter by wedges driven against blocks bolted on the inside of the battery posts. The small inside dimensions of the mortar are still more narrowed down by chilled-iron liners, which reach to within an inch of the dies. The main purpose of these liners is to bring the ore, on being fed, immediately under the shoes. They also protect the mortar against wear, and help to some extent in collecting and secreting amalgam. Quicksilver is fed to the batteries, and in some cases a considerable amount of amalgam collected is obtained from the mortars. The liners are fitted with dovetails and lugs at the end, and are finally held in place by two large keys driven against the screen frame, which is shod with wear iron on each side. On removing the front liner the mortar is opened to the floor. The dies, which sit in ½-inch depressions, are easily withdrawn, the back and side liners drop out, and the mortar can be cleaned in a few minutes. The whole clean up in a 10-stamp mill is accomplished in the space of half an hour. The front liner determines the height of discharge, which, when the dies are new, is about 2 inches. An annealed copper plate, 4 feet long and of the full width of the mortar, is in most cases considered sufficient for the outside amalgamation. The weight of the 450-pound stamp-mill is divided as follows:

	Pounds.
Stem or spindle	175
Head of boss	150
Tappet with keys	50
Shoe	75
Total weight of stamp	450
Die	50
Mortar	2100
Liners for same	240

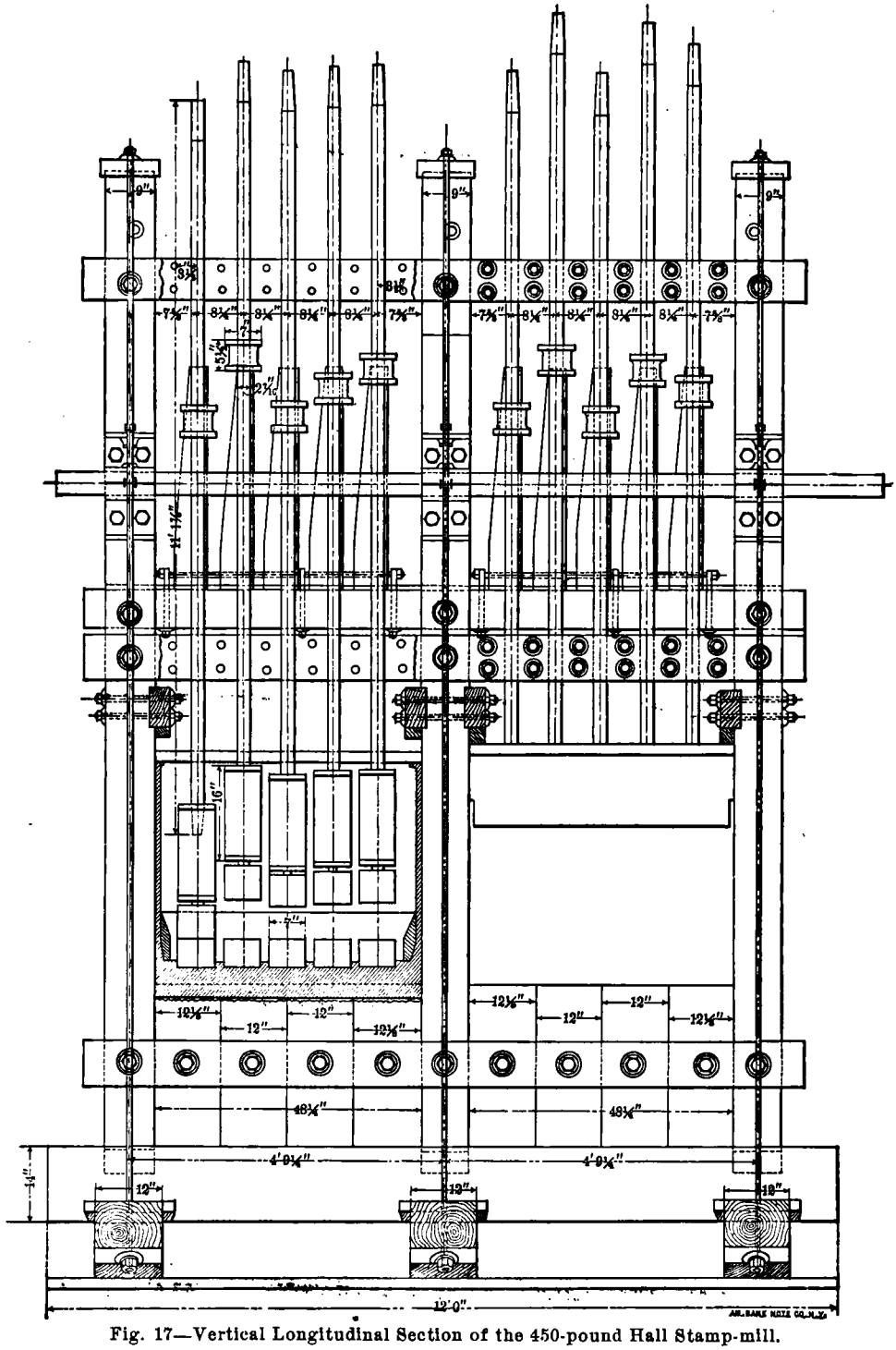


Fig. 17—Vertical Longitudinal Section of the 450-pound Hall Stamp-mill.

The average drop of stamp is 9 inches; number of drops per minute, 90. The whole machine is well constructed, and admirably fulfills its purpose of handling large quantities of the Dahlonega mill-stuff. The mill is also built with heavier stamps, and some slight changes are made in the frames of these. None of these heavier mills were seen in operation; but the setting employed is said to give as great satisfaction as in the lighter ones. Whether the application of this mill would be extensive for harder ores we are unable to judge. It certainly gives the extreme of rapid crushing, and might be adopted where such an object is in view.

The cost of these mills is light and that of installation small as compared with those of Western type.[1]

Almost all the mills in Dahlonega are operated by water-power, using turbines of the Leffel type for large quantities and low heads, and wheels of the Pelton type when the water is small in quantity under a high head. The crushing capacity of these mills varies from 2 to 5 tons per stamp of 450 pounds in 24 hours, depending greatly on the nature of the material run through.

In hydraulicking, and subsequent transportation by water, a partial concentration takes place, resulting in the eventual deposition of a largely enriched product in the mill. The light stuff and most of the slimes pass through the mill, in almost all cases without subsequent treatment, and the heavy product remains, the enriching being all the way from 2 to 5 times the original value of the ore in place. Besides this, free gold (generally about one-third of the total amount saved) is caught in the sluices before reaching the mill. Some of the losses in this process are evident from the above. Another serious loss, which is rapidly making itself felt as the mines grow deeper and less decomposed ores occur, is that of gold in the sulphurets. In such ores that carry sulphurets at all it is stated that they will run from 2 to 10 per cent., the concentrates from which are reported to assay as high as $40 and higher. Thus far, concentration has not been carried out on a working

[1] The following figures were obtained in the camp as representing the average cost of a 450-pound 10-stamp mill of the Hall type, as erected and used in the Dahlonega district:

All iron-work for batteries and setting, including copper-plates (f. o. b. works, Cincinnati)	$700 00
Freight on same, and cost of erection, about	500 00
Buildings, floors and sluices	400 00
Engine and boiler, with connections	600 00
Freight on same, about	150 00
Total cost of complete mill	$2350 00

Water-wheel and installation of same would cost about the same as engine and boiler. Chrome steel (made in Brooklyn, N. Y.) and Wilson pressed steel (made in St. Louis, Mo.) shoes and dies find about equal favor in the district, costing respectively 6 and 7 cents, f. o. b. works. Cast-chilled iron shoes are also used to some extent, at a cost of about 3 cents per pound.

Mills similar to the Hall type are also made in Gainesville and Atlanta, Ga.

basis. Despite many inquiries amongst local mill-men and others, we could hear no reports of losses in amalgamation resulting from so-called rusty gold. A loss of this nature was in a few cases ascribed to the finely-divided or flaky condition of the gold.

It is difficult to give any average values of the Dahlonega ores, or in fact to clearly designate exactly what the term ore applies to in this district. Material worth as low as 40 cents per ton has been milled at a profit. If this figure per ton, plus the gold saved in the sluices (20 cents per ton milled) represents the milling-value of 5 tons of material mined, as is stated to be frequently the case, then the value of the latter per ton must have been 12 cents. As a rule, however, the mill-stuff is of better grade than the above. The actual ore (quartz) is stated to assay from $1 up to exceptionally high values in the cases of rich stringers or pockets.

The cost of mining and milling throughout the district will average from 18 to 25 cents per ton of ore milled.

A description, somewhat more in detail, has been prepared of the following mine as representing perhaps most perfectly the Dahlonega method in its original type (of working soft saprolites or highly decomposed material).

DAHLONEGA METHOD AT HEDWIG MINE.

The Hedwig mine is situated near Auraria six miles west of Dahlonega. It consists of a large open cut about sixty feet in depth, run on a line of siliceous, micaceous ore-bearing schists, sixty feet in total width. The strike of the schistosity is N.E. and the dip 60° S.E. Three separate ledges of barren hornblende-gneiss (brick-bat) enclose two ore-bodies, striking and dipping conformably to them. But very few small quartz-stringers occur in the mass. Water is furnished to the giant (3-inch nozzle) under a maximum head of 60 feet from a reservoir situated on the hillside above the mine. Six men are employed at the mine at 80 cents per day (day-shift only).

The material is run to the mill in a flume 2800 feet in length and 14 by 16 inches in cross-section, made of oak boards. It is supplied with longitudinal riffles made of 2 by 3-inch post-oak scantling. The grade of this sluice is 4⅞ inches in 12 feet at the lower, and 3½ inches at the upper end, that is, in the cut where it is not necessary to avoid overflows. The outside mill-bin holds about 240 tons, and the material is flushed from here to the inside bin, which holds 200 tons. Formerly there were three outside bins and the ore was hauled to the mill in cars.

The mill is a 40-stamp one of the Hall pattern, with a 12-foot driving pulley. It is driven by a 4-inch Ridgeway wheel, using 40 inches of water from two 1-inch nozzles. The water is supplied from the same

reservoir that furnishes the giant at the mine, by an 18-inch spiral riveted pipe-line, 2880 feet in length, under a head of 226 feet. The weight of the stamps is 450 pounds; drop 9 inches, 80 times per minute; discharge 2 inches; round punched screen, 120 holes to the square inch; length of plates (plain copper) 8 feet in two sections; ten of the stamps were fitted with silvered plates in 2-foot sections. Only the upper 4 feet of the plates in the mill are kept in shape; it is stated that no gold was saved on the lower ones. The tailings flow off through mercury traps. The overflow from both the outside and inside bins runs through a short line of riffled sluice boxes. At the time of our examination seven men were employed in the mill in two shifts, at 90 cents per day.

THE LOCKHART MINE, LUMPKIN COUNTY, GA.

The Lockhart mine is situated on the west bank of the Yahoola river near Dahlonega, Ga. It represents the working of ore-bodies of the Dahlonega type by underground mining.

The Dahlonega method of mining the saprolites was formerly employed here, and the old open cuts, now practically abandoned, are of considerable extent. This is the only mine in the Dahlonega district where underground work of any importance has been carried on. The ore-bodies consist of veins of the Dahlonega type (see description, pp. 22 and 23) where the quartz-filling has been more extensive, in places occupying the greater part of the fractured gneiss bands, which in a mining sense may be termed the vein, the boundaries of the gneiss bands forming continuous, smooth walls, and being the limit of the mineable ore. The normal strike of the schists at the Lockhart is northeast and the dip southeast; at one point, however, the schists bend around a mass of "brickbat," the strike being abruptly changed to the northwest and the dip to the northeast.

The principal work has been done on the Blackmore vein, where the country is a biotite hornblende-gneiss. The strike of this vein is N.E. and the dip 30°–60° S.E. It varies in thickness from 3 to 6 feet. The ore-body is opened by two adit-levels on the vein, 60 feet apart. The lower one, which enters the hillside at a depth of about 135 feet below the original outcrop, has a length of 400 feet, and the ore has been stoped out between it and the upper level for a distance of 100 feet from the face, which is the length of the ore-shoot so far as explored. This shoot has also been worked from the upper level to the surface. The pitch is steeply to the N.E. The ores from this shoot mill from $4 to $5 per ton. Besides this richer shoot the bottom level exposes ore throughout its entire length. This, however, decreases in quality as the mouth of the tunnel is approached, where it yields only $1. The system of work is underhand stoping, stulls being placed 6 feet apart to hold

up the ground. The ore is carried from the stopes in barrows to a platform at the mouth of the tunnel, from where it is hauled to the mill by carts.

The same vein has also been opened by a shaft, 50 feet deep, at the mill house, which is situated about 300 feet N.E. from the mouth of the mine. A drift 300 feet long was run on the vein here, which is reported to be 14 feet thick, carrying highly sulphuretted ores, which milled $4. This part of the mine is now under water.

Other ore-bodies have been opened up to some extent, but not sufficiently to say much of their nature.

The ore is treated in a 20-stamp mill of the 450-pound Hall type, erected originally for working material from open cuts by the Dahlonega method. No crusher or mechanical feeder is used, and no concentration of the sulphurets has so far been attempted, although they are stated to be of high grade. The ore is fed by hand, one man attending to each ten stamps. The drop is 6 to 8 inches, 60 times per minute, and the discharge is about 2 inches high. The screen used is a No. 9 Russia slot. The plates are 6 feet in length, plain copper.

For the hard ores, such as are at present mined, this mill can scarcely be considered of the best type, being too light. A crusher and automatic feeder would also be applicable here, as well as concentrators and a subsequent treatment of the sulphurets. The mill-power is furnished by a turbine wheel, obtaining its head of water from a dam across the Yahoola river.

The cost of production at the Lockhart is given as follows:

	Per ton of ore.
Mining	$ .90
Hauling	.15
Milling	.20
Other expenses	.10
Total cost of producing bullion	$1.35

The average milling value of the ore for the month ending February 3, 1895, is given as $4.15 per ton. No figures of the assay-values of the tailings could be obtained.

CHAPTER VI.

MINING, MILLING, AND METALLURGICAL TREATMENT OF SULPHURET ORES AT CHARACTERISTIC MINES.

THE REIMER MINE, ROWAN COUNTY, N. C.

This mine is situated about 6 miles southeast of Salisbury on the waters of the Yadkin river. Geologically it is in the Carolina belt. It represents a highly sulphuretted quartz-vein of marked persistency, with smooth walls and a clay gouge, the ore from which is worked by stamp-mill amalgamation, concentration of the sulphurets, and chlorination by the Thies process.

The vein is said to average 3½ feet in thickness, varying from 1½ to as high as 9 feet. The strike of the outcrop, which has been traced for 2 miles, is in an east and west direction. The dip is practically vertical. The sulphurets, mostly pyrite with a little chalcopyrite, occur in bunches, averaging about 10 per cent. of the ore. The quartz is compact, white and glassy. The wall-rock is a coarse crystalline eruptive, probably a quartz-diorite, and a fine-grained phase of the same.

