PART THIRD.

THE MINERALS AND ROCKS OF SPECIAL USE.

1168. In the Part of the Report just finished, the principal purpose has been to describe the structure and the great rocky formations of the State, (§ 315,) the notices of the minerals, and especially useful mineral substances, although in many cases full, being subordinate. In this Part the latter are classified, and constitute the principal subject. Much, however, having been already written that properly belongs here, this division of the Report will be, to a considerable extent, an *annotated index* of the minerals and mineral substances already described. The whole is an outline of our mineral resources. There is yet much filling up to be done.

1169. The most important elements in the mineral resources of Tennessee are *iron-ore* and *stone-coal,* and this is as we would have it, for to these, above all other minerals, are the vigor, the thrift, and the wealth of civilized nations to be attributed. Our, *gold, zinc, lead, marble, petroleum,* and even *copper,* although constituting, in the aggregate, a very important general interest, are individually quite subordinate. These have a local interest. The *copper mines* have been a rich boon to Polk County, and neighboring parts of East Tennessee, and have, moreover, contributed to the revenue of the State; but the *iron-ore* involves an interest which is directly State-wide, and one which has added, and is adding, vastly more to the wealth of Tennessee. So the *stone-coal,* stored in a great field that lies between two of the most extensive sections of the State, that includes parts of many counties within its area, and has an extent of more than 5000 square miles, is something that we are all interested in individually and as citizens.

1170. It becomes us to look to these interests, and especially to the coal-interest, for the development of this is far behind what it ought to be. We need not send money to Kentucky or Pittsburg for coal. We must have a railroad across our coal field, and make the very heart of it accessible. Nashville and Knoxville are the important points, respectively, of two great sections of the State, and approximately on the same parallel, and one, moreover, north of the middle of the State, yet to pass from one point to the other, it is necessary to go out of the State into Georgia and Alabama, and go round our coal-field. Rather a severe commentary on our enterprise, especially when it is recollected that a direct road would pay for itself in the opening out of our buried resources. But it is gratifying to know that this state of things will soon be rectified. The Nashville and Chattanooga Road has done much, as we have seen, (§ 993,) towards the development of the coal interests of Tennessee; the Knoxville and Kentucky Road will do much; but the Tennessee and Pacific Road will do more.

CHAPTER XVI.

THE ORES AND METALS.

1171. In this chapter are considered the minerals used as ores, and such metals as occur native, like gold.

The chapter that follows will embrace minerals not used as ores, of which coal is an example, and rock-products, like marble and buhr-stone.

SECTION I.

IRON. (1.)

1172. The variety and the aggregate amount of *iron-ore* in Tennessee, its excellent quality, its favorable association with the necessary conditions for the economical manufacture of iron, place the State among the best as an iron-producing region.

1173. The localities and outcrops of the iron-ore of Tennessee, including all its varieties, whether in local deposits or in regular beds, are found in *three* belts of the State, which are

quite distinct, and differ, more or less, in geological and mineral character. These belts, or iron-regions, as I shall call them, are as follows:

(A.) THE EASTERN IRON-REGION. Extends through the State, lies along with and in front of the *Unaka Range.* (§ 41.)

(B.) THE DYESTONE-REGION. Skirts the eastern base of the Cumberland Table-land, or of Walden's Ridge, from Virginia to Georgia; extends out laterally into the Valley of East Tennessee from ten to twenty miles; the Sequatchee and Elk Valleys are included.

(C.) THE WESTERN IRON-REGION. Occupies a belt of the Highlands contiguous to the Western Valley, (§§ 250 to 252,) and a part of this valley itself; the belt runs through the State, from Kentucky to Alabama.

A.—THE EASTERN IRON-REGION.

1174. This region includes the counties of Johnson, Carter, Sullivan, Washington, Greene, Cocke, Sevier, Blount, Monroe, Polk, and the eastern part of McMinn, or, in other words, those counties in which the Unaka Range, with its outliers and included valleys and coves, is found. (§§ 41, and 124-137.) It is in these valleys and coves that most of the ore-deposits occur. As, for example, in the picturesque valleys of Johnson, in the Valley of Stony Creek, of Carter, Bompass and Greasy Coves, of Washington, the coves of Greene, those back of Chilhowee, in Sevier and Blount, and in those back of the outliers, in Monroe, and Star's Mountain further south. The valleys which skirt the outliers (§ 46) on the west are to be included. In all of these ore is found, and is to be looked for. No doubt numerous deposits remain to be discovered, notwithstanding the number known. Many of these valleys and coves are from ten to twenty miles long, and from one to five miles wide. Those in Johnson and Carter, especially, are remarkable for their extent, and for the numerous deposits, or banks, of ore occurring in them.

1175. The typical geological structure of many of the iron-bearing valleys and coves, is illustrated by the diagram on page 202. The bottoms of the valleys are occupied generally by variegated shales and slates, and magnesian limestones of the *Knox Group.* At many points these rocks have been greatly

leached or weathered, and have left ridges or knolls of *debris,* consisting of clay, sand, chert and shaly fragments, or where the rock is mainly limestone, or dolomite, little else than clay. In these leached masses the ore, at certain places, has accumulated, and thus the banks have been formed. See, also, §§ 562 and 563, and compare, in addition, § 1182.

1176. In the diagram referred to, the valleys (A and B) are flanked by a sandstone mountain on each side. Many of the iron-bearing valleys or coves, however, have a mountain on but one side. In a few cases, extensive banks, as those in Sullivan and one in McMinn, are entirely detached from the main mountains, and sustain no particular relation to them. These are exceptions, and are thrown into the eastern region on account of their proximity, and for convenience.

1177. The Eastern Iron-Region affords three species of ore, as follows:

(1) *Limonite;* contains, when pure, 60 (59.92) per cent. of metallic iron; powder brownish or *yellow;* by far the most abundant ore.

(2) *Hematite;* has, when *pure,* 70 per cent. of iron; powder *red;* includes two varieties, as follows: (a) *Hard Solid Ore,* and (b) *Dyestone,* or stratified ore.

(3) *Magnetite;* contains, when *pure,* 72 (72.4) per cent of iron; powder *black;* the richest and the rarest ore in Tennessee.

1178. (1.) *Limonite.* This is the great ore of this Iron-Region, and will always be meant unless the others are specified. When pure, it consists of

Iron,	59.92
Oxygen,	25.68
Water,	14.40
	100.00

It never, therefore, contains more than 59.92 lbs. of iron in one hundred of ore. Practically, it never contains this amount, owing to impurities.

1179. In the field before us, it occurs both as "honeycomb" and hard solid ore—occasionally in grains, and called shot-ore—sometimes in ochreous and earthy forms. It exists in the banks in masses of all sizes, from small lumps up to blocks and beds, sometimes ten or fifteen feet in diameter. It is found, too, in contorted layers, from a few inches to two or three feet in thick-

ness, partially stratified with seams of earthy matter, and, in some cases, more or less parallel to the irregular surface of limestone rocks below. The ores generally are excellent, yielding iron of first quality.

1180. The knolls, hills and ridges, which generally afford the most important banks, though some of them are in low grounds, are from fifty to two hundred feet high, and often several miles long. The deposits occur upon these at intervals, and sometimes the ore can be traced for half a mile or more.

1181. Considerable of the superior ore of Johnson, Carter, and Washington contains *lead* and *zinc.* The ore of Bompass Cove, in Washington, and that used at Carter's Furnace, in Carter county, are of this character. The iron made from both is excellent. Often, after blowing out, several hundred pounds of lead have been obtained in the crevices of the stacks. The zinc collects in a hard incrustation around the mouth of the furnace.

1182. It is an interesting fact pointing to the origin of the limonite in these banks, that localities are met with in the coves, in which the banks occur, where the limestones and dolomites contain disseminated grains of *pyrite, blende* and *galena, (galenite.)* Such is the case in Bompass Cove, and at one point the galena is so abundant as to have attracted notice as a *"lead mine."* (§ 566.) We are led to infer from such facts that the limonite of the ore-bank, at another point in this cove, and the *lead and zinc ores* associated with it, are oxidized portions of the leached remains of limestones, which, like those above, originally contained pyrite, blende and galena.

1183. The data on hand are not sufficient for the making out of a complete list of the limonite banks of the Eastern Iron-Region. The deposits are very numerous, and there is scarcely a cove or valley in which note-worthy accumulations of ore do not occur. The most of these, however, are of limited extent. The number of first class banks, that is to say, deposits upon which a furnace, or set of furnaces, could depend for an abundant supply of ore for years, or such as would justify the erection of extensive works, will average, perhaps, including the hematite banks of Sullivan, three or four to the county.

1184. The great caps of *limonite,* or *"gossan,"* over the Ducktown Copper Veins, may be enumerated here. The geological relations of these masses are different from those of the deposits we have discussed, and will be referred to under "Copper.

1185. (2.) *Hematite.* This includes, as stated, the *Dyestone;* some of its varieties are known as *Specular Iron.* It contains, when pure,

Iron,	70
Oxygen,	30
	100

Hence, one hundred pounds of this ore might afford seventy pounds of iron. In practice, however, as in the case of the ores mentioned, the maximum per centage, on account of impurities, is never reached.

1186. As before stated, there are two varieties of it in the iron-region under consideration.

(*a.*) *Hard Solid Ore.* I know of but three or four localities of this ore in Tennessee, excepting those of the small cabinet specimens of specular iron that occasionally occur in the older formations.

1187. The first is the *Cannon Bank,* seven miles from Elizabethton, in the valley of Stony Creek. The ore occurs here in a regular and solid bed. It rests upon a thin stratum of conglomerate, of pea-like quartz pebbles, while above and below the rocks are sandy slate, or shale, all having a gentle dip. There is some doubt in regard to its exact geological position. See § 511, where also this bank is noticed. It is worked at Nave's Forge, (1856,) and yields a good iron.

1188. The other localities which have come under my observation are in the eastern part of Sullivan, a mile or two west of the Holston, and near the residence of Mr. James Cowan.

One, known as the "*Crockett Bank,*" half a mile southwest of Cowan's, is an extensive bank or ridge of red earth, with numerous small blocks of solid hematite scattered through it. Near the surface, it is associated with more or less "honeycomb" brown ore. There is another locality about a mile and a half in the same range to the northeast, not as yet opened, which, from external appearances, promises to be valuable.

1189. About one and a half miles northwest or north of Cowan's, at the *Sharp Bank,* is an interesting vein-like mass of the same compact ore. This has been noticed in § 564. It appears to dip with the dolomites of the Knox Group. It is capable of affording much good ore.

1190. The neighboring localities, before spoken of, are doubtless associated with the same dolomite. It may be that the loose blocks have been derived from a vein like the last, which has not yet been exposed. Some of the small blocks were seen with imbedded crystals of quartz.

At all of these localities the ore is more or less magnetic. They have been worked to considerable extent by the furnaces and forges of Sullivan.

1191. These Sullivan ores are hardly true hematite; they occupy rather an intermediate position between this and limonite, or are mixed ores.

1192. (*b*.) *Dyestone*.—There is one interesting and extensive deposit of this ore, which, on account of its proximity to the Unaka Range, it has been found convenient to throw into this iron region. Its character, however, connects it with that next to be described. It is Hill's Bank, in the eastern part of McMinn. The ore is a stratified, fossiliferous, iron-rock. The main deposit is a third of a mile or more in length, and at some points fifty or sixty feet wide. For three or four miles, along its range, traces of the ore occur, and at several points it swells out into other important deposits.

The ore is composed, in good part, of flattened oolitic or rounded grains, and frequently contains impressions of crinoidal buttons. Owing to its separating into small blocks, it is sometimes styled "block ore." A small bloomary, five miles distant, uses this ore, and makes good iron—said to be "hard and tough."

The geological relations of this bed are spoken of in § 657.

1193. (3.) *Magnetite*.—This is also known as Magnetic Iron ore. When pure, its composition is:

Iron,	72.4
Oxygen,	27.6
	100.0

One hundred pounds of *pure* ore contains therefore 72.4 pounds of iron.

1194. Magnetite is a rare ore in Tennessee. I only know of one locality affording it in workable quantity. A locality in Cocke County is barely mentioned by Dr. Troost. The first referred to—which I have visited—is in Crab Orchard, Carter

County (§ 389.) It is about six or seven miles from the summit of the Roan, (§ 55,) and lies at its base. The ore is associated with a greenish crystalline mineral, called *sahlite*, and occurs with this, and with the decomposing gneissoid rocks around it, in irregular layers, patches, and wedge-shaped masses, often several feet or yards in length. No well determined vein has been exposed, though the ore and sahlite are found along a certain range for some distance.

1195. The masses taken out and used are composed of grains of ore, mixed, more or less, with quartz, sahlite and other foreign matter. This are occurs in the Metamorphic Group. (See also, § 414.)

The ore is worked at Hampton's bloomary, near the locality, and yields a most excellent iron. Several miles farther east, in North Carolina, are the Cranberry Iron Works, which makes use of the same kind of ore.

1196. The occurrence of cabinet specimens of magnetite in the semi-metamorphic strip in Union County, may be mentioned here. (See § 399.)

1197. Previous to the war there was considerable activity in the Eastern Iron Region in the business of making iron. But the grievous war prostrated all interests of this kind. How far these interests have been revived, how many forges have rekindled their fires, how many furnaces are under the blast, I know not. It is difficult to get reliable information as to such matters without traveling over, in person, most of the ground, and that has been out of the question.

1198. As to one county, however, *Greene*, I have partial information. This county has done well. Since the war two large furnaces have been erected within its limits, and are now in operation. The following letter from Gen. E. L. Hayes, describes one of them;

OFFICE GREENE COUNTY IRON Co.,
Hayesville, Tenn., Feb. 22, 1869.

DR. J. M. SAFFORD,
State Geologist, Lebanon, Tenn.:

DEAR SIR:—We submit the following information in regard to our Works, and hope it may be of service to you:

The *Greene County Iron Company* was organized in the City of New York, in September, 1867, in compliance with the laws of the State of New York, for the purpose of making iron in the State of Tennessee, with a capital stock of one hundred thousand dollars. The land purchased by the Com-

pany comprises 5,564 acres, mostly timbered mountain land lying in nearly a southern direction from Greeneville, and eleven miles distant from that place, on a small mountain stream known as Back Creek, a tributary of the Nolichucky River. The ore is found in great abundance on the right bank of the creek, and at the base of the mountains known as part of the Smoky Range [Unaka Range] which separates the States of Tennessee and North Carolina. The furnace erected by the Company is double hot blast, built of limestone, and said to be one of the finest in the United States. The capacity is from ten to twelve tons per day of charcoal iron. The ore is a brown hematite, (limonite,) yielding from 40 to 50 per cent. of tough gray iron. Both ore and charcoal are very accessible to the furnace. A town has been laid out, and named *Hayesville;* some forty buildings have been erected; a post-office has been established; a school district organized; and a school house and church are in process of erection.

Very respectfully, yours,
E. L. HAYES, *Supt.*

1199. In order that the reader may know what was once the extent of the iron-making business in the region under consideration, the statistics of 1854 bearing upon this business, (collected by the author,) will be given. Similar statistics will also be given for the remaining iron regions. These will be found presented in the tables at the end of this section.

1200. It will be seen, by referring to the tables that there were, in the Eastern Iron Region, in 1854, *nine furnaces,* and all but one, Tellico, cold blast; of these, five were in operation that year, and produced 1855 tons of cast iron—Tellico and Pleasant Valley producing by far the greater part.

The forges were much more numerous, thirty-nine in all ; of which thirty-two were bloomaries, and seven, refineries; making, altogether, in 1854, 912 tons of bar-iron, and 480 tons of blooms.

In addition, the Rolling Mill in connection with Pleasant Valley Furnace, is to be noted.

1201. We now pass to the western side of the Valley of East Tennessee. The middle part—that included between the iron regions—does not afford any very extensive banks of iron ore. Small deposits of limonite, however, are very numerous. They can be found upon most of the cherty ridges of the Knox Limestones. The ore occurs, within limited areas, scattered through the soil. At some points, enough could be obtained to supply a bloomery for several years. No forges, however, nor furnaces, are located in this part of the valley.

B.—THE DYESTONE REGION.

1202. This iron region differs from the eastern, in its geographical position, in its geological relations, and in its ores.

It occupies a belt of the State skirting the base of the Cumberland Table-land, or of Walden's ridge, as stated in § 1173. All of some of the following counties, and parts of the others, are included in its area: Hancock, Claiborne, Grainger, Campbell, Anderson, Roane, Rhea, Meigs and Hamilton. It embraces the Sequatchee and the Elk Fork Valleys; this places, also, parts of Marion, Sequatchee and Bledsoe counties, within its area.

1203. The great ore of this region is the stratified red ironstone, called at many points, *dyestone,* being sometimes used for dying purposes. It is a variety of hematite, as stated in § 1177. It generally soils the fingers readily. At most points the ore is hard enough to be quarried out in blocks; at others it is soft, and easily crushed, as at Kimbrough's, in Roane County. Sometimes the soft variety presents the appearance of a true, scaly, specular ore. The dyestone is further described in § 777, to which the reader is referred.

The impurities contained in the dyestone are sandy and argillaceous matters, and carbonate of lime. The presence of the latter is, in certain proportion, no defect, as it can be made to act the part of a flux.

1204. The iron produced from this ore is excellent, both the pig-metal of the furnaces, and the bars of the bloomaries. Occasionally the bar inclines to be *cold-short.*

1205. In addition to the dyestone, limonite is found on the ridges within this iron-region, under circumstances similar to those mentioned with reference to the middle part of the Valley. The two are sometimes mixed in working, with good results.

1206. In the description of the group or formation containing the dyestone beds, (page 302,) the geological relations of the ore have been sufficiently presented.

The ridges, or ranges, called *Dyestone Ridges,* in which the ore-beds occur, have also been enumerated. See § 784, and on. The outcrops of the ore-beds lie in the red lines on the Map.

1207. The first of these, the *Mountain Ridge*, is one of the most important. (See § 785.) The *bed of ore* in this skirting ridge extends, with but few interruptions, from Virginia to Georgia, a distance of nearly 160 miles. There are not more than three or four interruptions, averaging in length from two to three miles each; so that in this range, we have, what may be regarded, as a continuous band of ore 150 miles in length.*

At Cumberland Gap the ore is, as stated, (§ 756,) from 24 to 30 inches thick, and of excellent quality. I visited a locality in Roane, belonging to Gen. G. L. Gillespie, formerly of Kingston, where the ore appears to be seven or eight feet in thickness, though no excavation had been made. At other points near by, which could not be visited at the time, it is said to be much thicker. In the southern part of the State it is less heavy. The entire average thickness of the bed must be at least 20 inches; perhaps it is more.

At numerous points its quantity is greatly increased by the folding of the strata, giving often three or four parallel bands within a few hundred yards.

The soft ore at Kimbrough's is in this range.

1208. Col. W. B. Gaw, in a Report already referred to, (§ 1004,) has the following notes on *iron-ore*. The localities referred to belong mainly to the *Mountain Ridge or Range.*

"The first bed of ore upon our line, occurs in Hamilton County, across the river from Chattanooga. The beds are from one to four feet in thickness, and were formerly worked by the East Tennessee Iron Manufacturing Company, producing a good quality of iron. The ore is the dyestone.

"This ore is found in all the 'valley ridges' along the entire length of road, and in close proximity to it, but we will only mention the points where it has been, or is now worked.

"The next point where the ore has been worked, is at Smith's Cross Roads,

* In speaking of the occurrence of the dyestone, or, as it is often called, the lenticular argillaceous ore, I have confined myself to Tennessee. It has, however, a wonderful range beyond the limits of this State. It is a member of the Clinton Group, of the north, and reaches from Tennessee, through Virginia, Pennsylvania, into New York, and even into Canada. It has been traced out over a good part of this entire range. At numerous points in the states mentioned, it supplies furnaces and forges with ore. Southward, it reaches many miles into Alabama, where it finally disappears beneath more recent formations. This extent, considering that the beds are very seldom more than three feet thick, and often but a few inches, is truly wonderful.

We appear to have in Tennessee our full share of this valuable ore. So far as we have been able to ascertain, it occurs nowhere in beds thicker or more plentiful.

in Rhea County, where several bloomaries were in operation some years ago.

"There are two bloomaries at White's Creek, in Roane County, the ore used, being the same as that already mentioned.

"At Kimbrough's, extensive beds are found, and a bloomary was worked during the war.

"Ore is found in large quantities at D'Armond's Gap, but is not now worked."

1209. The other Dyestone Ranges, with notices of the beds of ore included in them, are described in §§ 788 to 799, to which the reader is referred. The ore of the Elk Fork and Sequatchee valleys is mentioned in §§ 804 to 806.

1210. As in the case of the Eastern Iron-Region, the facts in reference to the production of iron in this region, in 1854, may be found tabulated at the end of the section.

There were, it will be seen, five furnaces—two having steam power and hot blast. Only two were in operation in 1854, producing 1168 tons of cast iron. Of the five furnaces, two—the *Cumberland,* at Cumberland Gap, and the *Bluff,* at Chattanooga, were destroyed during the war. How it has fared with the others I know not.

The forges, which were fifteen in number, were all bloomaries, and produced in 1854, 257 tons of bar-iron.

APPENDIX.

1211. *The Cumberland Iron-Region.*—As an Appendix to the Dyestone Region, I bring in the Table-land as an *iron-field.* In the course of my investigations I have met with many beds of shales in the Coal Measures, containing *clay ironstones.* These are quite plentiful in the shales below the Wheeler coal, as at Wiley's Bank, on Coal Creek. (§ 1067.) Their occurrence is also noted in many of the sections given in chapter XII. See pages 372, 373, 396, &c.