Until 1884, when it was destroyed by fire, a concentration plant was in operation here. The concentrates which were obtained without previous amalgamation, were treated at the Yadkin Chlorination works near Salisbury. Work was not taken up again until 1894 and lasted until the fall of 1895. Fig. 18 gives a vertical section of the mine along the strike of the vein. The last work was concentrated at the bottom of No. 1 shaft (1), at a depth of 190 feet. The shaft is poorly constructed and very wet. A Cornish pump, driven by a belt from the crank of a small friction-clutch hoisting engine, raised the water from the bottom into a crude ring at the 150-foot level, from where a No. 9 Cameron sinking pump raised it to the surface. No development work was carried ahead, the ore being taken out by overhead stoping as soon as found. It was stated by the management that the poor condition of the mine and the crude method pursued was due to the more or less experimental nature of the late underground developments. The size and substantial construction of the mill and chlorination plant seem, however, to have gone beyond this stage. On account of the limited development the mine was worked in three shifts of eight hours each, with two miners and helpers on each shift, paid respectively $1.50 and

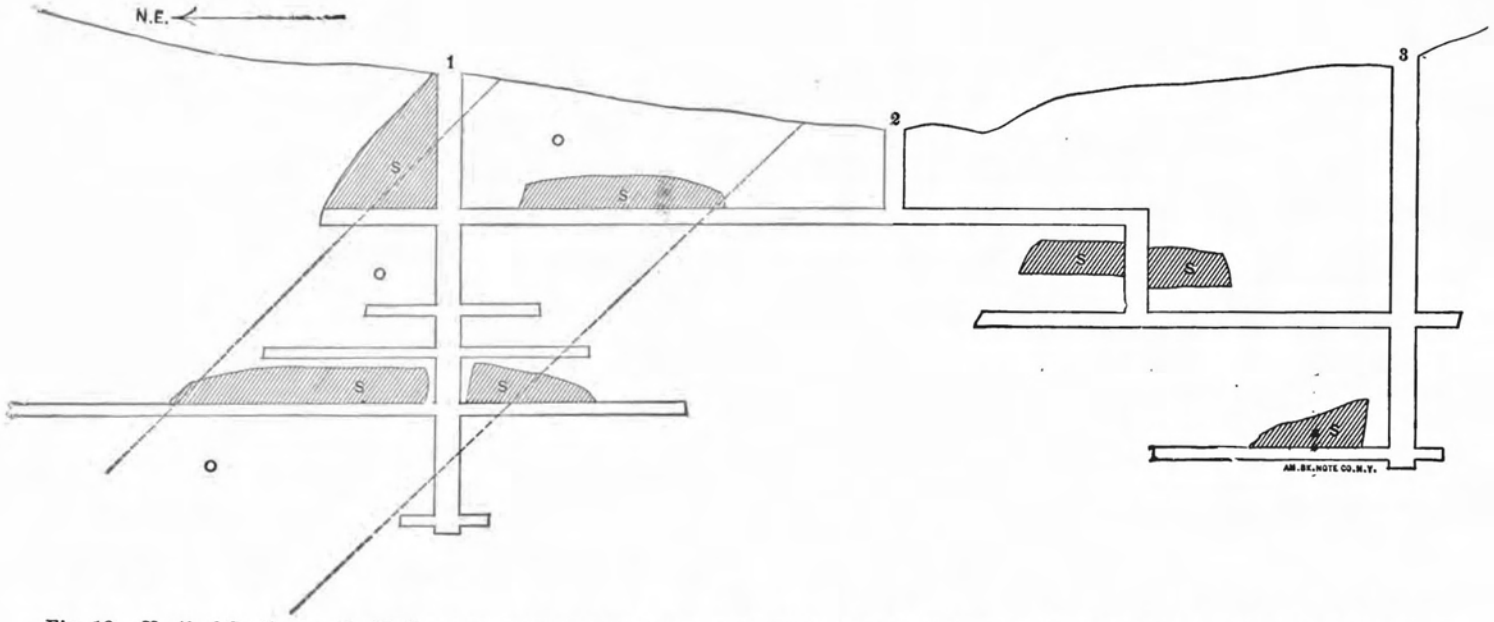


Fig. 18.—Vertical Section on the Strike of the Vein, Reimer Mine, N. C. Scale, 1 inch=80 feet. 1, shaft No. 1; 2, air-shaft; 3, shaft No. 2; O, dip of ore-shoots; S, stoped ground.

$1. The engineer, fireman and top-labor worked in two shifts of twelve hours each. No definite information could be gained regarding the cost of mining; but under the conditions existing, it must have been excessive. The mill is a 20-stamp one, built by the Mecklenburg Iron Works.[1] The mortar (fig. 19) is of a modified California type, and of medium width and depth. A novel feature in this mortar is a large opening above and in back of the screen by which the inside of the screen can be reached to clear it of foreign clogging matter. The inside plates may also be taken out through it without disturbing the screen. The weight of each stamp is 750 pounds, given 5- to 7-inch drop, 90 drops per minute. No inside plates are used at this mill. The height of the discharge is 5 inches, when the dies are new. The screens are 40-mesh, brass wire. The outside plates are similar to those at the Haile mine (see p. 136) The amount of ore milled was about 1 ton per stamp in 12 hours. About ⅓ of the gold extracted was saved by amalgamation. The tailings from the plates were concentrated on 2 Frue and 2 Triumph vanners, producing about 1 ton of concentrates in 12 hours, running from $30 to $40 per ton.

The concentrates were roasted in a large reverberatory furnace located in the mill building, the area of the hearth being 9x41½ feet. The capacity of this furnace was stated to be 4 roasted tons in 24 hours at a cost of $1.25 per ton. The furnace was worked in two 12-hour shifts with two men on each shift, head roaster at $1 and helper at 85 cents. Two cords of wood, at $1.25 per cord, were burnt in 24 hours.

The chlorination was carried on in a 1-barrel plant with a capacity of 4 roasted tons of concentrates per 24 hours. The building is arranged for the addition of another barrel which would allow the same work to be done in 12 hours, giving better opportunity for precipitation, and reducing the total cost of chlorination. The charge and the method of working was identical with that pursued at the Haile mine (see p. 140).

[1] The Mecklenburg Iron Works of Charlotte, N. C., Captain John Wilkes, Manager, make a specialty of gold-mining and milling machinery. In the summer of 1895 this company erected a 5-stamp test mill at their works, connected with a complete chlorination test plant having a capacity of half a ton of raw concentrates per day. As being of interest and value in a paper of this kind, we have obtained from them the following list of the cost of milling and chlorination plants erected in the South. The figures given are outside ones and apply in each case to a complete automatic plant.

The cost of the machinery for a 10-750-pound stamp mill with grizzly, crusher, self feeders, silvered inside and outside plates, Triumph concentrators (4 to every 10 stamps), engine and boiler, together with all attachments, and plans for erecting and locating machinery, is given at $5700 f. o. b., Charlotte, N. C. The same for a 20-stamp mill is $10,350.

The complete cost of a 10-stamp mill as above, set up (in the vicinity), will be about $8000. Of a 20-stamp mill, about $14,000.

The approximate cost of a 1-barrel chlorination plant with two reverberatory furnaces, erected, is given at $5500. The same for a 2-barrel plant with four furnaces at $9700.

The complete cost of a 10-stamp mill with concentrators, roasting furnaces and a Thies chlorination plant with all necessary power and expenses may be figured at $1200 per stamp. For a 20-stamp mill at $1000 per stamp, and for a 40-stamp mill at $900 per stamp.

The price of shoes and dies of a chilled charcoal iron mixture is 3 cents a pound f. o. b. works.

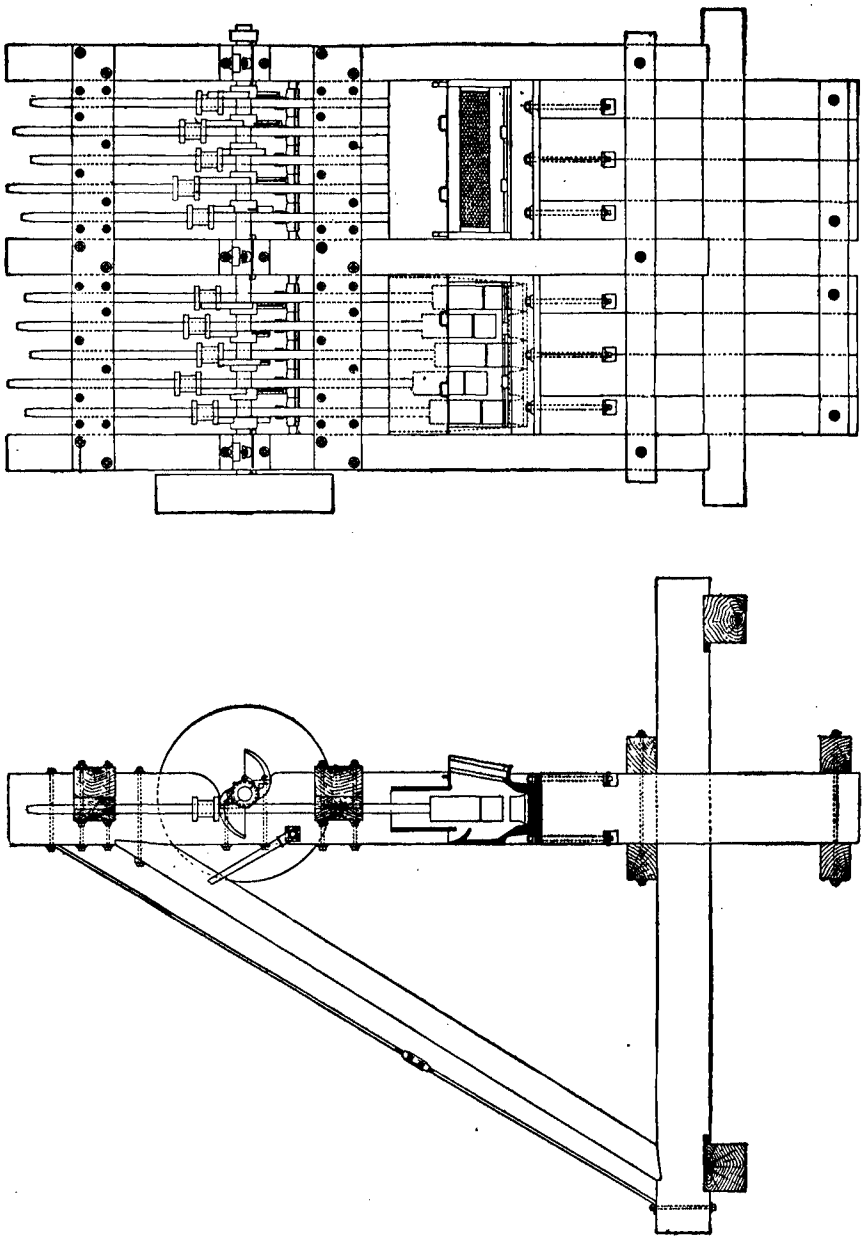


Fig. 19.—Mecklenburg Iron Works, 750-pound battery, Reimer Mine, N. C.

No satisfactory figures regarding the value of the tailings from either the concentration or chlorination could be obtained; the figures given were high as compared with those of other mines. The cost of milling, concentration, roasting and chlorination per ton of ore milled was given at $1.80 per ton. This excessive cost, almost three times as much as that at the Franklin mine, an almost identical case as far as the plant and the thickness of the ore-body are concerned, must no doubt be greatly laid to the fact that an attempt is made to supply a plant with a nominal capacity of 40 tons in 24 hours from a mine, in which the development does not warrant an output of 10 tons in this time.

The percentage and value of concentrates given above, with the addition of the gold saved on the plates, gives an estimated value of from $4 to $5 per ton to the ore mined, without including in this value the gold lost in tailings. Such an ore if found in sufficiently large bodies on developing the mine, should pay a profit with the above method of treatment under a close management.

Experiments were made with cyanide in 1896, but were not successful.

THE FRANKLIN MINE (CREIGHTON MINING AND MILLING COMPANY), CHEROKEE COUNTY, GA.

This mine is situated on the Etowah river, about 16 miles northeast of Canton, the county seat. Geologically it is in the Georgia belt. The proposition presented here is in most respects similar to that at the Reimer mine.

The country-rock consists of gneissoid mica- and hornblende-schists, often garnetiferous. The general strike is N. 55° E. and the dip 40° S.E. Granite dikes are stated to exist in the vicinity of the mine, but none have been as yet found intersecting the ore-bodies. The character of these ore-bodies has been described (p. 23). There are two parallel veins about 150 feet apart, known respectively as the Franklin and the MacDonald. Of these, the Franklin has been most extensively opened, and is the only one that has been worked during recent years. The strike and dip of the veins are, in the main, coincident with those of the country schists. The mineable ore exists in lenticular shoots or cylinders pitching 45° N.E. (see fig. 20). Four such shoots had been opened in the mine within a horizontal distance of about 750 feet on the strike, at the time of our visit. The largest one of these has a maximum length of 120 and maximum width of 14 feet. The average thickness of the ore-bodies is probably about 3 feet. All but one of the ore-shoots crop out at the surface, and they show considerable permanency in depth. The 350-foot drift in the mine was extended in a northeasterly direction about 400 feet beyond the last ore-shoot. Although a permanent vein with clay casings, and in places heavy quartz-

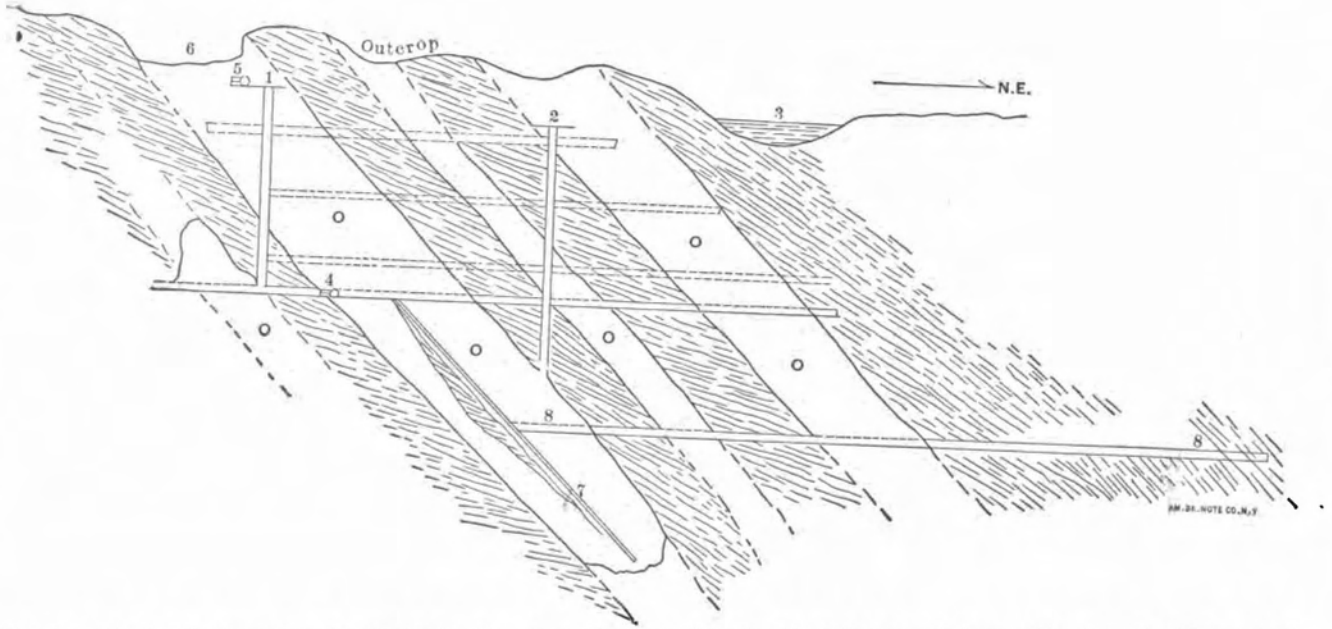


Fig. 20.—Vertical Section along the strike, Franklin Mine, Ga. Scale, 1 inch=200 feet. O, ore-bodies; 1, No. 2 shaft; 2, No. 1 shaft; 3, Etowah river; 4, underground hoisting engine; 5, surface hoisting engine; 6, Franklin Pit; 7, slope; 8, 350-foot level.

filling, had been found, the ore was not rich enough to mill. On the 235-foot level a horizontal diamond-drill hole (over 150 feet in length) was bored in the hanging, but no other parallel ore-body was found. Cross-fissures, from 3 to 6 inches in thickness, are met with in the mine, striking N. 30° to 35° W., with a vertical dip, and intersecting, though not faulting, the ore-bodies. These fissures are filled with coarse crystalline calcite, sometimes carrying inconsiderable amounts of pyrite. The structure of the vein-quartz at the Franklin is banded, and its character is milky, glassy. The sulphurets consist mainly of coarse crystalline pyrite (with very little chalcopyrite), usually occurring in bunches. Although the ore is over 50 per cent. free-milling, gold visible to the eye is of very rare occurrence. The fineness of the gold is 980 to 989.