1212. The *clay iron-stone* is an ore quite different, in appearance and in composition, from any worked at present within Tennessee.

It is an impure carbonate of iron. An analysis before us, by Professor ROGERS, of one of the best specimens found in Pennsylvania, is, in 100 parts of ore: *

* Overman's Manufacture of Iron; p. 30.

Protoxyd of Iron,	53.03
Carbonic Acid,	35.17
Lime,	3.33
Magnesia,	1.77
Silica,	1.40
Alumina,	0.63
Peroxyd of Iron,	0.23
Bitumen,	3.03
Water,	1.41
	100.00

Throwing it into another form, we have, in 100 parts:

Metallic Iron,	41.25
Oxygen of the Protoxyd above	11.78
Carbonic Acid,	35.17
Impurities and Water,	11.80
	100.00

The best ores, therefore, contain a little more than 40 per cent. of pure iron; practically, they yield 30 or 33—sometimes, however, approaching 40.

1213. This ore occurs in nodules and balls, or in flattened concretions, disposed in layers, and interstratified with the shales of the Coal Measures. These balls, or concretions, run up in size from small pebbles to masses weighing a ton or more.

The clay iron-stones are a variety of the crystalline carbonate of iron called *siderite.* Though not as rich as some ores, they are, nevertheless, highly valued, and partly on account of their association with stone-coal.

1214. Whitney, in his "Metallic Wealth of the United States, says :

"This is, perhaps, the most important ore of iron; not generally in its sparry state, but as a mixture with clay and the hydrated oxyd which results from its decomposition, and as constituting a part of the great Carboniferous Formation; hence, occurring with the coal required for its reduction, it becomes of great importance."

"It is to the abundance of her coal-measure iron-stones that England is indebted for her vastly preponderating production of this metal; and it is thus that she has been able to supply the rapidly increasing demand for railway iron, which the discovery of a new means of national inter-communication rendered necessary. The coal-fields of North and South Wales, North and South Staffordshire, etc., while they furnished fuel to

smelt the ore, furnished the ore itself, and the necessary flux from the same shaft, with hardly any increased expense beyond what it would have cost to raise the coal alone."

1215. Below the Wiley Coal Bank, in Anderson County, there is a bluff of shale 55 feet thick, with numerous layers of the balls, and flattened masses of this ore in it. Doubtless, along the base of the great ridge, at the foot of which the Wheeler Coal Bed outcrops, as well as at higher levels in this mountain, much clay iron-stone could be obtained. There are, also, other points within the area of the Table-land at which this ore deserves attention.

1216. There is another ore of iron which has, of late years, attracted much attention in Scotland and other countries. It is a *coaly* impure carbonate of iron, peculiar to the coal series, and called the *black-band* or *Musket iron-stone.* Indications of this have also been discovered in our Coal Measures. A layer of it, from 6 to 12 inches thick, is seen in the section taken three miles south of Beersheba Springs. (§ 970.)

Finally, in addition to the ores mentioned, more or less *limonite* is scattered over the Table-land; but, as yet, I have not met with any very considerable deposit.

C.—THE WESTERN IRON-REGION.

1217. The counties embraced within this Iron-Region have been given. It occupies a belt, about 50 miles wide, running directly through the State. See §§ 1157, 1158, and 1173. Within this area the banks are met with, at greater or less intervals.

1218. The mode of occurrence of the ore in the banks, as well as its varieties, have been spoken of in §§ 1157 to 1162. It may be added, here, that some localities do not abound in chert; a few afford ore, in red clay alone. The ore is raised from excavations, made either in the tops of the ridges, or in their sides—all being open to the day.

1219. It is not in my power to give a complete catalogue of all the noteworthy banks in this iron-field. As an illustration of their number and value, I will refer to those of Hickman County. It must be observed, however, that this, as an ore-

producing county, is *much above* the average of the counties embraced within the iron-region.

1220. In Hickman, at least *twenty banks* occur, upon nearly all of which a furnace could depend for a supply of ore. These lie on both sides of Duck River, and are thus located:

On the waters of the Beaver Dam—six; these, with those on Swan Creek, include the Ætna Furnace banks.
On the waters of Swan Creek—seven.
On Jerry's and Ore branches, north of Duck River—*one,* the *Brown Bank,* an excellent and extensive deposit of ore.
On *Haley's Creek,* the *Cantrell Bank.*
On *Defeated Creek,* the *Puckett Bank.*
On *Piny,* near Vernon, *Lee's Bank.*
On *Mill Creek,* also near Vernon, the *Extra Oakland* No.1, and *Oakland* No.2.
On *Garner's Creek,* the *Garner's Creek Bank.*

The localities of the most of these banks are indicated on the Map by groups of small dots.

1221. The greatest of these banks is one belonging to the Ætna Furnace property. We present it as an example of one of the most extensive banks, if not the most extensive, in the whole iron region.

It lies between two tributaries of Beaver Dam Creek—the Brushy and Piney forks. It is from two to three miles long, and will average nearly or quite a mile in width.

Here we have more than two square miles of ore ground, with a depth of from 10 to 100 feet. At scores of points over this area the ore presents itself in natural exposures, or proves its presence in quantity by the fragments scattered over the surface.

1222. It must not be understood that all this ground presents ore which it will be profitable to raise; by no means: it is rather a group of numerous rich deposits of ore. But there is no estimating the amount of mineral it can yield. Ætna Furnace has obtained its ore from the north-western end of this bank—that nearest the stack—and, although the furnace has made over 20,000 tons of metal, this end even is not fairly opened. Several large excavations have been made in the margin of the bank, in which large houses might be put, but they are as nothing—mere notches in the edge of the great plateau of ore.

The bank can feed as many furnaces as can be conveniently located around it. But the great quantity is not the only desirable feature of this bank; its mineral is of excellent quality, and the iron made from it is of superior character.

1223. The mineral resources of Hickman County have not been adequately developed, more on account of the want of

the means of transportation than anything else. Next to Hickman, Dickson and Stewart take rank as iron counties, but some of the others are not much behind them.

1224. The property of the Cumberland Iron Works, in Stewart County, is one of great extent and value. It embraces not less than 111.5 square miles of territory, much of which is good arable land. It has many exposures of ore upon it. Its two principal banks are the old *Bear Spring*, and the *Morgan Bank*. The first of these has afforded a great amount of ore. Several furnaces have been supplied from it. The Morgan Bank is comparatively a fresh one. The Cumberland Rolling Mill was formerly an important part of this property, but is now in ruins. One furnace is in blast, another on the property (Bellwood) was burnt during the war, and has not been rebuilt. A bed of fire-clay on this property has been spoken of in § 907.

The *La Grange* is another excellent bank in Stewart county.

1221. We have confined our attention to the western side of the Highland Rim; but this iron field has, in fact, a counterpart, though of much less extent and importance, on the eastern side of the Rim, lying in the range of counties along the base of the Table land, including White, Warren, Coffee, etc. These counties have afforded some ore; and one bloomary is now in operation on Rocky River, in Warren. We look forward with interest for greater developments in this detached section.

1226. The ores of the Western Iron-Region are generally of good quality, and make excellent iron. The following analyses were made by Dr. Troost:

No.	Peroxyd of iron.	Oxyd of Manganese.	Water.	Earthy matter and loss.	Per cent. of pure iron.	Locality.
1	83.0	1,0	14.0	2.0	58.1	Perry county. (?)
2	63.0	2.0	15.0	20.0	44.1	Hickman county.
3	80.0		12.0	8.0	56.0	Brownsport.
4	80.0	1.0	15.0	4.0	56.0	Bear Spring.
5	76.5	5.0	12.0	6.5	53.5	" "

1227. The ore that has been used at Marion Furnace is Hematite, as has been stated. (§1159, note.) It is related to the dyestone ore. It is a fine granular ore, at some points hard and compact, at others soft, unctuous, and staining a deep red. It occurs in several knobs in the region, and is irregularly arranged in layers, with red clay and shaly matter. The ore is highly esteemed, and yields an excellent iron.

1228. There were in the Western Iron-Region, before the war, 35 furnaces, the blast of all but two being made by steam

power. Many of them were extensive and elegant establishments. Thirty-one were in operation in 1854, and made 37,283 tons of iron.

Four bloomaries were in operation, making the same year, 91 tons of iron.

The refineries, thirteen in number, were generally efficient establishments, having about fifty-nine fires. They made in 1854, 6,808 tons of blooms, and a few tons of bar-iron. Further statistics are given in the tables.

1229. We add a word in regard to the *fuel* used by our furnaces and forges. As yet, it is throughout the State wholly *charcoal.* Wood in the iron fields is cheap and abundant, and will be for many years. When it becomes indispensable, we have ample supplies of stone-coal in the bosom of our Table-land, and by that time railroads, as well as our rivers, will bring it to the mouths of our furnaces.

1230. TABLE OF THE TENNESSEE FURNACES, INCLUDING THEIR PRODUCTS, ORES USED, ETC. (1854.)

(a) *Eastern Iron-Region.*

* Blast created by *steam*-power; that of the others by *water*-power. Nos. 8, 13 and 14, are *hot blast;* the others *cold blast.*

No.	Name.	Owners.	County.	PRODUCTS OF 1854.			Kind of Ore.	REMARKS.
				Pig Metal and Castings.	Cas'gs alone.	Mo's in bl'st		
1	Union,	Carter & Co.	Carter.	250	.....	.....	Limonite.	.....
2	O'Brien's,	.....	"	.....	.....	.....	.....	Out of blast since 1840.
3	Bushong's,	William Bushong.	Sullivan.	105	25	.....	Hematite.	.....
4	Welcker's,	Welcker, Beidleman & Co.	"	.....	.....	.....	"	In blast during 1855.
5	Pleasant Val'y	R. L. Blair & Brothers.	Washington.	700	100	6	Limonite.	Con. with ref. & r. mill.
6	Clark's Creek,	" "	"	.....	.....	.....	"	Out of blast since 1844.
7	Bright Hope	John Shields.	Greene.	.....	.....	.....	.....	Out of blast for sev'l yrs.
8	Tellico,	Welch, Harris & Co.	Monroe.	730	.....	7	Limonite.	.....
9	Ball Play,	S. S. Glenn & Co.	"	70	.....	2	"	.....
			(b) *Dyestone Region.*					
10	Cumb'lnd Gap	John G. Newlee.	Claiborne.	238	38	4	Dyestone.	Now extinct, (1869.)
11	Crockett's,	Rose & Fugate.	"	.....	.....	.....	D. and L. ?	In blast in 1855.
12	Sharp's,	.....	Grainger.	.....	.....	.....	Dyestone.	Repairing.
13	Eagle,*	T. T. Iron Manufac'g Co	Roane.	930	.....	7	"	.....
14	Bluff,*	" "	Hamilton.	.....	.....	.....	"	Now extinct, (1869.)