The property of the Creighton Mining and Milling Company comprises some 1800 acres. The first work done here was by open cuts in the outcrop of the ore-shoots. After the death of Mr. Franklin, the original owner, the mine was worked for a long time by his widow.

Before the adoption of the chlorination process for treatment of sulphurets by the present company, a cyanide plant was erected and operated for a short time.

The present condition of the mine is shown in figure 20, giving a vertical section along the strike. The mine is worked entirely through No. 2 shaft (1), driven in the hanging wall to a depth of 215 feet, at which point it strikes the vein. From this level work is carried on to a total depth of 430 feet by a slope on the dip of the vein and the pitch of the ore-shoot, resting on a small horse of poor ore.

The method of mining the ore is as follows: Levels are run every 100 feet, and the ore-lenses are entirely stoped out, leaving the intervening bodies of low-grade material as pillars. The levels are connected by a series of raises, their number depending upon the length of the ore-shoots. The ore is then stoped by underhand work, the raises acting as ore-chutes (mill-holes), and the cars being loaded directly from pockets in the level below. No pillars are left below the levels, the track, when necessary, being carried over the worked-out stopes on stulls. Only such timbers as are necessary to assist the men in their work are used, the walls requiring no support. All the material stoped is hoisted and milled, leaving no waste filling in the mine. Air-drills are used almost exclusively; for stoping, a Baby Rand with $\frac{7}{8}$-inch steel is used, while drifting is done with $3\frac{1}{4}$-inch cylinder Sergeant machines. The ore is raised in cars of $\frac{1}{2}$-ton capacity, first up the incline by underground hoisting engine (4), and then trammed to the bottom of the vertical shaft, from where they are hoisted to the surface on cages. No. 1 shaft (2) is used for ventilation and as a pipe-way. The mine is not a wet one, a small steam-pump, situated immediately below No. 2 shaft, taking

care of the water. At the surface, the ore is run over a grizzly and then through a crusher, the jaws of which are set 1½ inches apart. The crushed ore is hauled to the mill by mules in cars of 1½ tons capacity, which are loaded from a bin below the crusher.

During the summer and fall of 1895 two other shafts, No. 3 and No. 4, located respectively ¼ and ¾ miles southwest of No. 2, were in progress of sinking, with the object of developing in depth lenses of ore which had been located and worked to some extent on the surface. Considerable diamond drilling has been done on the property (some 800 feet in all) at a cost of about $1.25 per foot.

The mill is situated about ¼ of a mile from No. 2 shaft, on the east bank of the Etowah river. Water at a head of 7½ feet is supplied to two turbine wheels by a dam thrown across the river. One of the turbines, a 60-inch Leffel wheel, supplies 23 horse-power to the stamp-mill, while the other, a 56-inch Davis wheel, drives a duplex Rand air-compressor. The concentrators are run by steam-power, that derived from the turbine not being of sufficient regularity to secure a uniform product. There are 20 stamps in the mill, 10 of Western make and 10 erected by the Mecklenburg Iron Works. Weight of stamps 850 pounds, 7-inch drop, 70 drops per minute, 6-inch discharge. No inside plates are used and no quicksilver is fed to the battery (a little coarse gold is cleaned from the battery sands). The screens are No. 7 slotted Russia iron, corresponding to about 30-mesh. The outside plates have the full width of the mortar. They are 8 feet long, arranged in four steps, and are handled in the same manner as those at the Haile mine. About 55 per cent. of the gold extracted from the ore is saved by amalgamation. The ore is fed from bins by Hendey automatic feeders. The mill handles 35 tons in twenty-four hours.

The pulp from each 10 stamps is carried by launders to four hydraulic classifiers, the overflow from all these going to one slime-spitzkasten of 9 by 9 feet surface dimensions. The product of the 8 hydraulic classifiers goes to 8 Embrey tables, the product of the slime-kasten being distributed to 2, making 10 tables in all working on mill-pulp. Besides these, there are 3 tables working on old amalgamation tailings, assaying about $3 per ton. The concentrates are not clean, containing about 50 per cent. of sand, but close work would decrease the percentage of extraction. The average amount of sulphurets in the ore mined is about 5 per cent., sometimes running as high as 9 per cent. As high as 5¼ tons of raw concentrates are produced and treated in twenty-four hours. The tailings from concentration run at present about 85 cents per ton, giving a remarkably high percentage of extraction.

The concentrates are roasted in two double-hearth reverberatory furnaces, with a capacity of 2 tons of roasted ore each in 24 hours. Twelve

pounds of salt per ton are added to the charge to change the carbonate of lime present to chloride.

Chlorination of the roasted concentrates is carried on in a one-barrel chlorination plant, the arrangement of the same and the method pursued being identical with that at the Haile mine (see p. 137). The tailings from the chlorination run about 60 cents per ton, giving an extraction of over 95 per cent.

Labor, Costs, etc.—At the time of our examination about 90 men were on the pay-roll of the company, when work was going on at full capacity. The force of men is variable, however, depending upon the output and the amount of development work. The wages paid were as follows:

	Per day.
Drill runners	$1.55
Helpers	1.00
Muckers	.75 to 80 cents.
Trammers	1.00
Blacksmiths	2.25
Carpenters	2.50

Three men were employed on each 12-hour shift in the mill and concentration house at the following wages:

	Per day.
Amalgamator	$1.40
Concentrator	1.35
Helper	.75

Roasting.—Two men on each shift, at $1.25. Cost of roasting, per ton of roasted concentrates, $2.

Chlorination.—One man on each shift. Cost of chloridizing per ton of roasted concentrates, $1.48.

Supplies.—Timber, $9 per 1000 feet. Cord wood, $1.25 per cord, 8 cords used per day.

Cost per ton of ore mined:

Mining, crushing and tramming to mill	$2.05[1]
Milling, roasting and chlorination	.65
Total	$2.70

THE HAILE MINE, LANCASTER COUNTY, S. C.[2]

The Haile mine is situated 3 miles northeast of Kershaw in Lancaster county, S. C. It is the property of the Haile Gold Mining Company (New York office, 17 Maiden Lane), Capt. A. Thies, superintendent and general manager.

[1] This figure includes all development work. The average value of the ore and the concentrates cannot be given for private business reasons.

[2] Written in co-operation with Mr. A. Thies.

This mine represents an example of gold mining in its highest development in the South, on large bodies of low-grade sulphuret ore.

It is situated in the Carolina belt. The country is a siliceous hydromuscovite- and argillaceous-schist striking N. 45° to 70° E. and dipping 55° to 85° N.W. The rock is impregnated with auriferous pyrite, free gold, and in places small quartz-stringers. This is the mass that constitutes the ore-bodies, which are lenticular in shape. Their outline, however, does not necessarily conform with the strike and dip of the slates, but is determined rather by the degree of impregnation. The lenses are about 200 feet in length and 100 feet in maximum width. The pitch is 50° to 60° N.E., and the dip N.W. from 45° to nearly vertical. The country is intersected by a number of diabase dikes, from a few feet to 150 feet in width, striking across the slates at various angles, and in one instance (Beguelin mine) parallel with them. Where these dikes cross the ore-bodies they appear to have exerted, in some cases, an enriching influence on the ore. A short distance to the southeast of the main workings is the outcrop of a heavy quartz-vein (F., fig. 21) from 10 to 12 feet thick, which strikes parallel to the slates; it is apparently barren. As explained above, the ore consists of pyritic slates, silicified in varying degrees, from soft, sericitic slate to very hard hornstone. The more siliceous ores are usually the richest; graphitic laminæ are also good indications. In the better grade of ore the pyrite exists in a finely divided condition. Ore containing coarse sulphurets is generally of poor grade. The crucial test, however, of the value of the ore is the amount of free gold it contains, which is in direct proportion to that contained in the sulphurets, and is determined by daily panning. The ore at present delivered to the mill averages $4 per ton (assay value), of which about one-third is free gold.[1] The percentage of sulphurets in the ores varies from 2 to 25 per cent.

The first work done at the Haile mine consisted of branch washing in 1829, which led afterwards to the discovery of gold on the hillsides. All work was open cutting until 1880, when underground mining was begun, and this is continued to the present time. Although visible coarse gold is now of rare occurrence, the mine has yielded some nuggets worth from $300 to $500 from the decomposed slates in the shallow open cuts.[2]

The first mill was a 5-stamp one, afterwards enlarged to 10, and in 1881 to 20. About 1884 a Blake dry-crushing mill was erected in connection with 20 Embrey tables.[3] This was soon abandoned, and the mine was worked in a dilatory way with the 20-stamp mill until 1888.

[1] Ores as low as $2.75 have been successfully milled.

[2] *First Annual Report on the Survey of South Carolina for* 1856, by O. M. Lieber, Columbia, S. C., 1858, p. 62.

[3] "The Blake System of Fine Crushing and Its Economic Results," by T. A. Blake, *Trans. Am. Inst. Min. Eng.*, xvi, 753.

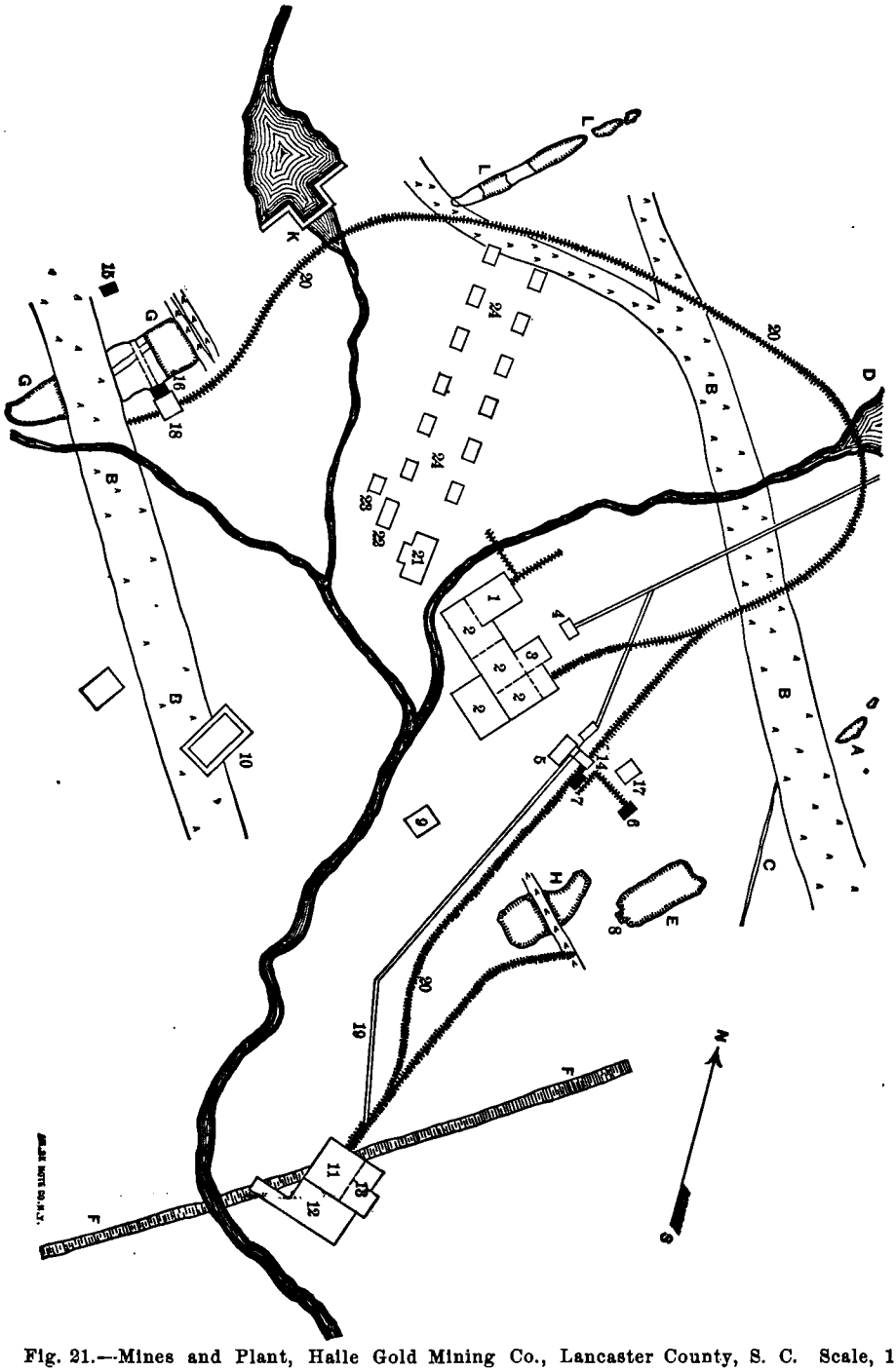


Fig. 21.—Mines and Plant, Haile Gold Mining Co., Lancaster County, S. C. Scale, 1 inch=400 feet.

A, Red Hill pits; B, Diabase dikes; C, clay dikes; D, outlet of large reservoir; E, Bumalo pit; F, quartz-vein; G, Beguelin mine; H, Haile pit; K, small reservoir; L, Chase Hill pits; 1, chlorination house; 2, roasting furnaces; 3, boiler house; 4, pump; 5, machine shop; 6, No. 2 shaft; 7, new shaft; 8, No. 3 shaft; 9, offices; 10, superintendent's residence; 11, mill; 12, concentration house; 13, boiler and engine; 14, crusher; 15, new Beguelin shaft; 16, Beguelin slope; 17, boiler house; 18, crusher; 19, flume; 20, mine railroad; 21, commissary; 22, church; 23, school; 24, village.