15	Brownsport*	Ewing, Dick & Co.	Decatur.	2109	.....	11 5	Limonite.	.....
16	Decatur*	Golladay, Cheatham & Co	"	.....	.....	.....	"	Started Jan 55, c. 2000t
17	Marion*	J. J. H. & J. K. Walker.	Hardin.	915	?	6	Hematite.	Made some sugar ket'ls.
18	Forty-eight*	F. & S. Pointer.	Wayne.	2445	.....	12	Limonite.	Uses two stacks alter'ly
19	.....	.....	Lawrence.	.....	.....	.....	"	Out of blast sev'l years.
20	Cedar Grove*	Wm. Bradley & Co.	Perry.	1500	?	.....	"	Uses 2 stacks alter'ly.
21	Ætna*	Goodrich, Fell & Hillman.	Hickman.	1509	.....	9	"	.....
22	Oakland*	Studdurt, Foulkes & Brat'	"	385	.....	3	"	.....
23	Worley*	Jas. L. Bell.	Dickson.	950	.....	.....	"	Has a refining fire.
24	Jackson	Estate of M. Bell.	"	50	.....	.....	"	In blast but a few w'ks
25	Piney*	Napier & Holt.	"	1731	70	.....	"	..... [of '54.
26	Laurel*	William C Napier.	"	257	.....	4.5	"	Has a refining fire.
27	Cumberland*	Anthony Vanleer.	"	1926	.....	.....	"	.....
28	Carroll*	Robert Baxter.	"	1050	.....	9	"	.....
29	Louisa*	Jackson, McKerman & Co	Montgomery	2154	.....	.....	"	.....
30	Sailor's Rest*	Isaac D. West.	"	600	.....	7	"	In '54 wat'r-power now
31	Yellow Creek*	Robert Steele.	"	600	.....	.....	"	Same as last. [steam.
32	O. K.*	Caldwell, Vanleer & Co.	"	1160	.....	.....	"	.....
33	Phœnix*	.....	"	1500	.....	11 5	"	.....
34	Montgomery*	Russell, Robertson & Co.	"	1000	.....	.....	"	.....
35	Poplar Sping*	John H. Jones & Co.	"	1175	.....	.....	"	..... [kettles.
36	Saline*	Lewis Irwin & Co.	Stewart.	1200	1200	.....	"	Iron made into sugar
37	Great West'n*	Newell & Prichett.	"	.....	.....	.....	"	Started in 1855, of large
38	Iron Mount'n*	Brien, Ledbetter & Co.	"	1015	.....	4	"	New furnace. [capacity
39	Peytona*	Thomas Kirkman.	"	1220	.....	7	"	.....
40	Bellwood*	Woods, Lewis & Co.	"	2006	.....	.....	"	.....
41	Cross Creek*	Newell, Irvine & Co.	"	1905	.....	11.5	"	.....
42	Rough & Ready*	Barksdale, Cook & Co.	"	1050	.....	11.5	"	.....
43	Bear Spring	Woods, Lewis & Co.	"	885	.....	.....	"	This furnace now ext'ct
44	Dover No. 2*	" "	"	.....	.....	.....	"	New, old site; blast '55
45	Union*	Standfield & Kimble.	"	550	.....	.....	"	New furnace.

TABLE OF FURNACES, ETC.—*Continued.*

(*c*) *Western Iron-Region.*

No.	Name.	Owners.	County.	PRODUCTS OF 1854.			Kind of Ore.	Remarks.
				Pig Metal and Castings.	Cas'gs alone.	Mo's in bl'st		
46	Ashland*	.....	Stewart.	1200	.....	.....	Limonite.	.....
47	La Grange* ...	Cobb, Phillips & Co.	"	1910	.....	.....	"	.....
48	Eclipse*	" "	"	641	.....	4	"	New furnace.
49	Clark*	Broaddus, Vaughn & Co.	"	585	.....	4	"	New furnace.

The whole amount of cast iron produced in 1854, was 40,306 tons, (2268 lbs. to the ton,) of which 1433 were castings. At a few of the furnaces, other castings, to a limited extent, were made for local use; such are included with the pig-metal.

The production of the furnaces for 1855, would be considerably over the above amount.

1231. TABLE OF THE BLOOMARIES, INCLUDING THE NUMBER OF FIRES, PRODUCTS, ETC. (1854.)

(a) *Eastern Iron-Region.*

County.	No. of forges.	No. of fires.	1854. Fires used.	1854. Tons of bar iron made.	Remarks.
Johnson.....	14	26	26	367	All use Limonite.
Carter.....	5	10	10	168	Limo. mostly; also Magn. & H.
Sullivan.....	2?	4?	4?	30?	Hem. See table refin'res & note
Washington	2	4?	4?	55	One, cin. and Lim.; other, Lim
Greene.....	6	9?	7?	95	Limonite.
Sevier.....	1	1	1	2	"
Blount.....	1	1?	1?	12	"
McMinn.....	1	1	1	13	Dyestone (See § 1192.)
(b) *Dyestone Region.*					
Hancock.....	1	1	.....	.....	When operating uses Dyestone
Claiborné...	3	5	4	90	Dyestone, sometimes with Lim
Campbell,...	5	10	5	105	" " " "
Anderson...	?	?	.....	.....	Sev'ral old forges not operating
Roane.....	1	1	1	5	Dyestone.
Rhea.....	5	10?	10?	55?	"
(c) *Western Iron-Region.*					
Lawrence...	3	3	3	80	
Warren.....	1	1	1	11	
Total.....	51	87	78	1090	2240 lbs. to the ton.

So far as I was able to ascertain, this table included all the *working bloomaries* in the State. There were other old blooming forges which had gone partly or entirely down. Some of them in the Western Region had been converted into refineries.

It is proper to state that most of the bloomaries in the table were not in operation more than half of 1854, owing to the unusually low stage of water in the streams—all of them deriving their blast from water-power.

1232. TABLE OF THE REFINERIES, INCLUDING FIRES, PRODUCTS, ETC. (1854.)

(a) *Eastern Region.*

COUNTY.	No. of forges.	No. of fires.	OPERATIONS OF 1854. Fires used.	Tons blo'ms made.	Tons bar-iron.	REMARKS.
Carter*.....	3	5?	2?	.....	20?	Most likely more iron [made.
Sullivan†.....	2?	8?	6?	.....	75?	
Washington.	1	5	5	480	.....	Pleasant Valley W'ks.
Monroe.....	1	2	2	.....	75	In '55, wk'g old cinder

(b) *Western Region.*

Davidson‡	2	10	5	600	.....	1 not operating in '54.
Dickson‖	1	6	4	140	20	1 run-out fire besides.
Montgom'y§	5	23	17	2900	.....	Three steam forges.
Stewart.....	2	14	14?	3068	....	Both steam forges.
Humphreys¶	1	4?	4?	100?		
Hickman.....	2	2?	.....	.....	.....	Formerly bloomaries.
Total,.....	20	79	59	7288	190	

A ton of blooms in the Western Iron-Region is 2464 lbs. It may be that the 480 tons made at the Pleasant Valley Works were estimated at 2240 lbs. per ton; if so, the *total amount* will be reduced to 7244 *bloom* tons. The bar-iron is estimated at 2240 lbs. to the ton.

The table gives *less* than the actual production of 1854. It was almost impossible to get the necessary information from some of the forges.

Between 2000 and 3000 tons of the blooms were converted

* Product of one small forge not included.

† There were *four* forges altogether in Sullivan, making in 1854 about 105 tons of bar-iron. My information was not sufficiently definite to enable me to separate satisfactorily the *refineries* and *bloomaries;* in fact, some of them had both refining and blooming fires.

‡ One did not operate in 1854.

‖ Operated but part of the year.

§ Having no statistics from the Tennessee forge, in Montgomery, its fires, products, etc., were not included.

¶ This forge did some work in 1854. We have not been able to procure the necessary items in regard to it.

into manufactured iron by the Cumberland Rolling-Mill in 1854; the remainder was mostly sold in Cincinnati—some in Pittsburgh.

TENNESSEE ROLLING-MILLS—THEIR PRODUCTION, ETC. (1854.)

1233. There were in 1854 *three* rolling-mills in the State; two in East and one in Middle Tennessee; the last two are now extinct.

1st. Pleasant Valley Rolling-Mill, in Washington—R. L. Blair & Brothers. Manufactured, in 1854, 480 tons of blooms into nails. This rolling-mill, as before stated, was, and perhaps is now, connected with a furnace and forge, all located at the same point on the Nolichucky, which supplies a splendid water-power.

2d. The Rolling-Mill at Loudon, in Roane—Samuel M. Johnson & Co. Operated on a limited scale in 1854. Amount of products not known.

3d. Cumberland Rolling-Mill, in Stewart—Woods, Lewis & Co. Product in one year, from October, 1853, to October, 1854, 2223½ tons of manufactured iron, which was distributed about as follows: 1000 tons to Memphis, Vicksburg, and New Orleans; 800 tons sold in Nashville; 423 tons sold at the works, and consumed in Kentucky and Western Tennessee.

Two furnaces—Bellwood and Bear Spring—and a refinery, with eight fires—all steam-power establishments—were connected with this rolling-mill. Their respective products, for the time specified above, were: pigmetal, 3241½; blooms, 2068½ tons; manufactured iron, 2223½ tons. (see §1254.)

The entire value of all the iron produced in 1854, including pig-metal, castings, blooms, and manufactured iron, was but little short of *two millions of dollars.*

SECTION II.

COPPER. (2.)

1234. The Ducktown Region is the only locality in Tennessee yielding *copper-ore* in note-worthy quantity.

1235. Two points have been met with, one in Monroe, and another in Grainger, between Clinch Mountain and Copper Ridge, where very small quantities of carbonate of copper, *malachite,* occur in limestone. At the latter place also a little sulphuret is found associated with pyrite.

Some green carbonate has been found on the waters of the Tellico River, and of Cane Creek, in Monroe.

At many points within the Unaka region, traces of copper are met with, but no locality of any importance has come under my observation.

1236. The history of the developments at Ducktown, is full of interest. Previous to 1860, Polk County had attracted no attention, and was simply known as an out-of-the-way, mostly mountainous section. But the discovery of the copper deposits at Ducktown, and the great developments made there, soon placed this county among the highest tax-paying counties of the State. Bradley County also, and the town of Cleveland, as well as the whole southern part of East Tennessee, felt the influence of this new interest, partook of its life, and were not a little benefited.

1237. It is not proposed to give a full account of the mines at Ducktown. What is presented is mainly an outline of the history of the developments made, and of the character of the deposits.

1238. The *Ducktown Region,* or simply *Ducktown,* is part of a mountain basin belonging *physically* to North Carolina and Georgia. Accidentally, as it were, the south-eastern corner of Tennessee was thrown beyond its normal place, and the State made to include the area of the mines. See §§ 68, and 396, and also, Map.

1239. The surface of the country about the mines is rolling—cut into ridges by rather deep valleys and ravines. The general elevation is about 1,000 feet above the valley of East Tennessee, and not far from 2,000 above the sea. (§§ 419 and 428.)

1240. The region is intersected by the *Ocoee River,* the course of which, after entering Tennessee, conforms successively to the character of this area, and to that of the mountain ranges through which it afterwards breaks. Flowing out of Georgia, this stream (passing in the meantime through the southern part of the mining district) flows *quietly* north-westward for five or six miles, until it strikes the main Unaka Range. It then begins to descend *in rapids* through the wild *narrows* of the mountains. For twelve or thirteen miles in its tortuous course, it rolls along over the rocks, while high and grand cliffs of *slate and conglomerate* come down to the water's edge on both sides, scarcely affording, at any point, space enough for a garden spot. After leaving the narrows, the river flows for four or five miles through a more open valley, and then escapes entirely from the mountains into the great Valley below.

Along the river, through the narrows, a good road running

but little above the water's edge, has been cut out of the cliffs, a work originating with Mr. John Caldwell, one of the pioneers in the Ducktown developments. The magnificent scenery along this road, enlivened by the constantly roaring rapids, will itself repay the amateur on a visit to the copper mines, even before he reaches his destination. See also §§ 423 to 428.

1241. *Historical Sketch.**—In 1836, Dr. Troost passed through the Ducktown Region, and in his subsequent Report, (the Fourth,) has the following brief statement:

"Continuing my reconnoissance in a northwest direction between the Hiwassee and Ocoee Rivers, I came altogether on grauwacke and grauwacke slate to near the junction of the Ocoee and Hiwassee rivers. At several places in the mountains between these two rivers, I saw hydroxide of iron, similar to the ore used in Middle Tennessee in the blast furnaces."

1242. For several years previous to the discovery of the Copper mines, much excitement had existed through the country on account of the discovery of gold on Coqua Creek.

In 1843, a Mr. Semmons, one of the gold-hunters, struck with the appearance of things at the point where the Hiwassee mine is now located, began to wash in the branch for gold. At first he thought himself highly successful, finding an abundance of what he took to be the precious metal. Upon a second examination, however, it proved to be crystals of *red copper ore.* This discovery led to no important results. "Some further work was done by Mr. Grant, who found several rich specimens of native copper."

1243. Some time afterwards, it appears, the property got into the hands of others, who discovered the *"black oxide,"* which has been, so far, the most important ore of the mines. Its nature and value, however, were unknown to them. The company forwarded a quantity of "samples" found in their work, and in the vicinity, to New York, for examination, but, regarding the *black ore* as worthless, they did not, with perhaps

*The following facts bearing upon the history of the mines were, for the most part, published in my Reconnoissance in 1856. They were collected from a variety of sources; some of them from gentlemen directly concerned. We I\re especially under obligations to Dr. Charles A. Proctor, and formerly of the mines, not only for the tables included in this article, but also for several maps and sections relative to Ducktown. Valuable facts, too, have been obtained, and quotations made, from an article on the "Copper District," in The Southern Journal of the Medical and Physical Sciences.

the exception of a single fragment, include it. The report received, as might have been anticipated, was unfavorable, and resulted in the winding up of operations for that season.

1244. In April, 1847, Mr. Weber, a German, informed the company of the value of the black oxide, and, securing a lease from them, commenced mining operations. The result of this work was the shipment of ninety casks of ore "to the Revere Smelting Works," near Boston, the value of which was thus reported: Three casks were very poor, so that they were not sold. The balance were put up in two lots. No.1, of 18,750 lbs., deducting water, was worth 32.5 per cent.; No.2, 12,460 lbs., was worth 14.5 per cent. copper." Meanwhile, Weber left, and operations were suspended.

1245. There is another circumstance bearing upon the discovery of copper at other points in Ducktown, which is in place here.

The same year, 1847, Mr. B. C. Duggar, attracted by the high price of iron in this region, and the immense masses of iron-ore, or *"gossan,"* which occur along the outcrops of many of the veins, commenced building a forge for the manufacture of iron, on property now belonging to the Cherokee Mine. In 1848, the forge was completed; but this enterprising gentleman was doomed to disappointment. The iron produced was *red-short,* and of but little value. "If heated to a white color, and immersed in water until cold, it would show a very thin copper precipitate on the surface. Sometimes the forge flame had a green tinge." After fully trying the *"gossan"* of Ducktown, Mr. Dugger was finally compelled to get his ore from a distant locality. The facts thus developed had their effects ultimately upon the copper interests.

1246. In May, 1849, the property which Weaver had leased was secured by another person, who let it remain undeveloped until 1850, when general attention began to be called to the mines.

1247. In order to show the spirit which animated and the circumstances which surrounded some of the pioneers in the development of this copper region, I take the liberty of quoting the following interesting letter, written by Mr. John Caldwell, at the request of Dr. Proctor:*—

"GENTLEMEN:—I came to Ducktown in 1849, scouting for copper, and found some five or six tons in a cabin, ten feet square, on the property now known as the Hiwassee. I found the country unexplored—the school section, a property now worth a million of dollars, attracting little or no

*Southern Journal, vol. iii., page 43.

attention. Sat down in the woods for three hours, to mature a plan to control and open the section. I owned, at the time, one twenty dollar bill. After three hours' reflection, resolved to call a meeting of the citizens of the township, and make a speech explanatory of the value of the school section, and of the importance of leasing it for mining purposes. Told the people that as soon as the mines could be opened, their condition would be improved, and that civilization, intelligence, comfort and wealth, would be the inevitable results. At the conclusion of this remark, a speaker arose in the crowd, and informed me that a large portion of the inhabitants had come here to get away from civilization, and if it followed them, they would run again.

"After the speech was made, drew up a memorial to the Legislature, praying the passage of a law authorizing the commissioners to give a mining lease on the school section. The memorial was signed by a majority of the citizens, and, on personal application, the law was passed, and under it the lease was taken.

"In May, 1850, commenced mining in the woods. In the same year sunk two shafts, and obtained copper from both of them. The excavations made did not exceed twelve feet—at that depth the copper being found. Commenced mining at the Hiwassee Mine in 1851, in connection with S. Congdon, the agent of the Tennessee Mining Company. Built a double cabin, and taught Sabbath-school in the kitchen end of the establishment, aided by young Mr. Walter Congdon."

In regard to the road down the Ocoee, of which I have already spoken, (§1240,) he says: "While this same miner"—one who had spoken irreverently of their laudable Sabbath-school efforts—"was planning a way to pack the copper ore out of the mountains on mules, I surveyed the Ocoee River, and determined to make a road eighteen miles through an impassable desert. I had no means, but a strong determination to surmount every obstacle. Going to a Methodist camp-meeting, I obtained permission to make a road speech in the recess of Divine service. The speech over, we took up a collection, principally on a credit and payable in trade. This, however, served the purpose; and on the 6th of October, 1851, the work was commenced. On the first day, three hands worked; on the second, two; and the third, worked *alone*—public opinion, strong and powerful, being against the enterprise. On the fourth day, hired a dozen Cherokees.

Thus began one of the most important projects in the State, which was consummated in two years, at an expense of about $22,000. The Tennessee Company came early to help in the enterprise, but the Hiwassee held back till fourteen miles of the road were passable for wagons. At the close of the first year, Robert McCampbell was employed as the engineer of the road, after which I again turned my attention to mining."

1248. As a continuation of this historical sketch, I give on the next page, a table of the mines, made out the last of September, 1855.

No.	Name of Mine.	When opened.	By whom.
1	Hiwassee	August, 1850.	T. H. Callaway.
2	Cocheco	October, "	J. V. Symons.
3	Tennessee	October, 185¹.	John Caldwell.
4	Polk County	November, 1852.	" "
5	Cherokee	December, "	Samuel Congdon.
6	Eureka	April, 1853.	John M. Dow.
7	East Tennessee	June, "	Capt. J. Tonkin.
8	Isabella	July, "	C. A. Proctor.
9	London	Sept, "	Capt. J. R. Pill.
10	Mary's	" "	C. A. Proctor.
11	Callaway	Nov, "	" "
12	Culchote	February, 1854.	William Bunter.
13	United States	August, "	Capt. Williams.
14	Biggs	" "	William Mayfield.

1249. The last table, together with the one immediately following, both of which are from my Reconnoissance in 1856, exhibits the progress already made. The one below gives the product and the condition of the mines for the month mentioned above, (September, 1855;) also, the per centage of the ore sold, and the points where sold.

No.	Name.	Lbs. produced in Sept., 1855.	Value per cent. of ore last sold.	Where sold.
1	Hiwassse	269,174	24	New York.
2	Cocheco			
3	Tennessee	217,641	26	Baltimore.
4	Polk County	254,172	29½	London.
5	Cherokee			
6	Eureka	281,714	33¾	Boston.
7	East Tennessee			
8	Isabella	279,614	29	London.
9	London	239,716	41	"
10	Mary's	267,146	36	"
11	Callaway			
12	Culchote			
13	United States			
14	Biggs			

According to the table, seven of the mines produced in September, 1855, 1,809,177 lbs., or a little more than 807½ tons. Though I have not the facts necessary to determine accurately, yet the value of this ore is, perhaps, about $80.000.

1250. I add below another table, showing the extent of operations, and the entire amount of ore shipped from the mines up to the last of September, 1855.

No.	Name.	Tons shipped.	Feet of shafts	Drivage in ft.
1	Hiwassee	4156	641	2784
2	Cocheco		98	74
3	Tennessee	7355	472	1161
4	Polk County		347	1341
5	Cherokee		335	1147
6	Isabella		217	711
7	Mary's		189	197
8	Eureka	1100	180	872
9	London	1680	264	742
10	East Tennessee		191	640
11	Callaway		100	147
12	Culchote		207	289
13	United States		114	100
14	Biggs		70	14

It will be seen that eight mines produced and shipped 14,291 tons, worth more than a million of dollars. The Hiwassee alone shipped 4156 tons—about two-sevenths of the whole.

1251. To bring this sketch down to later years, I add the following, from a Report published in 1866 for the Union Consolidated Mining Company of Tennessee.*

"In 1854, a couple of blast furnaces had been erected at the Tennessee Mine, but were afterwards abandoned for want of competent persons to smelt the ores. In June, 1855, smelting-works on the Welsh (Swansea) plan, were commenced at the Eureka Mine, and soon after put in operation, with complete success, shipping regulus of an average quality of 54 per cent. In the following year, smelting was successfully recommenced at the Tennessee Works. Another similar establishment was built at the Hiwassee, and additional works constructed at the Eureka Mine.

In the progress of this industry, it was soon discovered that considerable quantities of copper could be produced from the mine-waters; and in 1859, the Hiwassee, Eureka, and Isabella obtained monthly more than 40,000 lbs. of copper from that source alone.

The smelting-works at the Isabella and Cocheco Mines were erected in the same year; and, after some experiments, it was found that ingot copper, and that of a superior quality, could be produced in the metallurgical establishments.

*This Report was published by the American Bureau of Mines, in New York, October, 1866.