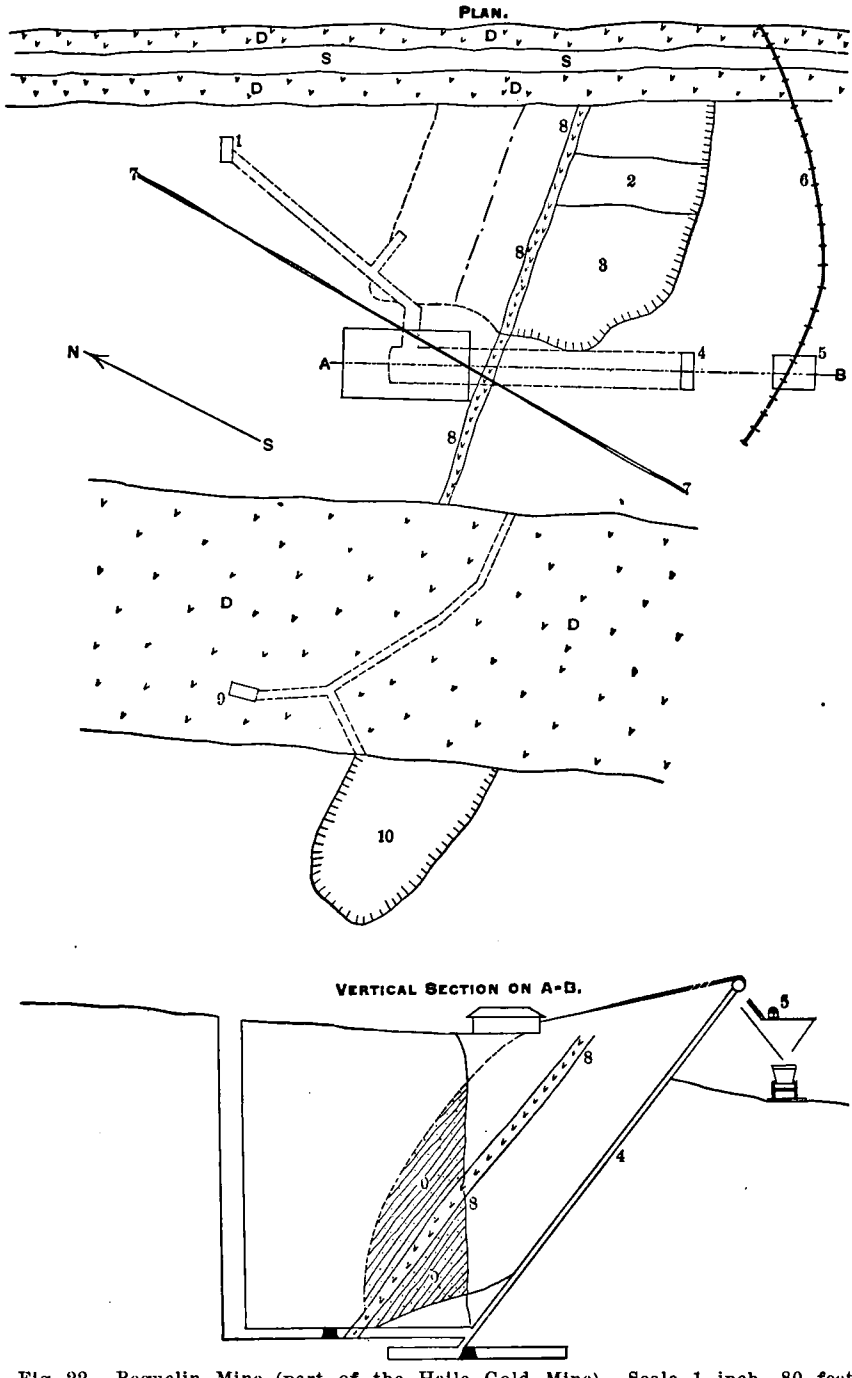


Fig. 22.—Beguelin Mine (part of the Halle Gold Mine). Scale 1 inch=80 feet D, diabase dikes; S, slate; O, ore-body; 1, new shaft; 2, pillar; 3, pit, 160 feet deep; 4, inclined shaft; 5, crusher and ore-bin; 6, mine railroad; 7, 22-inch diabase dike; 8, dlabase dike, parallel to ore-body; 9, old shaft, 50 feet deep; 10, open cut, 40 feet deep.

During this time, and previously, many unsuccessful experiments for the treatment of sulphurets were made.[1] In 1888, Mr. A. Thies took charge of the Haile mine. He operated the 20-stamp mill until the mine was sufficiently developed to warrant a larger plant. At this time a 2-barrel chlorination plant was added and increased later on to 3 barrels. In 1889 the Blake mill was changed to a 60-stamp, back-to-back mill, with 20 concentrators.

DESCRIPTION OF THE MINE WORKINGS; HAILE MINE.

The present workings consist of the Cross (a continuation in depth of the old Haile and Flint pits, H, fig. 21), and the Beguelin (G, fig. 21) mines. The Bumalo, Red Hill and Chase Hill pits (E, A and L, fig. 21) have not been worked for some time, although in the first there has been considerable underground work.

Work at the Cross mine was stopped in 1888, and all attention was concentrated on the Beguelin (formerly Blauvelt) mine. Fig. 22 gives a plan and vertical section of the open pits and some of the underground workings of this mine. The old workings consist of some shallow open pits and 3 perpendicular shafts, one 70 feet deep in ore, one 54 feet deep in the diabase dike (9, fig. 22), and one 70 feet deep in the foot-wall slates on the southwest side of the dike (not shown). The first of these was transformed, from a depth of 60 feet downward, into an inclined shaft (4, fig. 22), and sunk in the ore-body to a depth of 195 feet. This shaft was rigged with a self-dumping skip, crusher and ore-bin situated over the railroad tracks which had been extended to the mine. At 60 feet a drift was run in a northeast direction until the diabase dike was reached. Meanwhile sinking was continued in the shaft to 120 feet. From this level drifts were run and connections were made with the 60-foot level, which prepared the ground between them for stoping. At 180 feet a similar drift was run to the dike and connections made with the upper levels in such a manner that the ore from the 60-foot would fall to the 180-foot level, and from there be hoisted to the surface. At 180 feet a drift was started in a southwesterly direction, encountering at 64 feet a dike 125 feet thick, through which the drift was continued to a distance of 600 feet from the shaft. At a depth of 70 feet a similar drift was run and the ore-body beyond the dike was prepared for stoping by connecting these two drifts by several raises. At the present day all ore on the west side of the dike has been stoped out to the 180-foot level. To the northeast of the shaft a considerable body

[1] "Gold Mining in South Carolina," by E. G. Spilsbury, *Trans. Am. Inst. Min. Engs.*, xii, 99.
"Notes on the General Treatment of the Southern Gold Ores and Experiments in Matting Iron Sulphides," by E. G. Spilsbury, *Ibid.*, xv, 767.
"Chlorination of Gold Bearing Sulphides," by E. G. Spilsbury, *Ibid*, xvi, 359.

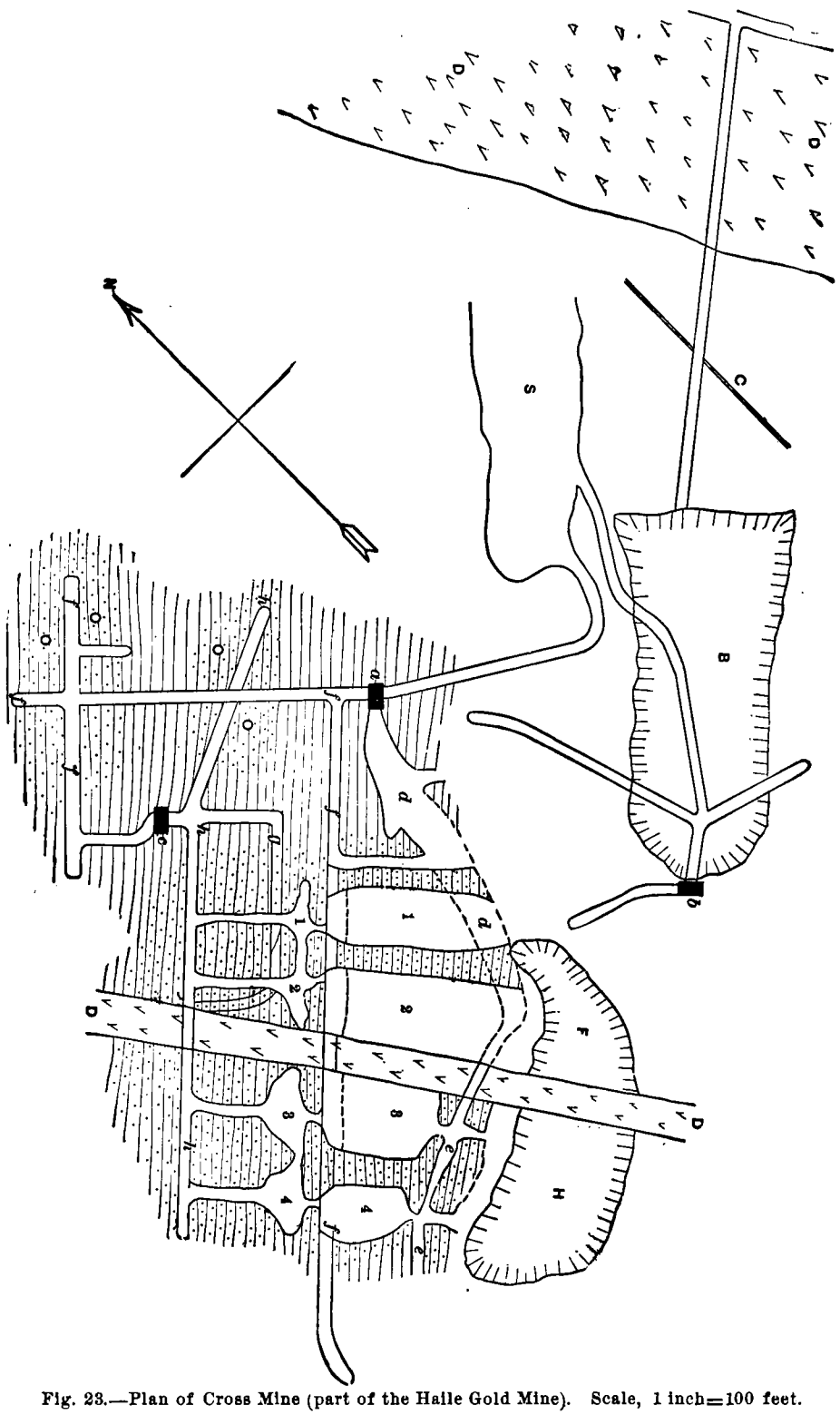


Fig. 23.—Plan of Cross Mine (part of the Halle Gold Mine). Scale, 1 inch=100 feet.

B, Bumalo pit; C, clay dike; D, diabase dikes; F, Flint pit; H, Halle pit; S, old stope, 200-foot level; *a*, No. 2 shaft; *b*, No. 3 shaft; *c*, new shaft; *d*, bottom of old stope, 160 feet, rising to 100 feet; *e*, 120-foot level; *f*, 200-foot level; *g* and *h*, 270-foot level; O, ore-bodies; 1, 2, 3, 4, stopes.

of ore was still standing above the 60-foot level. In order to extract this ore it became necessary to open the mine from the surface, and the open pit (3, fig. 22) was started. The ground was stripped to a depth of 15 feet, and from that point on the ore, though lean, was used in the mill. At 60 feet a diabase dike (8, fig. 22), lying parallel to the schistosity of the country, was encountered in cross-cutting and was at first believed to represent the hanging wall. On cutting through it, however (a distance of 4 feet), it was found to merely divide the ore-body. Under the altered conditions it became necessary to sink a new shaft (1, fig. 22) in the hanging wall as an outlet for the ore and for pumping. This shaft was sunk to a depth of 165 feet; connections were made by cross-cuts with the present inclined shaft and everything prepared for taking out the shaft pillars, as well as the remainder of the ore. This is the present condition of the mine. The maximum thickness of the ore-body at the Beguelin was 80 feet, and the best ore was found between the two large cross-dikes. A large amount of heavy sulphuretted ores is at present in sight.

Five hundred feet northeast of the Beguelin mine are several open pits known as the Chase Hill (L, fig. 21). The character of the ore at this point is somewhat different, being a banded, colored slate, barren of sulphurets, but carrying several gold-bearing quartz-veinlets. Taken as a body it will not make ore.

To the northwest of the Beguelin are several ore-leads as yet unprospected.

The 60-stamp mill was run on Beguelin ores three years. The Cross mine was then reopened (1891). A plan of the Cross mine is given in fig. 23 showing the open pits and present underground workings, as well as some of the abandoned ones. After the water had been pumped out, and the old shaft No. 2 (*a*, fig. 23), 200 feet deep, was fully secured, a cross-cut was driven in a northwesterly direction from the bottom, a distance of 25 feet. A drift (*f*, fig. 23) was started from that point in a southwesterly direction, reaching ore at a distance of 75 feet from the cross-cut. This drift, on being continued 200 feet, encountered a dike 25 feet thick, which was cut through and the drift carried on for 100 feet more. The old workings (*d*, fig. 23) were also continued through the dike, the drift (*e*, fig. 23) on the 100-foot level being run 100 feet beyond it. Four upraises were driven between these two levels, two on each side of the dike, opening up 4 large stopes of ore. This ore ran low in sulphurets, but carried more free gold and furnished one-half of the quota to the mill. In order to work the ores below the 200-foot level a new shaft (*c*, fig. 23) was sunk to a depth of 270 feet. A cross-cut was run from the bottom in a southwesterly direction for a distance of 75 feet; 15 feet from the shaft a drift (*h*, fig. 23), parallel to

the drift (*f*) on the 200-foot level, was carried in a distance of 250 feet. The dike when encountered was 35 feet thick and no longer decomposed on the wall, as was the case in the upper level, but hard and solid. By upraises 4 more stopes were opened. The ore was of a better grade in proximity to the dike on both sides.

During 1896 an open-cut was made opposite the old Haile pit, in order to take out the pillars and the ore in the hanging, above the 200-foot level.

The old workings (S, fig. 23), which were continued from the Bumalo pit (B, fig. 23), to a depth of 200 feet, and were for a long time inaccessible, have been opened up by a diagonal drift from the 270-foot level (*h*, fig. 23). Some time ago a northeast tunnel was driven from the Bumalo pit, at a depth of 50 feet and for a distance of 150 feet, to a diabase dike 150 feet in thickness, and later continued through this. Drifts on the further side showed up only barren ground, but good ore was found from the mouth of the tunnel to the dike, being richest near the dike. This ore-body was encountered in the 270-foot level with the drift above mentioned, and the ores are found to be more heavily sulphuretted than anywhere in the Cross mine.

So far as explorations have gone, 3 different lenses have been encountered: 1. The Bumalo, furthest northeast; 2. The Haile or middle lens; 3. A small lens 80 to 90 feet west of the Haile (outcrop under the new boiler-house, 17, fig. 21).

During the summer of 1896 an electric diamond-drill hole was started in back of the old store building (just to the right of 5, fig. 21). At a depth of 58 feet the cores showed ore, assaying as high as $6, and it appears as though this were in a new hanging wall lens. In order to solve this question a cross-cut is being driven on the 270-foot level along the 25-foot dike in a northwesterly direction.

Red Hill (A, fig. 21) consists of a number of open pits on the northwest side of the 150-foot dike, where ore was formerly mined to a depth of 60 feet. It is supposed to be in a line with the Haile lens.

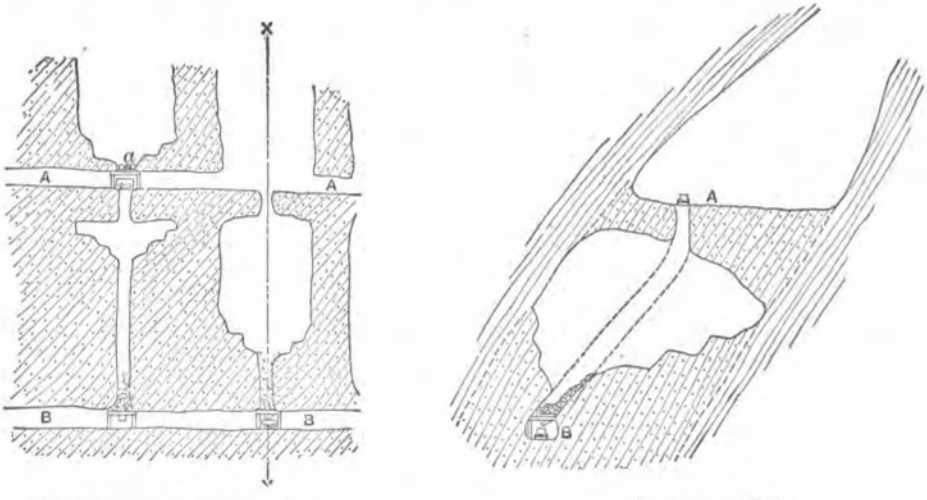
The thickness of these lenses varies, reaching 100 feet in places, while at others, near the end of the lenses, it is only from 25 to 30 feet.