Upon the basis afforded by these facts, and in view of the great advantage of uniting isolated interests, a consolidation of some of the most productive mines was effected in 1858, including the East Tennessee, Mary's, Callaway, Isabella. Cherokee, and others. This combined property is now owned by the Union Consolidated Company. It comprises the following areas:—

East Tennessee	480 acres.
Mary's	160 "
Callaway	320 "
Maria	80 "
Isabella	240 "
McCoy	140 "
Buena Vista	240 "
Johnson	315 "
Beaver	40 "
Cherokee	320 "
Ocoee	240 "
Total	2,575 acres

In 1860, it was resolved by this and other companies, to construct refining-works in common. These works were finished in the same year, and, except during the greater part of the late rebellion, have been ever since in most successful operation, producing refined copper of excellent quality, and eagerly sought in the market.

Another proof of the confidence placed in these copper mines was furnished in the erection, by a new company, of an excellent copper rolling-mill, together with wire-works, at Cleveland Tennessee. This establishment produced sheets and wire of good quality, but was unfortunately destroyed during the war.

The interruption of mining operations during the greater part of the war rendered their resumption peculiarly difficult at its close. In view of the dispersion of skilled workmen, and the inevitable effects of so protracted a suspension in the mines themselves, it is not a little surprising to find the underground operations of the Union Consolidated Company, as well as the smelting-works, again in full activity, amply provided with all the necessary supplies, and running according to a well-organized working system. There appears to be no reason why these mines should not continue to be largely productive. The refining-works have yielded since the war more than 1,000,000 lbs. of ingot copper, of which some 600,000 lbs. were for the Union Consolidated Company,

These remarkable results, as well as the great success of the Ducktown mines and furnaces before the war, are due in large measure, to the ability and energy of Mr. Julius E. Raht, who still holds the position which he has so long and so creditably occupied, as General Superintendent and Agent of most of the companies actively at work in the district. This gentleman is efficiently supported by assistants, among whom Capt. John

Tonkin, one of the oldest mining officers in Ducktown, deserves especial mention."

1252. *The Veins and their Geological Relations*.—The rocks of the Ducktown area are, for the most part, as already stated, (§ 405,) talcose, chloritic, and mica slates. The strata generally dip at high angles to the southeast, and consequently, outcrop in lines having a northeasterly and southwesterly direction. The age of these rocks is spoken of in § 408, to which the reader is referred.

1253. The *ore-deposits* are not true *fissure-veins,* yet I see no reason why, they may not be called *veins.* They are great lenticular masses of ore and gangue material, lying conformably between strata of the country rock. These lenticular masses, or veins, occur, for the most part, in long ranges, or belts, one succeeding another longitudinally, in approximately the same line; sometimes their feather-edges overlap though thrown apart by intervening rock.

1254. The walls of the veins are not well defined, for the reason that the ore, away from the centres of the masses, is seen in the slates, and disappears gradually. Hence the deposits are said to be *impregnations.* This may be such, but it does not necessarily follow; for, as Mr. Dana says: "Such a blending of a vein with the walls, is a natural result, when its formation in a fissure takes place at a high temperature during the metamorphism, or crystallization of the containing rock."*

1255. I quote further from the able report above mentioned, with reference to the *belts* and the *deposits* included in them.

"The hitherto discovered deposits of Ducktown are in three series, or belts, which have been erroneously regarded as three great veins. It is probable that the progress of mining operations will eventually expose other deposits, so that they will appear, not confined within particular limits, but scattered with less regularity over a wide area. The discovery of those deposits only, which lie in certain lines, is explained by the fact that the miners have always supposed them to be veins, and have, therefore, conducted explorations mainly, or wholly, on the course of mines already opened.

The Ducktown deposits all have the same course as the country rock, viz.: N. E.—S. W., and the same steep dip to the S. E.

The first and most westerly of the three series, or so-called "veins," con-

* Manual, page 714.

tains the deposits of too Burra-Burra, (*i. e.*, Hiwassee and Cocheco,) the London, and the East Tennessee Mines.

The second and middle series includes the Cherokee, Tennessee, Culchote, Eureka and Isabella.

The third comprises the Polk County, Mary's and Callaway deposits.

Of these properties, the Mary's, Callaway, Isabella, Cherokee and East Tennessee, belong to the Union Consolidated Company, in fee simple.

In the following, the Ducktown deposits from the outcrop downward, four entirely different zones or stories are passed through, which are generally sharply distinguished from each other, Their depth, their specific character, and their distance from the surface vary in the several deposits; but the following order of succession is common to all :

1. Upper part of the "vein," consisting of "Gossan," *i. e.,* sandy, porous, massive or reniform ore, mixed with streaks of reddish-brown slate. In this zone, and especially in its lower portion, occur malachite, azurite, cuprite, in grains, masses, and threads, and native copper in foliated and dendritic forms. Cuprite, (the red oxyd of copper,) and the so-called black oxyd, become more and more abundant, and gradually form

2. The second zone, the transition to which occupies generally, not more than ten feet on the dip of the vein. This may be called the zone of the black copper ores. It branches upward, somewhat into the Gossan. It varies in depth from two to eight feet, and appears to follow with its upper limit, the contour of the surface above. In it are found layers, nodules and pockets of cuprite, and granular admixtures of iron and copper pyrites.

This division is abruptly cut off below by

3. The third zone—that of iron pyrites, and pyrrhotite (magnetic pyrites,) containing but little disseminated copper pyrites, and, on the other hand, a large proportion of tremolite and actinolite, of radial, fibrous structure, and wine-yellow to brown, color. The disseminated copper pyrites grow more abundant in depth, until they form

4. The fourth zone—that of copper pyrites. In the centre of the deposit this mineral is almost pure and solid, containing some 30 per cent. of copper. Towards the walls, where it is mixed with pyrrhotite, iron pyrites, tremolite, and, actinolite, the average contents of copper in the whole mass is 8-10 per cent.

In almost all the Ducktown mines, operations have been confined to the rich zones of black and red copper ore. These have been followed and wrought, and abandoned as soon as the pyrites was reached. Only in one mine—the East Tennessee—a shaft has been sunk through the valueless pyritic zone, and mining is now carried on with profit in the yellow copper ore below, of which, more hereafter.

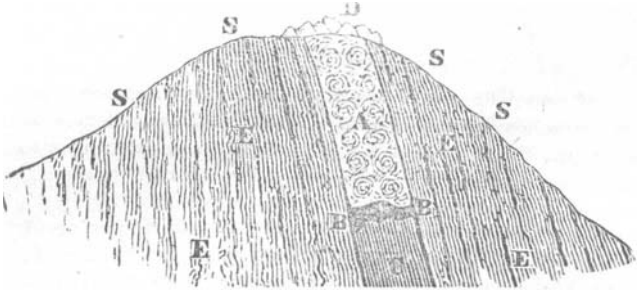
The decomposition of the Ducktown deposits, from the outcrop to the water-line, (which, as has been said, is not a horizontal line, but follows the depressions and elevations of the surface,) is the result of penetrating waters and atmospheric influences. A slow and gradual process of decomposition, reduction, oxydation, and mutual chemical reaction, has been going on, producing new mineral combinations. Among the results of

this secondary process, must be included the formation of the whole zone of oxydized copper ores."

A list of the ores and minerals of the Copper Mines will be found on page 179 of this Report.

1256. The following diagram will illustrate, in a general way, the character of the Ducktown deposits. It represents the section of a ridge supposed to contain one of the veins:

SECTION OF A DUCKTOWN COPPER "VEIN."



S, S, S, S, surface of the ridge intersected. E, E. E, E, talcose and micaceous slates. A, C, the vein. D, "gossan" on the surface.

1257. It will be seen that the "vein" is composed of three distinct portions, as follows:

(1) The part A. This is the upper zone (1) of page 478 , consisting of "Gossan," etc.

(2) The portion B, B, corresponding to 2, on the same page.

(3) The part C. This includes zones 3 and 4, mentioned above. I doubt the propriety of dividing this.

1258. Below are examples of some of the principal mines. The extent and volume of the deposits are illustrated by them.

"I. *The East Tennessee Mine.* This is the northern mine of the western Ducktown belt. It is wrought upon an impregnation of ore, with massive lenticular centre, which has been exposed in a longitudinal extent of 600 feet, and has a maximum thickness of 60 feet, contracting at both ends to a few feet. * * * * * * * *

The zone of pyrites in this mine consists of pyrites and pyrrhotite, with more or less copper pyrites, hornblendes, (tremolite, actinolite,) and now and then, a little galena or zinc-blende. The various proportions of these different minerals, and the degree of their predominance over the slates which they impregnate, give to this zone some variety of appearance.

As has already been stated, a shaft was sunk in the Tennessee Mine through the pyritic zone, which is too poor in copper to be worked. An improvement was soon observable; the copper ore began to concentrate and become more abundant; and at 130-140 feet depth, the shaft entered a massive body of copper ore, almost free from iron and hornblende, into which it has now penetrated for 55 feet. This ore contains about 30 per cent. of copper. It has been explored by drifts for a length of 100 feet or more, and the thickness of the massive central body is about 20 feet, so that a mass of 100,000 cubic feet, or about 10,000 tons of rich copper ore is exposed. This estimate, as appears from the foregoing description of the character of the deposit, is only a rough one, and certainly far below the truth; since, outside of the massive center of the deposit, and gradually passing into the wall-rock, stands a considerable thickness of ore, which, although not so rich, may still be worked with profit. * *

II. *The Isabella* Mine.—This is situated on the northernmost deposit of the middle belt, which comprises the Cherokee, Tennessee, Calchote, Eureka and Isabella properties. This deposit has an enormous outcrop of gossan, which appears in a thickness of about 350 feet on the right bank of Potato Creek, on the precipitous side of that valley. (Fig. 3.) During the war, the ferruginous quartzite and the iron ore of this outcrop were used in the production of iron at the neighboring Eureka Furnace, which was altered for the purpose. An adit from the valley bottom has been driven through this deposit, exposing a thickness of nearly 400 feet, The gossan zone extends to about the level of the adit, below which the black ore suddenly appears, carrying however, an average proportion of only 5 per cent. of copper, and having a depth of but 3 or 4 feet. It is not horizontal in upper or lower limit, but follows more or less closely the rise of the hillside above. Below, it is cut off suddenly by the zone of pyrites.

Hitherto only the black ores have been mined at the Isabella. The zone containing these has been followed, and the sulphuretted ores in depth are entirely untouched. The analogy of the East Tennessee Mine, and the occurrence of rich yellow copper at the bottom of the neighboring Eureka shaft, on the same deposit, leave no doubt that deeper workings on the Isabella will open a large and profitable mining ground. This course is urgently recommended.

At present, water is conducted through the old workings, so as to dissolve the effloresing salts of copper; and from this solution about 9,000 lbs. of cement-copper, containing 75-90 per cent. of pure metal, are produced monthly.

III. *The Cherokee Property*.—This contains several deposits, belonging to the same belt as the foregoing. Two of these have been developed by small openings, now in ruins. They have no gossan, and almost no black ore; both these zones having probably been rendered friable by atmospheric influences, precipitated down the steep hillside, and carried entirely away by the mountain brook. One of these deposits is 10 feet, and the other 4 feet, in thickness; they consist of predominating iron pyrites, showing some

yellow copper, which, judging from analogy, is likely to be more abundant in depth. Their character is certainly promising, although they are not sufficiently developed to be thoroughly studied.

"IV. *The Mary's Mine*, (*including the Callaway Property*.)—This comprises a number of deposits belonging to the southeastern belt. Their lenticular form is most clearly seen in Mary's Mine. They lie in such a relative position that one commences where another ends, without being in exactly the same line; so that if the series were considered as a vein, that vein would appear to have suffered a number of dislocations. The real explanation of this phenomenon has been repeatedly given in the present Report.

The operations in this mine have been confined to the black ores. It presents an inviting field for enterprise, since the deposits attain a thickness of 75 feet, and their whole character, as well as the analogy they bear to the East Tennessee, justifies the belief that in depth they will pass into copper pyrites."

1259. Aside from the refining works mentioned above, the Union Consolidated Company has *smelting works* of its own, as follows:

1. At the Isabella Mine. Three blast-furnaces, with ample blast-apparatus, having as motor a waterpower, which also drives the pumps of the mine; one calcining-furnace of large size; a new roasting-kiln; and a number of substantial sheds for heap-roasting and storage of charcoal, ore, and other material. There are two furnaces always in operation while one is undergoing repairs.

2. On the Tennessee School Land, (leased by the Company:) Four blast-furnaces, with two sets of blast-apparatus and water-wheels, and all necessary ore, coal, and roasting sheds.

The smelting capacity of the furnaces of both works is at least one thousand tons per month. The production is estimated at about 400 tons of matte, of which nearly half is re-smelted after roasting, so that there could be delivered monthly at the United Refining Works, from 280 to 300 tons of copper-matte.

The United Refining Works comprise four blast-furnaces, a calcining--furnace, three reverberatories, a 45-horse-power steam-engine, with blast--apparatus, crusher, stamps, and all necessary sheds for coal, ore, and roasting the matte. Connected with the establishment are blacksmiths' and carpenters' shops, an office, and a well-arranged chemical laboratory, fitted up with all the apparatus required for copper assays and complete mineral analyses.

The capacity of this establishment will allow a production of 14,000 lbs. of refined copper, daily, provided the three companies now furnishing it with matte for refining, deliver their product of an average quality, not below 30 per cent. of copper.

The present monthly production of the Union Consolidated Company's mines is from 350 to 400 tons of ore, yielding 10-12 per cent. of copper.

It is intended to raise the production to 1,000 tons per month, and to introduce at the same time extensive dressing machinery, by means of which the average quality of the ores will be considerably improved; so that the increased production will not necessitate any additional furnaces or machinery.

SECTION III.

LEAD AND ZINC. (3 *and* 4.)

1260. Ores of both these metals occur at numerous points in East and Middle Tennessee, but most frequently in unimportant quantity. The two metals are often associated. They occur as sulphurets, (*galenite and blende*,) in veins; in centres in limestone or dolomite, points at which the rock is more or less richly impregnated with the ores; or sparsely disseminated (*galenite*) in grains and buttons through the mass of extensive strata.

1261. The following are the ores occurring, the second and third being of little importance:

(1) *Galenite*, often named *galena* and *sulphuret* of lead; when pure, contains in 100 parts,

Lead	86.6
Sulphur	13.4
	100.0

This ore is recognized, generally by its metallic lustre and *lead* color. An important ore.

(2) *Cerussite: White Lead ore, or Carbonate of Lead.* It is composed, when pure, in 100 parts of

Lead	77.7
Oxygen	5.9
Carbonic Acid	16.4
	100.0

In small quantity; results from the decomposition and oxidation of galenite.

(3) *Sphalerite*, or *Zinc Blende;* named also *Sulphuret of Zinc*, and "*Black Jack*," has the following composition:

Zinc.....67
Sulphur.....33
100

This is a brittle mineral with a resinous lustre, and generally brownish yellow, though sometimes of other colors.

(4) *Smithsonite; a Carbonate of Zinc; Dry Bone* of the miners; is composed of

Oxide of Zinc.....64.8
Carbonic Acid.....35.2
100.0

Color usually white or gray, sometimes brownish; effervesces with acids.

(5) *Calamine*, or *Silicate of Zinc*, with a composition of

Oxide of Zinc.....67.5
Silica.....25.0
Water..... 7.5
100.0

Color, white, also yellowish or brown. Smithsonite and Calamine are usually associated, and are sometimes mixed in the same mass.

1261a. The last two minerals have little of the aspect of ores, and would escape the attention of one not acquainted with them. They occur massive or incrusting: sometimes in mammillated or stalactitic forms; often as earthy or stony masses of yellowish-gray colors. As a general thing, masses, supposed to be these ores, may be tested by pulverizing them, and throwing the powder on glowing charcoal. If zinc be present, a white cloud of oxide will arise, and may be collected on a cold plate of iron over the fire. The weight will sometimes give a useful hint as to their nature.

1262. *Lead in East Tennessee.* There is scarcely a county in East Tennessee in which *galenite*, in small quantities, may not be found. It occurs, for the most part, in strata of the Knox Dolomite. (§ 535.) Its modes of occurrence are given in § 566, as well as in § 1260 above.

1263. In Claiborne and Union Counties, there are numerous localities of this ore, which have attracted attention, and at several of which, a little work has been done. These localities are, generally, near Powell's River, on the back of the great anticlinal, spoken of in §§ 544 and 550.

There is an extensive region herein which the sparry dolomites contain, generally, much galenite. But it is thinly scattered through the rocks, and is not available. The principal

stratum of this kind, has been mentioned in § 567. Most of the localities of ore referred to above, are nothing more than centres, where small masses of galenite have accumulated in the dolomites. At some of them, however, veins do exist.

1264. Of all that I have seen, there, is but one that I regard as promising, and that is the *Caldwell Mine* on Powell's River. (§ 566.) This is in Union County, at a point on the river between Tazewell and Jacksboro', and about sixteen miles from the former place. The vein fills a nearly vertical fissure, about twenty inches wide, in nearly horizontal rocks. It can be traced for nearly a mile. At the time of my visit, (July, 1855,) very little had been done towards its development, but its character, in one place on the surface, could be distinctly seen. The galenite, associated with blende, and some pyrite, occurs in several sheets, with an aggregate thickness of about five inches. The sheets are separated by a gray vein-stone. There is reason to believe that the character of the lode will improve farther down. The property belongs to Messrs. Caldwell, Birdseye, and others,

Since the above observations were made, Mr. Caldwell has sunk a shaft on this vein. He states the results to be as follows:

"Went down 24 feet to the vein, and then into it five feet; vein at first, two feet thick, increased slowly in descending; the galena at the bottom of the shaft, in two sheets, averaging, in the aggregate, 12 or 16 inches; outside of the sheets, the galena diffused through the gangue."

The vein crosses Powell's River, and runs in a nearly east and west direction.*

The gangue rock appears to be a breccia made up of fragments of dolomite and chert, the former most abundant.

1265. In Johnson County, south of the Watauga, on the Duggar property, there appears to be a vein of galena with blende. It was not sufficiently exposed, however, at the time of my visit, to enable me to form an opinion, of its character.

1266. In the valley-range west of the line of *red knobs* that extend from Strawberry Plains to Georgia, (§§ 112 and 615,) there are in Bradley and Monroe counties, three points at which considerable lead mining has been done. The most southerly

* N. 75° W., and S. 75° E.

of these is in *Chatata Valley*, in Bradley, which is one section of the valley-range referred to. This locality belongs to Mr. John Hambright. The others are in Monroe, and are known, respectively, as the Carter and Montgomery Mines.

1267. (1) *Hambright's Mine* is about four miles south of Charleston, near the middle of the Chatata Valley. It is in the Knox Dolomite, (§ 535,) but near the junction of this with the Maclurea Limestone. (§ 590.) I have been at this point several times, but never found the excavations open. The following information was given me by Mr. Hambright: "The *lead vein*, when worked, showed a layer averaging eight inches in thickness, and dipping with the rocks [about at an angle of 15°] to the southeast. The gangue was heavy spar. The *galena* exposed was a continuous layer, ranging from one to four inches in thickness, and associated with more or less blende, and other ores of zinc. Where the layer of galena was thin, the enclosing rocks held more or less of the ore in grains.

"Masses of galena have been found in the neighborhood of the vein, weighing from 200 to 300 pounds. A flat mass, weighing 53 pounds, was taken from the vein. Two or three tons have been dug out of the earth near the vein since 1850."

At this locality are old and quite extensive "diggins," about which the oldest inhabitants, and the Indians before them, knew nothing. They were, doubtless. made for loose pieces of galenite in the soil.

1268. (2) The *Carter Mine* is three miles directly east from Sweetwater. It is in the same valley-range, as stated, as the Hambright Mine, and has about the same geological relations. I visited this point in 1859, and received the following items: The mine was worked in 1826 by John Carter and others, under the name of Bell & Co. They worked ten negroes for a year, sunk a shaft 25 or 30 feet deep, and raised enough ore to pay expenses, and perhaps something over.

After that, and nearly up to the time of my visit, nothing had been done. In 1859, John Smith & Co., had an engine on the ground, and were preparing to resume operations. What they did I am not informed.

I am not able to give the features of this deposit; when there, the shaft was full of water. The galenite, both at this and the mine mentioned below, is associated with barite, fluor, blende, and pyrite.

1269. (3) *The Montgomery Mine* is about two miles northeast of the last. It was also held under lease by Smith & Co. An engine had been placed at this mine also. I have never seen this point. Its features are, doubtless, like those of the Carter Mine.

1270. The lead of ore of *Bompass Cove* has been spoken of in connection with the origin of the iron-ore occurring in the same cove, (§ 1182,) and also in § 566. Some work has been done here, but the developments made are not promising.

1271. Many years ago some lead-ore was raised in Jefferson County, but I know nothing of its mode of occurrence.

1272. The presence of *cerussite* in the soil, at a point in the valley between Greeneville and the Warm Springs, is mentioned in § 568.

1273. Galenite also occurs in Grainger, six miles north of Rutledge, in Roane, in Bradley, a few miles southwest of Cleveland, and, as I have said, in most of the counties of East Tennessee, but generally in quantities too small to be of special interest.

1274. The limestone constituting the base of the Cumberland Table-land, which lies both in East and Middle Tennessee, affords lead-ore at several points. A vein occurs in Marion County; other localities are on the sides of the mountain above Sequatchee Valley; lead, too, has been found in White, in the "Gulf of Caney Fork." (§ 932.)