METHOD OF WORKING; HAILE MINE.

The method of working these deposits is the pillar system (Pfeilerbau), illustrated in fig. 24.

The levels (8x7 feet) are run 70 to 100 feet apart, and nearer the hanging than the foot-wall. At intervals of about 50 feet upraises are made, with a cross-section of 8x7 feet. These are carried forward at an inclination as near as possible to 45°. If necessary, the upper portion through the chain pillar left under each level is carried up vertically.

This raise serves afterwards as a chute (mill-hole). Drifts are then run below this pillar until the limit of the stope in length (about 30 to 40 feet in all) is reached, leaving a vertical pillar 15 to 20 feet in thickness between the stopes. The ground is then cut away between the foot- and hanging walls, completely exposing as roof the bottom of the chain pillar above, which is sprung in the shape of an arch, with its heavier toe in the foot-wall and a minimum thickness of 15 feet. This, as well as all other work in tight ground, is done by air-drills. Stoping is then carried downward by hand-drilling in circular steps, arranged in such a manner as to allow the broken ore to drop into the chute, without further handling. The angle of 45° given to the latter allows a steady flow of



Vertical Section along Strike. Section on X-Y.

Fig. 24.—Method of Stoping at the Cross Mine (Haile Mine). Scale, 1 inch=60 feet.

the material down the foot-wall without completely choking it. At the bottom of the chute is a rough grizzly (*a*, fig. 24) made of logs, which holds back the larger boulders and prevents them from choking the smaller loading pocket below. This grizzly is easily accessible from the drift, and the larger pieces of ore are here sledged. The loading-chute and grizzly are kept up as long as possible, until the stope is finally broken through to the drift-level below, the ore being shoveled into cars. As far as possible, the pillars are left in poor ore, the diabase dike fulfilling this purpose admirably. No timber whatever is used, and although chambers 100 by 100 by 40 feet have been cut out, there seems to be no danger of a fall, the country-slate being very tough and self-supporting. The stopes from the 100- and 200-foot levels are connected with the surface by raises, so that at a future date the worked-out

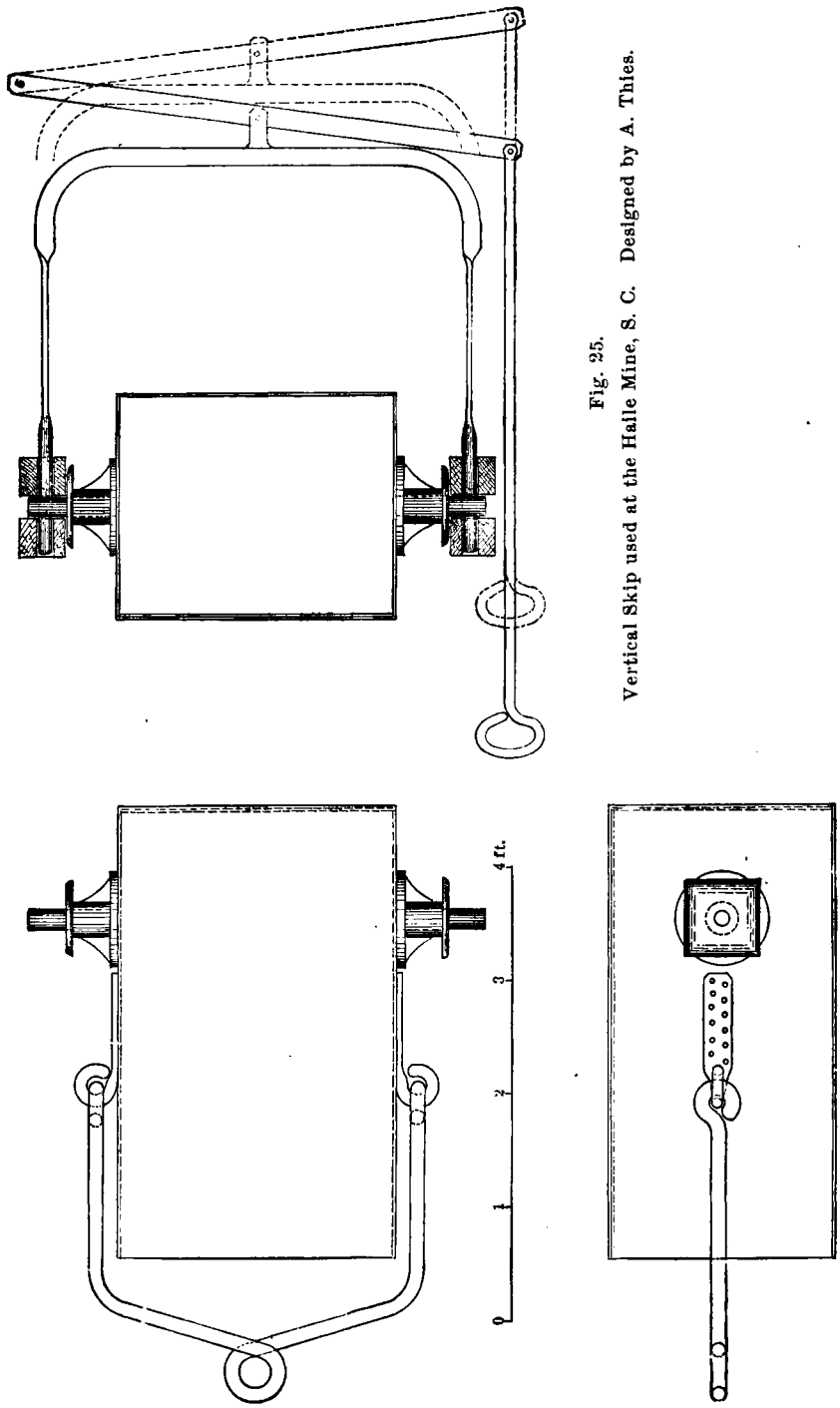


Fig. 25.
Vertical Skip used at the Halle Mine, S. C. Designed by A. Thies.

stopes can be filled from the surface and the ore in the pillars, *i. e.*, what is left toward the hanging wall, can be taken out.

Blasting is done with 40 per cent. Hercules powder. One-inch steel is used for both hand and machine-work. The number of air-drills is limited by the size of the compressor—an Ingersoll machine, with 3-drill capacity. The ore is carried from the loading-chutes to the shafts in sheet-iron cars of ¾-ton capacity, running on 18-inch gauge track. At No. 2 Shaft (7x12 feet, single compartment) they are hoisted by cage, with automatic safety catch. The new shaft is 6x14 feet, double compartment, and the ore is raised by a novel skip designed by Mr. Thies (fig. 25). The body of the skip, made of sheet iron, has two projecting lugs riveted to it below the centre of gravity and the bail is lugged one inch from the vertical centre line.

Each lug runs between a pair of yellow-pine guides set 2 inches apart. When the skip is raised above the landing-chute two iron pins are thrown across the openings between each set of guides. The skip is dropped down on these and the ore is dumped into a loading-chute placed on the heavier side of the skip. The skip is raised and righted by the bail, the iron pins are withdrawn by the lander, and the skip descends. The operation is rapid and simple and the cost of the device is light. The mine is not wet, a No. 9 Cameron pump easily handling the water.

MILLING AND ORE TREATMENT AT THE HAILE MINE.

The ore is crushed to 1½-inch size in a 10x20-inch Blake crusher at the Beguelin, and a 7x10-inch crusher at the Cross mine, and is stored at both places in bins of 30 tons capacity. The broken ore is hauled to the mill in narrow-gauge, bottom-dumping cars, holding 3 tons; 8 cars are run to the trip. The mill bin has a capacity of 300 tons, and is so arranged that every stamp can be supplied separately with ore, as, owing to the different character of the ore at the Beguelin and the Haile, it is treated in separate batteries. A hinged plate, not shown in the accompanying illustration, is for this purpose hung at the apex of the bin floor. A vertical cross-section of the mill is shown in fig. 26. Two vertical sections of a similar battery at the Reimer mine are shown in fig. 19 (p. 120).

The mill is a 60-stamp back-to-back one, 30 on each side, built by the Mecklenburg Iron Works of Charlotte, N. C. The ore is fed by Hendey self-feeders. The weight of the stamps is 750 pounds; chilled iron shoes and dies are used; the stamps drop 6 inches, 86 times per minute, in the order 1, 3, 2, 5, 4. The crushing capacity is 2 tons to the stamp in 24 hours. The screens are 30-mesh, made of No. 20 brass wire; these work well if no cyanide is used in the battery. The average height of

discharge is 6 inches. Amalgamation is accomplished: (1) In the mortar by a curved front plate attached by means of a wooden chuck-block to the lip of the mortar, immediately below the discharge; it is held in position by bolts and can be rapidly and easily removed. It presents an amalgamation-surface of 1.75 square feet and is made of No. 7 silver-plated sheet-copper. The gold being very fine, its accumulation in the mortar between the dies is insignificant, and the mortar is seldom cleaned

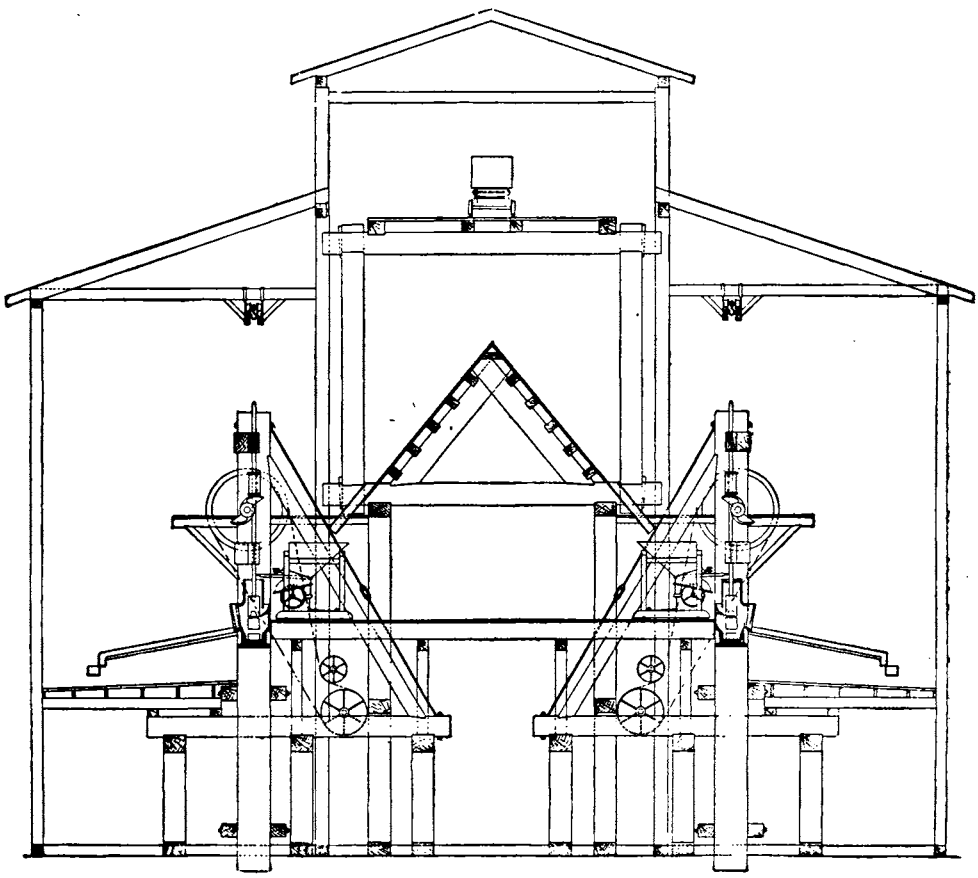


Fig. 26.—Vertical Cross-section of 60-stamp Mill at the Haile Gold Mine.

out. (2) On the outside plates, made of No. 12 silvered copper-sheet, and presenting an amalgamation-surface of 32 square feet to each battery of 5 stamps; they are the full width of the mortar and are arranged in four steps, each 2 feet in length, and overlapping the next by 1 inch, the inclination being 2 inches in 1 foot. They are fastened directly to the battery, the tremor caused hereby being considered beneficial to amal-

gamation. These plates are interchangeable; whenever the upper plate becomes hard and unfit for amalgamation, it is interchanged with one of the lower plates, thus giving in rotation to each plate a position at the head of the table. The outside amalgamation-surface of each battery is further increased by 12 additional square feet, arranged by a drop system of three plates, the pulp discharging from one to the other before it enters the main launder. Each battery is provided at the screen-discharge with an impact-plate, not only for amalgamation, but to retard the velocity of the pulp. They are cleaned from verdigris with a weak solution of cyanide, and a little potash is sometimes fed into the battery. Phosphate of sodium is used in the mill to keep the quicksilver bright and lively. It has been found expedient to remove the inside plates every 24 hours; as duplicate plates are kept on hand, no delay occurs while they are being cleaned. The amalgam from these, which is collected and weighed daily, forms an excellent indication of the value of the ore milled. The amalgam is removed from the outside plates whenever it is necessary. A regular clean-up is made only once a month. About one-third of the gold is saved on the inside plates. The fineness of the mill gold is 880. The average amount of water used per stamp is $3\frac{1}{2}$ gallons a minute; and the average consumption of quicksilver is 0.35 ounce per ton of ore. The wear of shoes and dies is 1.3 pounds per ton of ore stamped. As a lubricant for the cams, molasses thickened with flour is used and gives excellent results.

The pulp is carried to the concentrators in launders lined with riffles for a distance of eighty feet. No attempt at sizing the pulp is made, but the ores from the Beguelin and Cross mines, owing to the difference in contents of sulphurets, are concentrated separately. The Cross ore averages about 2 per cent., the Beguelin running from about 7 to 25 per cent. sulphurets. They are milled separately in the proportion of $\frac{4}{10}$ Beguelin and $\frac{6}{10}$ Cross, so as to obtain an average of 7 to 8 per cent. sulphurets from the total ore milled. The concentration is done on 20 Embrey tables (4 by 12 feet), with smooth rubber belts which are set at an inclination of $2\frac{5}{8}$ inches and travel 5 feet per minute, receiving at the same time 192 percussions. The concentrates contain 90 per cent. pyrite, which is pure sulphide of iron with occasional small traces of arsenic. The loss in concentration is 15 to 20 per cent. The average value of these concentrates is $25 to $35 per ton.

Chlorination.—The concentrates are hauled on the mine-railway to the chlorination plant. They are roasted in two double-hearth reverberatory (see fig. 27) and one revolving pan-furnace, the sulphur being reduced from about 43 to as low as $\frac{1}{4}$ per cent., and the value of the material being increased by $\frac{1}{3}$. Each double-hearth furnace is worked by two men to a shift of 12 hours, the output being 2 tons of roasted

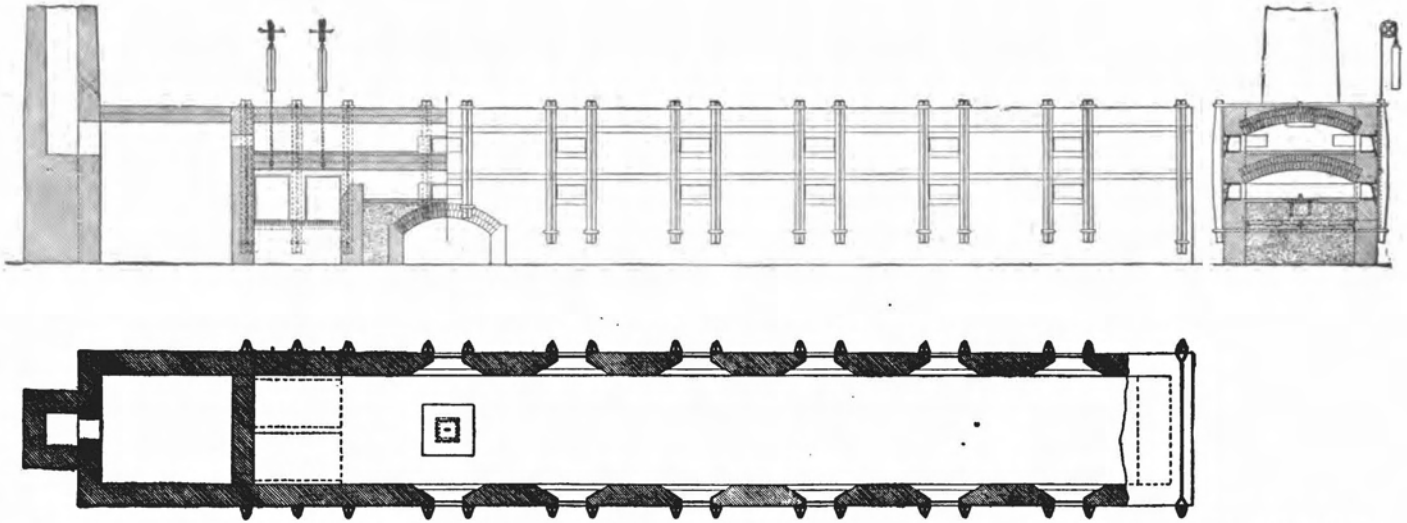


Fig. 27.—Double-Hearth Roasting Furnace; Chlorination Plant; Haile Gold Mine. Dimensions of hearth: 5 feet wide by 40 feet long. The upper figure represents a vertical, and the lower a horizontal section of the furnace.

concentrates per 24 hours for each furnace. The revolving pan-furnace is worked by three men per 24 hours, with the same output as the double-hearth. The fumes from these furnaces carry off into the air the equivalent of 13 tons of 50 per cent. sulphuric acid. The management has investigated the erection of lead chambers, but so far have not considered such an installation to their advantage. The Spence furnace has

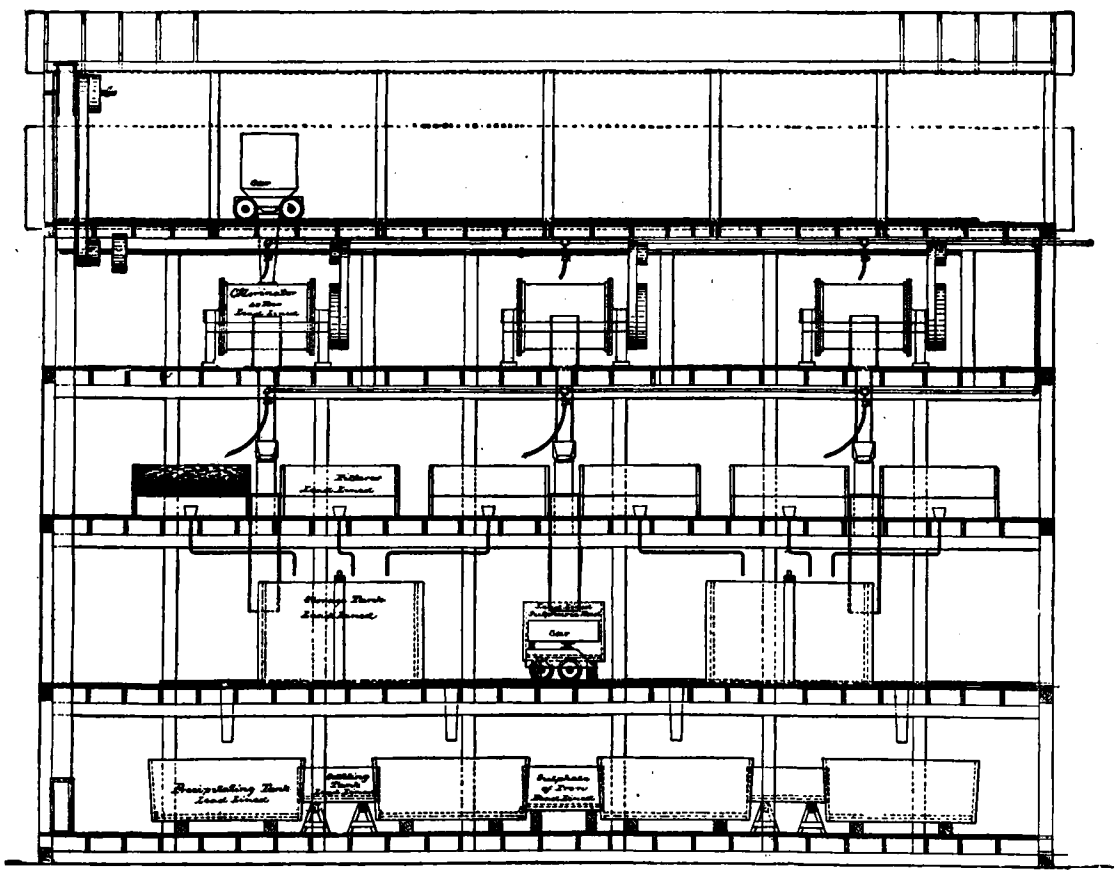


Fig. 28.—Chlorination plant at the Haile Gold Mine. Vertical Longitudinal Section.

been tried at the Haile, without success.[1] The roasted ore after cooling is elevated to the top floor of the chlorination house, 32 feet high. This consists of a four-story frame building, containing 3 chlorination-barrels, 11 filtering-tanks, 2 storage-tanks, and 13 precipitating vats (see figs. 28, 29). The ore is charged through a hopper into the chlorination-

[1] See paper by A. Thies and W. B. Phillips, "The Thies Process of Treating Low-grade Auriferous Sulphides at the Haile Gold Mine, Lancaster Co., S. C.," *Trans. Am. Inst. Min. Eng.*, xix. 601.

barrels (see fig. 30) by cars holding 1 ton each. The barrel is 60 inches long by 42 inches in diameter, made of cast-iron and lead-lined (12 pounds of lead to the square foot). It also contains a lead valve in order to ascertain whether the necessary amount of free chlorine is present. (The use of this valve is unnecessary after the character of the ores becomes known).

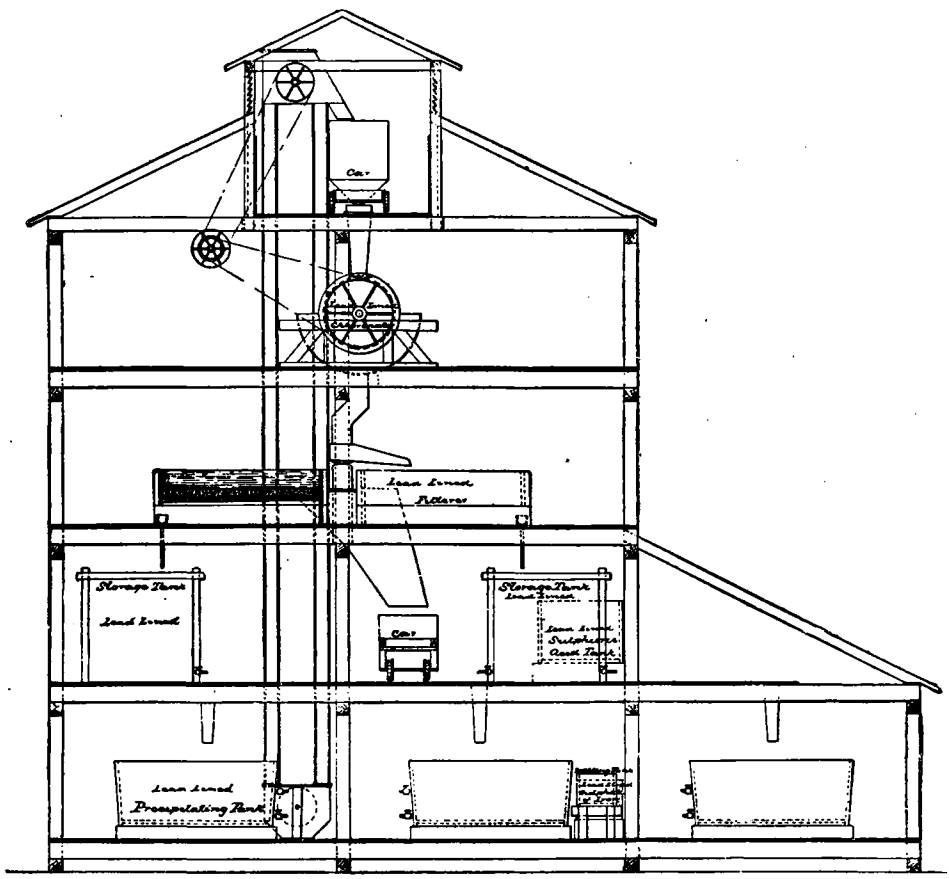


Fig. 29.—Chlorination Plant at the Haile Gold Mine. Vertical Cross-section.

The full charge consists of 120 gallons of water (to make an easily flowing pulp), from 8 to 11 pounds of bleaching powder, then the ore, and finally 12 to 15 pounds of sulphuric acid. The barrel is hermetically closed and revolves for about 3 hours at the rate of 15 to 18 revolutions per minute. (A 5 horse-power engine performs this work and also the elevating of the ore.) The barrel is then inverted, opened and discharged through a lead-lined semicircle in the floor to a filter on the

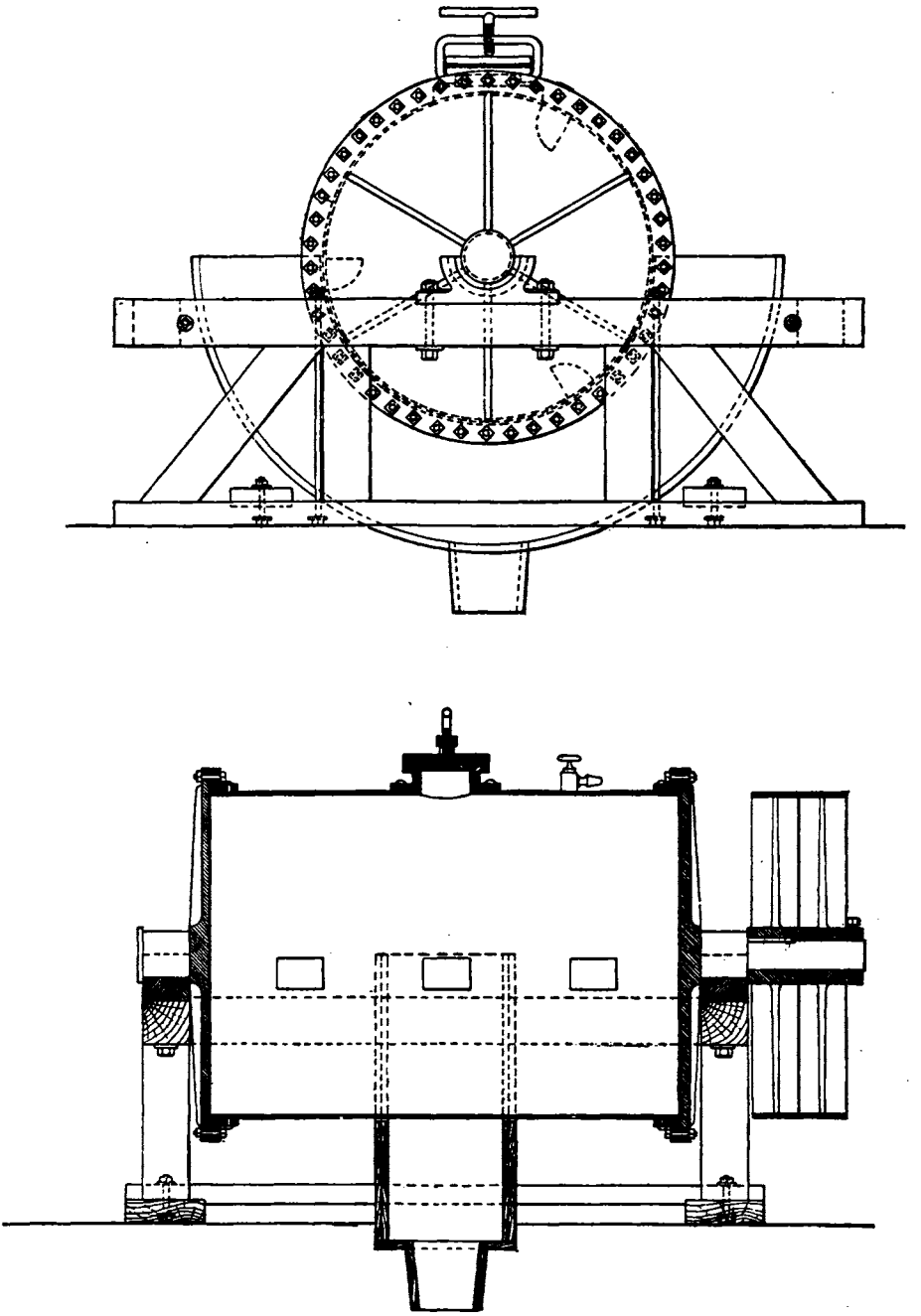


Fig. 30.—Chlorination-Barrel, Halle Gold Mine. The upper figure is a vertical cross-section, and the lower a vertical longitudinal section. Inside dimensions: Diameter, 42 inches; length, 60 inches.

floor below. There are 4 lead-lined filters to each barrel, their sizes being 6 by 8 feet by 18 inches deep in front and 17 inches in back. The bottom is covered with mineraline[1] tiles 12 by 12 inches by 1 inch thick, perforated and having ½-inch gutters underneath; on top of these is placed a rack of 1¼-inch wooden slats, 4 inches high and 8 inches apart; the first layer above the tiles consists of 4 inches of coarse quartz pebbles (⅛ to ½ inch size), and this is covered by from 1 to 2 inches of ordinary clean sand. Before emptying the contents of the barrel, the filter is flooded with water to the level of the top of the filter-bed to act as a cushion. Then the original solution is passed through, striking on a float to prevent breaking the filter-bed. The ore-pulp is washed twice with clean water; the first time enough is added to stand 4 inches above the surface of the pulp, and the second time the tank is entirely filled.

This amount is found sufficient to thoroughly remove all traces of chloride of gold from the pulp (tests are made with $FeSO_4$). The filtered solutions are stored in two stock-tanks on the second floor, and are drawn off from these into the precipitating-tanks as required. The latter are 8 feet in diameter and 3 feet high, made of wood, the interior coated with asphalt. They are provided with three outlets, the upper one 18 inches from the top, the middle one 1 inch above the bottom and the lowest one in the jamb. The gold is precipitated in the metallic state with an excess of fresh ferrous sulphate, made in a small lead-lined tank. In warmer weather 48 hours suffice for settling, and in colder weather from 3 to 4 days. The supernatant liquor is drawn off through the two upper outlets, opened one after the other (in order to prevent any stirring of the precipitates), and passed through a box filled with sawdust to catch any precipitate. The gold precipitate is drawn from the tanks through the jamb-opening into a small lead-lined settling-tank 2 by 2 by 4 feet. After standing 24 hours the supernatant liquor is siphoned off, and the precipitate filtered on paper. This is dried and mixed with about half its weight of borax and soda in almost equal proportions. Should iron salts be present, a little quartz sand is added. It is melted in graphite crucibles and cast into ingots of about 990 fineness. The whole operation is so simple that the most ordinary laborer can acquire the mechanical knowledge in a day. The repairs are practically *nil*.[2]

LABOR, COSTS, ETC., AT THE HAILE MINE.