1275. *Lead in Middle and West Tennessee*.—Veins of galenite, generally associated, as in the Eastern Division, with blende, occur in many counties in Middle Tennessee. Most of them are of no practical importance. See §§ 700, 701, 740, 824, and 932.

1276. In regard to a "large vein" in Davidson, in the vicinity of Haysborough, Dr. Troost, in his seventh report, says:

"It is very probable that this vein is very extensive and rich, and the ore is good. It has been penetrated about ten or twelve feet, and has already, at this inconsiderable depth, produced about 1000 lbs. of lead. This vein being situated near a rivulet, the work was impeded by the water, and the operation abandoned. By an accurate search, the same vein may be found at a more convenient place; or by erecting pumps, the vein may, perhaps, be worked with advantage. It is very probable, as I mentioned above, that this vein is extensive; traces of it are found on the bank of the Cumberland River in several places."

This galenite, associated with some blende, occurs in a *gangue of barite.* It is not at present in a condition to admit of examination.

1277. Some lead ore has been reported as occurring in the limestones of West Tennessee. Loose fragments or pebbles of galena have occasionally been noticed in the gravel-beds of this part of the State.

1278. *The Zinc of East Tennessee*.—I have already had occasion to speak of the occurrence of blende in connection with galenite. The two important ores of zinc, however, are smith-

sonite and calamine. (See §§ 1261 and 1261a.) They occur in deposits, and in irregular veins, in the dolomites of the Knox Group, (see § 1260, and also § 569,) at numerous localities, the most important of which are in Union, Claiborne and Jefferson counties.

1279. The zinc ores of Claiborne and Union have been long known.* They occur at intervals, with more or less galenite, on the back of the anticlinal referred to in § 1263, and described in previous sections. Many of these, however, are too limited to be worthy of special mention.

1280. The *Stiner* locality is the most important that I have met with in this region, and it is certainly an interesting one. This locality is in Union County, near one of the roads leading from Tazewell to Jacksboro', and about three-fourths of a mile from Powell's River, and is, moreover, from three to four miles, in a southwesterly direction, from the Caldwell Lead Vein.

1281. The ore outcrops here in a belt or zone, which is from 50 to 60 feet wide, and runs, in an east-northeasterly direction, across a low ridge. This zone has always been marked out by the absence of trees. Over the area, six or seven pits, (at the time of my last visit, 1865, mostly filled up,) were dug many years ago, and a dozen tons of ore thrown out. Some of this was taken down the river, but the most of it has been lying on the ground ever since. So far as could be seen, the ore, *smithsonite* and *calamine,* with here and there buttons, and small masses of galenite, and occasionally of blende, occurs, with much siliceous matter, in irregular "veins," or in a network of veins. The veins *apparently* run vertically into the rocks, are from a few inches, to several feet, in thickness, and with the enclosed matter, make up the zone above mentioned.

The rocks of the vicinity are dark and blue magnesian limestones, of the lower part of the Knox Dolomite. (§ 535.) Some of them are oolitic, and a few thin beds of Knox variegated shale are met with. The strata, in general, are approximately horizontal.

The masses of ore thrown out are rough, heavy, and generally more or less open.

1282. There are doubtless a number of localities in the Lead and Zinc Region of Powell's River, that will, hereafter, prove themselves to be valuable, notwithstanding the failures thus far, to open remunerative mines. The region is away from the

* To Dr. Troost is due the credit of having first called attention to the zinc of East Tennessee.

means of transportation, the river amounting to but little, and this has embarrassed and retarded mining operations.

1283. Five or six miles from Tazewell, in the vicinity of Mr. John Fulps, on Straight Creek, are deposits of ore, both of lead and zinc. Some digging has been done, and ore taken out, but the extent of the deposits remains to be determined.

1284. At several points in Jefferson County, ores of zinc occur. The most important appears to be at Mossy Creek. At this locality, numerous irregular "veins," in rocks nearly horizontal, and of the Knox Dolomite Formation, occur on a hill-side within an area of several acres. The ore is smithsonite and calamine, with more or less blende.

1285. Within a few years, works have been erected at Mossy Creek, for working the zinc ores, and especially, as I understand, for the manufacture of the white oxide used like white lead in painting. For a few months after the completion of the works, the proprietors succeeded in making considerable quantities of the oxide, ("zinc paint;") but after that, for reasons that I do not understand, operations were suspended, and the works have been idle ever since. I have not had occasion to visit Mossy Creek since the operations above mentioned commenced, and know not what developments were made. I am told that the ore proved abundant, and of good quality.

1286. Some ore has been found in the vicinity of Dandridge. From Mossy Creek, down, through the New Market Valley, and in a southwesterly direction, through Knox, as far as Loudon, zinc ores, smithsonite, etc., are found in small quantity, at numerous points.

Localities also exist in Cocke County.

In Middle Tennessee, there are no noteworthy localities of zinc ore, that I know of. The occurrence of blende, with galenite, in this part of the State, has been referred to.

APPENDIX.

1287. *Note on Silver*.—In Dr. Troost's Fifth Report, as well as in my *Reconnoissance*, (1856,) mention is made of the finding of *"Sulphuret of Silver"* in Cumberland Mountain and Calf-killer River. After further investigation, I have satisfied myself that the specimens in question were *not* of Tennessee origin. I have reason to believe that the specimen found in the Calf-killer, by Troost, was purposely placed there by some unknown person. It is time the whole matter was expunged from Tennessee Reports.

1288. *Silver in Lead—Indian Stories*.—Some silver, though generally in mere traces, is found in our lead ores. I know, as yet, of no locality of such ore, of any importance, though such may be looked for. A lead ore containing five or six per cent. of silver, would be a silver ore.

The *numerous* old Indian stories about silver mines, which are so common in East and Middle Tennessee, there being at least one, perhaps two, on an average, for every county, are entitled to no credit. To give a specific amount of them, would require a volume, which, when written, would be worth practically nothing.

SECTION IV.

GOLD. (5.)

1289. During the last thirty-eight years gold, in limited quantity, has been obtained in Tennessee. The region which affords it lies in the south-eastern part of the State. From my own observations, I would give greater limits to this region than those hitherto assigned it.

1290. More or less gold could doubtless be found in the mountain parts of all the eastern counties, from the French Broad to Georgia, wherever the semi-metamorphic slates of the Ocoee Group are to be met with.

In many parts of this region lenticular conformable veins of quartz abound, and some of them will doubtless prove to be rich enough to work. (See § 475.)

1291. There are numerous localities where gold has been found. At most of them it occurs in small quantity. In all cases, with but a few exceptions, it has been washed out of the gravel and sands of branches, creeks or rivers.

The following are some of the localities: In Blount County, a few miles east of Montvale Springs, and back of Chilhowee Mountain; in Monroe, at several points, as follows—on the waters of Citico Creek, in the bed of Cane Creek, on the headwaters of Tellico River, and on those of Coca or Coqua Creek; in Polk County, also, it has been found.

1292. *Coca Creek and Vicinity*.—The localities which have afforded most of or nearly all the gold, are those of *Coca Creek and vicinity*, embracing a strip of country perhaps eight or ten miles long, and two or three wide. This region is a part of the

depression or mountain trough spoken of in § 437. It is intersected by the Tellico, and supplies some of the important tributaries of that river. Coca Creek, a tributary of the Hiwassee, flows through the southern part.

1293. The first gold was discovered in 1831. So soon as the fact became generally known, hundreds of persons flocked to the golden field, and engaged in working the debris of all the low places and streams, small and great, in the region. Every year since, more or less work has been done, and gold to the value of many thousand dollars has been collected and carried off.

At first, in the richest localities, an *industrious* man could average two dollars a day, which was then, when wages were low, considered an excellent business. In a short time, the average was reduced to a dollar and a half, and then to one dollar, and lower.

At present some washing is occasionally done. About fifty cents a day to the hand can be depended upon, with the additional prospect of greater yields at intervals.

1294. The following table shows the amount of Tennessee gold deposited at the United States Mint, and branches, from 1831 to 1853, inclusive:*

VALUE OF TENNESSEE GOLD DEPOSITED AT THE UNITED STATES MINT, ETC.

Years.	Value.	Years.	Value.	Years.	Value.
1831	$1,000	1839	$300	1847	$2,511
1832	1,000	1840	104	1848	7,161
1833	7,000	1841	1,212	1849	5,180
1834	3,000	1842		1850	1,507
1835	100	1843	2,788	1851	2,377
1836	300	1844	2,240	1852	750
1837		1845	3,202	1853	119
1838	1,500	1846	2,642	1854	
					$46,023

The largest *piece* of native gold that I have heard of, found

*The part of the table from 1831 to 1847, inclusive, has been taken from Dana's Manual of Mineralogy; the remainder, from 1848 to 1853, from Whitney's Metallic Wealth of the United States.

In the latter work, the amount deposited from 1838 to 1847, inclusive, is given in the aggregate at $50,446; while in the former, the amount for the same time is but $16,499, making a difference of $33,947, As the product of each year is specified in Dana's Manual, we adopt $16,499 as being most likely correct. Whitney gives $79,970 as the entire yield for the period included in the table above.

at any time in the Coca region, weighed twenty-one pennyweights; a smaller piece weighed eleven.*

1295. *Source of the Gold—the Whippoorwill Vein*.—The gold found in Tennessee has been derived mainly from *quartz veins.* Liberated by the disintegration of these, the rains and the streams have washed it, together with gravel, sand and earth, into the low places. This view has been confirmed, within a few years, by the discovery of a *gold-bearing quartz vein* in the Coca Creek Region. This has been found on a small branch called *Whippoorwill,* the waters of which find their way into the Tellico. The place is near a low ridge, dividing the Coca Creek and Tellico waters, and is about six miles east of the Tellico Iron-works.

1296. Through the kindness of Austin Fry: Esq., I had the opportunity of seeing and examining this locality.

The "vein" lies *between* the strata, not intersecting, but dipping with them to the south-east at an angle of about forty-five degrees. It is composed of brittle quartz, rather compact, but occasionally affording cavities, some of which are rhombohedral or cubic (pyrite) in outline, and filled with brownish or yellowish ferruginous matter. This vein or sheet of quartz, has an average thickness of about six inches; its surfaces have a wavy or rolling character like those of the adjoining slates.

The outcrop was exposed for many yards, and ran up the side of the hill. The gold occurs in grains and scales through the quartz, and also occasionally in the ferruginous matter mentioned above. I saw many fragments of quartz, taken from the vein along its outcrop, containing visible particles. Some very fair cabinet specimens have been obtained.

1297. A company was formed some years ago, under the style of the Whippoorwill Mining Company, that proposed to ascertain the richness of the quartz, and the extent of the vein. What they have done, if anything, I am not advised.

This vein we regard as but one of many auriferous veins like it, some of them perhaps much more extensive, that may be found at different points in the region specified in the beginning of this section.

The geological character of the Coca Creek Region is given in §§ 437 and 438, to which the reader can refer.

*A pennyweight of native American gold is usually worth from ninety-five cents to one dollar.