Some of the figures of costs of labor and working at the Haile mine are given below. For private business reasons it is impossible to give these as fully as we should like to.

[1] A melted mixture of sulphur and quartz.

[2] The Thies chlorination process has been described in detail by T. K. Rose, in his *Metallurgy of Gold*, C. Griffin & Co., London, 1894.

Mines.—Cost of Labor:

	Per day.
Holders	$ .90
Strikers	1.10
Machine-runners	1.25

255 cords of wood at $1.50, burned per month.

Mill (2 shifts of 12 hours each).—Distribution and Cost of Labor:

One superintendent	$
" laborer (amalgamation) per shift	2.50
" " " "	1.00
" " (concentration) "	1.25
" " " "	.80
" fireman per shift	1.00
" engineer per day shift	1.75
" " per night shift	1.50

150 cords of wood at $1.50, used per month.

Repairs (wear of shoes and dies, etc.), 4 cents per ton of ore.

Roasting and Chlorination.—Distribution and Cost of Labor:

Roasting furnaces, producing 6 tons of roasted concentrates per 24 hours; six men, day shift, each	$1.00
Five men, night shift, each	1.00

3 cords of wood at $1.50, used per 24 hours.

Chlorination (1 shift of 12 hours) working 6 tons of roasted concentrates:

Two men, each at	$1.00
One man at	1.25

Cost of roasting per ton of roasted concentrates:

Labor	$1.83
Fuel	.75
	$2.58

Cost of chlorinating 1 ton of roasted concentrates:

Labor	$ .50
Foreman	.20
Power	.12
Sulphuric acid for $FeSo_4$	.06
11 pounds of bleaching powder, at 2½ cents	.27½
15 pounds of sulphuric acid, at 1 cent	.15
Wear and tear	.10
Superintendence	.05
	$1.45½

Cost of roasting and chlorination per ton of raw concentrates	$3.02
Cost of roasting and chlorination per ton of ore mined	.19

Percentage of Extraction:

Mill: Tailings from concentrators	85 to 90 cents.
Showing a yield of	75 to 80 per cent.
Chlorination: Tailings as high as	$1.50
Average yield	94 per cent.

THE BREWER MINE, CHESTERFIELD COUNTY, S. C.

The Brewer mine (the De Soto Mining Company) is situated on Lynch's creek, about 13 miles by road northeast of Kershaw, the nearest railroad station; it is about 8 miles (air-line) northeast of the Haile mine.

The mining problem presented here is the working of large bodies of low-grade, sulphuretted ores by quarrying, milling, concentration, and chlorination.

Geologically, the mine is situated in the Carolina belt. The country-rock is a hard, devitrified acid volcanic (probably quartz-porphyry), of a light bluish-gray color, resembling hornstone or chert. It is in part sheared into sericitic schists, similar to the slates at the Haile mine, though more highly silicified. Masses of coarse, pyroclastic breccia were found in the bottom of the large mine-pit, but the rock was not observed in place. The strike of the siliceous schists is very much confused, being in all directions; the normal strike is probably something like N. 70° E., and the dip 60° N.W. Numerous coarse-grained granitic dikes (G, fig. 31) intersect the country, and the local abnormal strikes and dips of the schists may be due to their intrusion. These rocks occupy an elevation known as Brewer hill, which rises some 200 feet above the level of the main drainage basin, Lynch's creek on the east and Flat creek on the west. A heavy diabase dike lies on the west bank of Flat creek, and to the west of that, the country-rock is granite.

The ore-bodies at the Brewer are similar to those of the Haile mine, being auriferous pyritic impregnations in the country-rock, and assuming more or less lenticular forms. Free gold appears as thin films or coatings on the cleavage- and joint-planes of the schists. The ore-bearing rock is decomposed, in certain streaks more than in others, to the deepest workings of the mine, 150 feet, resulting in soft, friable masses which disintegrate into finely divided white sand. Certain portions of the deposit are richer in gold, and these also have an imperfect lenticular shape, from 10 to 30 feet in thickness (O, fig. 31). These better grade ores will run from $5 to $7 per ton, assay value, while the average run of the mine is in the vicinity of $3. The fineness of the gold is from 970 to 984. The total width of the ore-bearing ground is stated to be 800 yards. The main ore-body has been opened for a distance of 600 feet in a north and south, and 250 feet in an east and west direction. The sulphuret contained in the ore (finely divided pyrite) averages about 7 per cent of the total mass. In one portion of the mine enargite (and perhaps also covellite) appears in some quantity, but its occurrence is local. Other sulphurets occur in small quantities, but are interesting merely from a mineralogical standpoint. Tinstone (sometimes in direct association with gold) has been found in hydraulicking

at the Tan-yard deposit; and pyrophyllite occurs as an alteration product in the granitic dikes.

The ore itself is practically devoid of auriferous vein-quartz. Small reticulated fissures filled with barren quartz intersect the country; and in the Tan-yard (an old gravel-channel to the east of the mine) a large barren quartz-vein, 5 to 20 feet in thickness, is to be seen.

The Brewer mine, probably one of the first developed in South Carolina, was opened in 1828 by shallow pits in the saprolites and in the gravels of the Tan-yard, the material being worked in rockers. This work continued until 1857, and it is stated that in various years during this period as many as 100 to 200 hands were employed at one time, making $1.50 to $3 per day each, and paying nearly 30 per cent. royalty. From 1857 to 1862 Commodore Stockton mined and milled the ore in arrastras and Chilian mills. Up to 1879, when the Brewer Mining Company took hold of the property, there seems to have been a lull in the activity of the operations. In this and succeeding years the old Tan-yard placer was reworked by hydraulicking. This deposit is an old river-channel, and was extensively worked in former days, being, in fact, the site of the first discovery of gold on the property. The width of the channel is from 200 to 300 feet, and its length about 1½ miles; it is now intersected by a large valley. The original overlay was about 6 feet, and the gravel from 3 to 6 feet in thickness, underlain by a thin bed of compact conglomerate, cemented by iron oxide; the bed-rock is a siliceous sericitic schist. The old miners in working this deposit did not wash the overlay, nor did they take up any part of the bed-rock. In reworking, the whole mass (from 5 to 20 feet in thickness) was hydraulicked, and as much as 4 to 5 feet of the loose bed-rock was also torn up. Water was pumped about 200 feet in vertical height, from Lynch's creek to a small reservoir situated at the head of the placer, from where a portion of it was delivered to the giant (2½-inch nozzle), by a force-pump under a pressure of 80 pounds, and the remainder run directly through the ground-sluices to carry off the tailings. Six men were employed in cleaning bed-rock, and two at the sluices. It is stated that a handsome profit was realized by this work.

In 1885 a 5-stamp mill was erected and run on ores produced in prospecting work. In 1887 an adit-level (A, fig. 31), 1200 feet in length, was driven into the hillside under the main ore-deposit, and the mine was opened from below by a raise, which was at the same time used as a chute, connecting with the open pit above. The stoping was carried on overground, and the material taken out through the tunnel. In 1888 a 40-stamp mill was erected, and started up in May, 1889. A Thies chlorination plant was added in 1892, and operated for a short time during 1893. From that date until June, 1895, the mine was idle, but at that time preparations were being made for starting work again.

Figure 31 represents the plan of the Brewer mine as it is at present developed. It consists of the large open pit (P), 150 feet in depth, about 200 by 250 feet on the surface, and 100 by 180 feet in

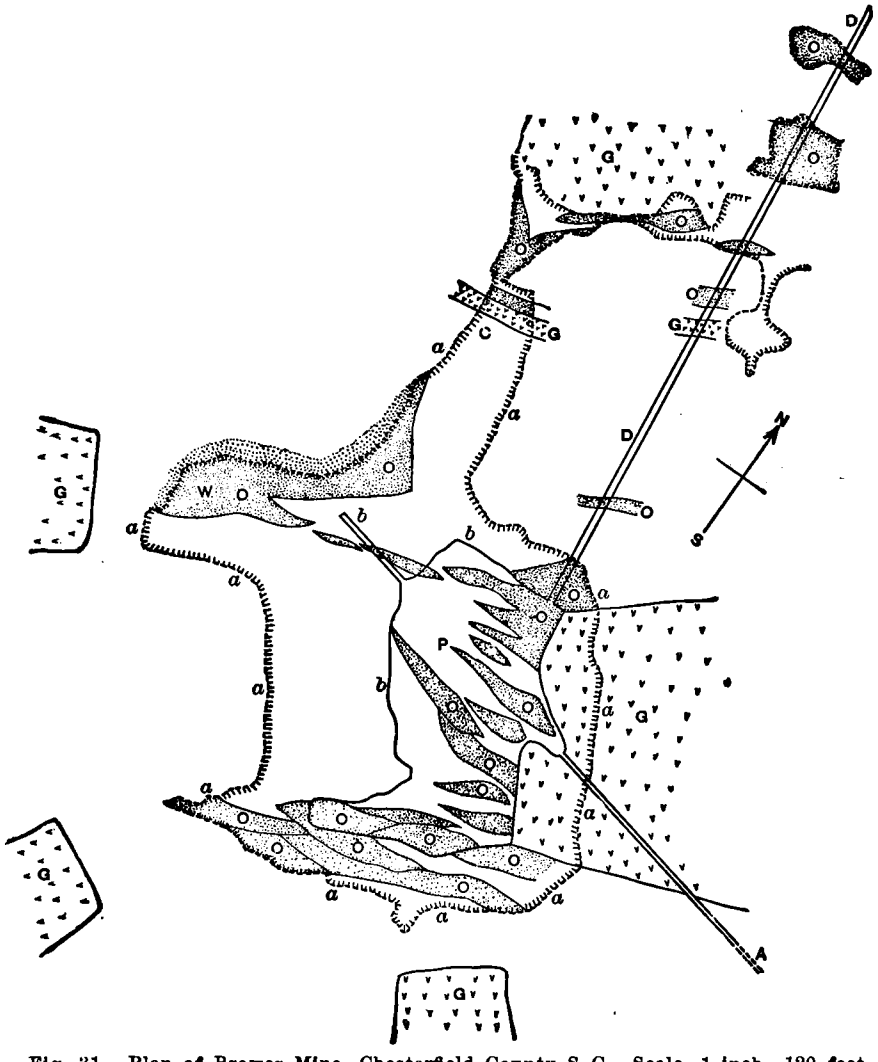
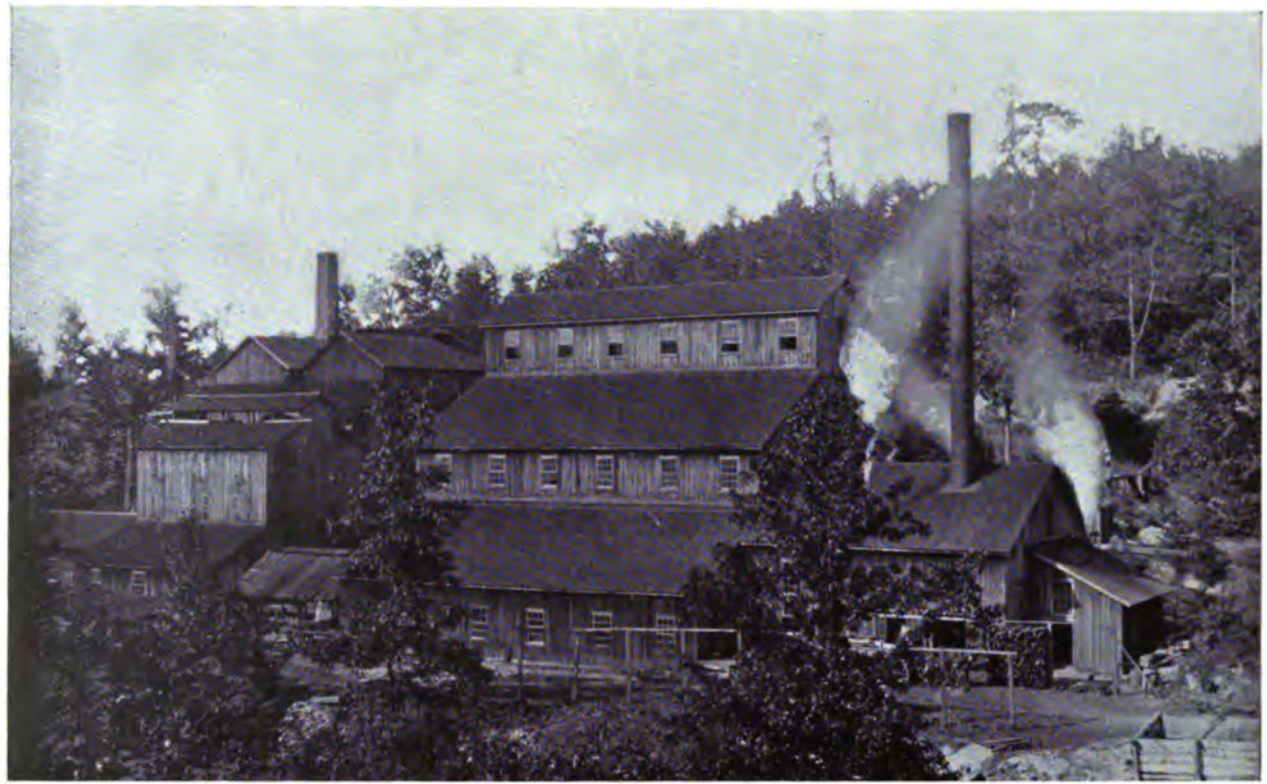


Fig. 31.—Plan of Brewer Mine, Chesterfield County, S. C. Scale, 1 inch=120 feet
A, adit-level, 1200 feet long; C, north cut, 40 feet deep; D, drift, 150-foot level; G, granitic dikes; O, streaks of best ore; P, bottom of main pit, 150 feet deep; W, west cut, 50 feet deep; *a a*, surface line of open cut; *b b*, 150-foot level.

the bottom. The ore-body has been further explored by a drift (D), on the bottom level, extending 430 feet in a northerly direction, and being in ore all the way. The tunnel (A) is laid with narrow-gauge



FORTY-STAMP MILL AND CHLORINATION PLANT, BREWER MINE.

track, over which the ore is hauled to the mill by a small locomotive. This tunnel is drained by a wooden gutter situated in the center of the track line. At present ore is being quarried in the west cut (W) near the surface, from where it falls to the bottom of the pit (P), and is hauled to the mill through (A). The 40-stamp mill, which was not in operation when visited, is situated about a quarter of a mile east of the mine, on the west bank of Lynch's creek. It is of the Western type, built by Fraser & Chalmers. The weight of the stamps is 900 pounds. The mortars are 15 inches wide at the lip, and are fitted with front inside plates and 30-mesh steel wire screens. The outside plates of silvered copper are 8 feet long by 54 inches wide. Below the plates is situated a line of pointed boxes, serving simply as amalgam-traps, which discharge 2 feet above the bottom to four Frue vanners with 6- by 14-foot belts. This is one of the most substantial and best constructed mills in the South. (Plate X.)

The chlorination plant consists of 2 revolving-pan furnaces, 2 barrels, 8 filters, 2 stock-tanks, and 8 precipitating-vats of the same construction and arrangement as at the Haile mine (see pp. 139–142).

When the mill was last operated (in 1893), the object was to put through as much material as possible; 5 to 6 tons of ore per stamp were milled in 24 hours, with 4-inch drop, 90 drops per minute, crushing through a 20-mesh screen. Naturally, the pulp flowed over the plates without a large portion of it coming in contact with them; and, with only 4 vanners, the ultimate loss in tailings was so great as to leave little if any profit. The concentrates that were obtained ran from $15 to $20. About 50 per cent. of the gold in the ores is free, and of the amount saved in amalgamation 50 per cent. was in the battery and on the inside plate. The cost of mining and milling at the Brewer mine, as practiced above, is given at 75 cents; and the total cost (including maintenance, salaries, etc.) at $1 per ton of ore mined.

Laboratory experiments with cyanide, and others with chlorination in bulk (the latter by Mr. P. G. Lidner), have been tried at the Brewer, but proved unsuccessful. In the latter part of 1895 cyanide experiments were again undertaken with reported favorable results.

CHAPTER VII.

SOME CONCLUSIONS CONCERNING GOLD MINING IN NORTH CAROLINA AND ADJACENT SOUTH APPALACHIAN REGIONS.

Bonanzas, in the general meaning of that term, have not been found in North Carolina nor in the adjacent South Appalachian regions, and probably never will be, unless we except rich pockets of limited extent which for a time might prove to be such to the individual operator or tributor. The Western saying that "A good gold mine is one which will pay dividends under poor management," would exclude all Southern gold mines from even this distinction. There are, however, a few mines in the south, notably the Haile and the Franklin, which, under able management, fully conversant with all the requirements and exigencies of the case, have been developed into remunerative business enterprises. The wide distribution and the variety of the auriferous deposits throughout the South do not preclude the possibility of these mines serving as examples for a larger number of operations, instead of being isolated cases as at present.

By far the greater portion of the gold that has been produced in the South was derived from the placers, including bottom and sidehill gravels, as well as auriferous saprolites and decomposed vein outcrops. From such deposits the cream has been worked off, and what remains are the old gravel heaps and such virgin ground as in the earlier days proved inaccessible to water and unprofitable for primitive methods, or was overlooked by the prospectors. Of the latter class the Crawford mine, described on pp. 91–95, is an example. Although the earlier prospecting for gravel deposits was carried on in a thorough manner, there were no doubt large plantations on which such work, especially in the fertile bottoms, was not countenanced. It is also probable that deeper lying gravel-channels, of which there are no indications on the surface, remain to be exploited, as, for instance, in the South Mountain and Dahlonega districts. The installation of pumps (or where these have been unsuccessfully used, the erection of improved or more economic plants), as well as more thorough and extensive surveys for ditch lines, may open up much ground which was formerly inaccessible to water. Hydraulicking under direct pressure from a pump may in many cases be feasible, and may prove more economical as far as plant is concerned.

Bottom-gravel mines were operated in the earlier days almost entirely by pitting, draining the excavations with water-wheels, and raising the gravel by hand to rockers and sluice-boxes, the tailings being left in large heaps. This work was often done in an unsystematic manner; portions of the ground could not be worked at all; and, in general, only the richest gravel received attention, the overlay and the bed-rock being neglected entirely. Some of these gravel heaps have frequently been reworked, in one case (on the Mills property, N. C.) as often as seven times. The additional gold obtained in these operations was partially due to the incompleteness of the preceding washings, as well as to the subsequent further disintegration of vein-quartz carrying free gold and sulphurets. A number of these old bottom-placers may warrant a remunerative reworking on a large scale, either by the use of giants and bed-rock sluices when sufficient fall is available, or where the latter is not the case (a common feature in the South) by the application of the hydraulic gravel-elevator.

Virgin placer deposits also exist, which, on account of the low grade of gravel, or the great depth of the overlay, could not be profitably worked by the more primitive methods. For such, the above appliances may also furnish a solution. The Southern gravel deposits are far less extensive than those of California and New Zealand, and therefore as low a grade of gravel cannot be worked, although the South has cheaper labor in its favor. Systematic work has rarely been pursued, and records of such work have not been kept. For this reason, as well as on account of the unequal concentration of the gold in the deposits and the varying working conditions met with, it is impossible to give limiting values per cubic yard to guide operations in the future. For the same reasons, preliminary testing will be difficult, especially in ground that has already been worked.

In general, it may be said that the great extent of the rock-decomposition in the South (often from 25 to 100 feet in depth), and the easy disintegration of the same has resulted in a greater concentration of gold in the gravel, considering the richness of the ore-bodies in place, than in many other gold fields.

The auriferous saprolites and decomposed vein-matter have been most extensively worked in the Dahlonega district. Here the decomposed material, in which gold from the eroded vein-matter is more or less concentrated, has to a great extent been worked down to the harder rock. In the Dahlonega method of working, everything seems to have tended towards the simplification of the process and plant, with the object of milling as large an amount of low-grade material as is possible with economy in labor and plant, irrespective of close working. Both on account of the greatly impoverished material and its increasing unfitness

for disintegration with the giant, a limit to this method of mining must ultimately be reached here. The ore-bodies continue in depth and should open up a probably more productive field in deep mining, with less loss of gold and more economical output.

Although the Southern gold field has been known and worked since the beginning of the century, it has not had the benefit of such thorough and systematic vein-prospecting as most of the later discovered fields. It was already a well-settled farming country, generally owned in large plantation-tracts, when gold was first sought after; and such lands as were unoccupied were the property of the State governments, which did not offer special privileges and inducements to the development of the mining industry. Hence the Western system of mineral lands and mining claims did not exist, and the field was not opened to the individual professional prospector. The same condition practically exists to-day. It is difficult to make satisfactory arrangements with the property holders for prospecting; and propositions for such work from outsiders are as a rule regarded with suspicion. Even the larger tracts owned at present by mining companies have not been prospected to any extent. A notable exception to this is the development work carried on by the Yonah Land and Mining Company in Georgia. If this example were followed by other mining corporations whose acreage runs into the thousands while their operations are limited to a few square rods, it would greatly help to develop the possible gold resources of the South in the direction of new discoveries. We do not, however, wish to give the impression that larger and more valuable ore-deposits than those already exploited are still to be found; the more easily recognizable and richer outcrops have been worked over, and in any case such finds as may be made will probably present no new features.

In general, the abandoned mines present the same features as those that are working. Judging from some of the older reports (Silliman, Rogers, Emmons, etc.), the surface ores of these mines were very rich, due partially to local concentration near the surface from the eroded portions of the vein, and in other cases perhaps to pockets and shoots of limited extent and depth. In the earlier days, few of the veins were worked below the water-level; the abandonment of these older mines, cannot, however, always be laid to the appearance of refractory sulphurets. In the sulphuretted ores worked to-day from 20 to 60 per cent. of the gold is free, and in many of the earlier mines, where rich ores occurred in continuous shoots, these were followed down far below the water-level and the free gold which they contained was obtained by simple amalgamation, as for instance at the Gold Hill mine in North Carolina, where the workings extended to 740 feet in depth. The more plausible reasons for the abandonment of the so-called *rich* Southern gold

mines may be attributed to the pinching out of the ore-shoots outcropping at the surface or a diminution in the assay value of the ore. It is probable that the more expensive and difficult operations at such depths precluded the further search for other ore-bodies below the water-level. It must also be remembered that as early as 1840 at least partially successful attempts were made to work sulphurets.

In many of the mines, however, the ore-bodies were of low grade, though sometimes of large extent, and the small extraction of the free gold in the sulphuretted ores did not permit of a profitable continuation of the work. As in all mining regions, many other so-called plausible reasons are given for the abandonment of the mines, as, for instance, mismanagement, disputes among the owners, etc.

To determine the probable value of a mine an examination is of course absolutely necessary. A conclusive opinion is, however, in most cases impossible, even after the mine has been pumped out and examined, on account of the poor condition of the workings and the, at best, limited exposures of the ore-bodies. The prospective investor must, with few exceptions, bear the cost of the necessary exploratory development, which expenditure must be considered speculative. A great number of the properties are held at prohibitory figures, and arrangements for satisfactory examination under option or otherwise cannot be made, traditional merit and output being considered a sufficient proof of value by the owners.

In low-grade highly sulphuretted ore-bodies assays may give a fair indication of the value of the ore if the samples be fairly taken; but a test on a larger scale at one of the experimental chlorination plants,[1] in cases where it is intended to subsequently adopt the chlorination process, would be much more conclusive.

On higher grade, free-milling ores, however, assays, even if taken with care, will be of little value; the results will, in fact, often be misleading. In such cases a mill-test is imperative, and it can generally be made either in the mill at the mine itself, at some neighboring mill, or at test mills especially operated for this purpose.[2]

The most feasible propositions in the South appear to be the working of the larger low-grade ore-bodies. Rich veins as a rule have been in pockets and of small extent, more suited to the operations of tributors or small landowners, with the help, perhaps, of the wooden stamp-mill. It is a well-known fact that ore-deposits of this uncertain character cannot be worked systematically by larger companies with an extensive plant, and must be left to the individual miner, whose personal success pays his daily wages, and to whom an occasional strike is an inducement for continuous work.

[1] Captain A. Thies, Haile Mine, S. C., and Mecklenburg Iron Works, Charlotte, N. C.
[2] Mecklenburg Iron Works, N. C., and the Salisbury Supply Co., Salisbury, N. C.

Systematic work can only be pursued where the ore-bodies are large and continuous enough to warrant the establishment of a regular plant for mining, milling and reduction of the ores. The question of quantity means more than that of quality, so long as the former does not fall below a certain limit.

Among such may be classed the wide lenticular bodies of auriferous and pyritic slates, as at the Haile and Russell mines, and the persistent and continuous quartz-veins of sufficient width, such as at the Reimer and Capps mines. The more continuous and stronger ore-leads of the Dahlonega type may also be included here, such as at the Lockhart and the Franklin mines, which are at present being worked as deep mines, as well as those which have so far been worked by hydraulicking, like the Hand, Singleton, Findley, etc., mines.

In some localities smaller or irregular quartz-veins lying close together have been worked separately; it may prove feasible to mine these together as a body of low-grade ore, especially where the intervening and adjoining country-rock is to some degree auriferous, as at the Rocky River mine.

Such ores as are alluded to may be said to average between $3 and $7 per ton. There are exceptional cases of richer ore-bodies which have shown considerable continuity, as, for instance, at the Phœnix mine; but here, as is usual, the size of the vein and hence the quantity of the ore decreases proportionately with the improvement in the quality.

Almost without exception, a profitable extraction from Southern gold ores can only be attained by supplementing amalgamation with concentration of the sulphurets and by subsequent treatment of the latter. The practically universal adoption of the stamp-mill in the South verifies, as in other gold-mining regions, its more general applicability for crushing compared with other machinery. The two types of stamp-mills more especially characteristic of the South, each having its own field of action, have been described on pages 111 and 119. The milling practice varies greatly, as might be expected from the extremely variable character of the ores.

All of the Southern ores contain at least a portion of their gold in the free state, and excepting where other ingredients offer serious obstacles, or where a smelting process is intended, concentration is best preceded by amalgamation, so as to obtain the free gold as soon as possible and not endanger it to loss in subsequent treatment. Especially where the sulphurets are coarse and the crushing is not fine, a preliminary sizing in hydraulic classifiers and spitzkastens, and the treatment of each size on a separate vanning machine, is advisable. There has been a tendency to overcrowd these machines in the South; a saving of original cost here is but poor economy. It would seldom be advisable

to use less than two 4-foot belts to every five stamps. The degree of concentration (cleanness of the concentrates) must depend upon the ratio between the cost of subsequent treatment per ton, on the one hand, and a greater loss in tailings occasioned by close concentration on the other, the cost of concentration itself being practically the same in either extreme.

For the economical treatment of the concentrates chlorination by the Thies process furnishes in almost all cases a ready solution. The process is a simple one and is not patented; the cost of plant is comparatively small, and the percentage of extraction is high (94 to 97 per cent.). It has been in active operation on a continuous working scale at the two most successful mines in the South (Haile and Franklin mines). The presence of copper is objectionable in this process, as it increases the consumption of chemicals, and if in too large a quantity it may preclude the adoption of the process. At the Phœnix mine, N. C., ores running as high as 3 per cent. copper were, however, successfully treated. Ingredients which make dead-roasting difficult may also add to the cost of the process.

Sulphuret ores assaying only $3 per ton, when existing in extensive bodies, so as to permit operations on a larger scale, other conditions being favorable, might be worked at a profit by the application of this process.

Should concentration, on account of the too finely divided condition of the gold and sulphurets, prove impossible without a heavy loss in tailings, the cyanide, bromination or Swedish chlorination process might prove of value for a direct treatment of the ore; or the ore might be treated in bulk by the modification of the Thies process in use at Deadwood, Dakota; or by the Thies process proper on an enlarged scale, using, if necessary, closed filtering-tanks under pressure. In all of the above previous roasting is necessary, excepting perhaps in the cyanide process. Attempts with the latter have so far been unsuccessful. It will be of interest to watch the outcome of the plant at the Russell mine, N. C. Lack of success in the use of cyanide cannot always be laid to its lack of applicability; it certainly has, however, this disadvantage, that it requires a careful experimental trial, best made on a large scale and therefore expensive, as well as a continuous supervision afterwards by an experienced chemist, together with more or less skilled assistance, which is a requirement not always conformable with Southern conditions.

A small class of the Southern ores, referring particularly to those containing lead, copper and zinc, would have to be treated by smelting. A smelting plant would, however, only prove a financial success under the concerted action of all—or at least most—of the mines producing such

ores, a state of affairs which, under the present condition of gold mining in the South, seems difficult to attain. Several attempts have been made to gain this end, but have not been successful.

Taken as a whole, the gold ores of the Southern Appalachians present no greater difficulties of treatment than those of other fields, the distinguishing feature being perhaps their large variety, which makes a close study of each separate ore-body necessary.

As to the cost of labor in the South, it may be said that while it is low compared to that of the Western mining districts, and unskilled labor can be obtained at especially low cost, skilled labor commands about the same wages as throughout the East. It will be found here, as in other places, that the laborer is worthy of his hire. Some difficulty may be experienced in obtaining suitable labor, especially in those districts where no active mining work has been going on. In general there are no mining camps, in the Western sense of the word, and hence no regular mining population that might otherwise engender a more energetic mining spirit.

Among the facilities for operations in the South are the climate, which permits continuous working throughout the year; the accessibility of the mines to railroad lines, and their comparative proximity to investing Eastern capital. Lumber, timber and cord wood can be obtained at very low cost. Mining supplies and machinery are furnished from several central points in the field (Salisbury, Charlotte, Dahlonega, Atlanta). Water-power—in most cases, however, undeveloped—is abundant throughout a great portion of the mining belt. Should a revival in mining favor a development of properties in groups, central electric power distribution plants would be practicable in most districts.

Gold mining in the South has its favorable features, which should facilitate the economic working of the ore-deposits as legitimate business undertakings, with close and intelligent management. A considerable number of properties are at least worthy of investigation, and to the best of our belief, such investigations will disclose remunerative working opportunities, and will ultimately lead to a reasonable revival of gold mining in the South. Examinations would be greatly stimulated by more disinterested co-operation and reasonable demands of the mine owners, ultimately to their benefit. It is to be hoped that speculative investments in the Southern gold mines have had their day, and that all future operations will be conducted on such a business-like basis as begets confidence and stability.

INDEX.

BULLETINS OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map.....Postage 10 cents.

2. Building Stone in North Carolina, by Joseph A. Holmes and J. Volney Lewis .....In preparation.

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18. Road Improvement in North Carolina, by J. A. Holmes and William Cain.....In press.

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