# TIN RESOURCES OF THE KINGS MOUNTAIN DISTRICT, NORTH CAROLINA AND SOUTH CAROLINA.

By Arthur Keith and Douglas B. Sterrett.

## INTRODUCTION.

The Kings Mountain district, in which the tin ores here described are found, is included in the Gaffney, Kings Mountain, Lincolnton, and Gastonia quadrangles mapped by the United States Geological Survey. The district is almost equally divided between North Carolina and South Carolina, the part in North Carolina being a little larger.

The examinations on which this report is based were made by the authors in preparing the Gaffney-Kings Mountain and Lincolnton-Gastonia folios of the Geologic Atlas of the United States. A previous and less detailed examination was made by L. C. Graton.[1] Mr. Sterrett carried on his work in 1908 and in subsequent years up to 1914. The district has also been examined in detail by Mr. Keith, in company with Mr. Sterrett, with special reference to the general geology and the formations and structures of the region.

## GEOGRAPHY.

The Kings Mountain district is in the central part of the Piedmont Plateau, of which it may be considered a typical area. The country is one of broad, flat or gently rolling ridges that become more broken near the larger streams, where deep valleys have been cut. The sky line as viewed from the higher ridges is that of a nearly level plain, above which stand a few elongated hills and mountains, called monadnocks. Most of these hills are in a narrow central northeastward-trending belt.

A few low ridges rise above the plateau surface in the southeastern part of the Lincolnton quadrangle, but these do not compare in height and roughness with the more prominent peaks in the Kings Mountain quadrangle, to the south. The smooth, broad ridges pass rather sharply into steeper slopes at the foot of the monadnocks and near stream valleys. Many of the valleys in these quadrangles are

[1] Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, 1906.

rather broad and have nearly flat bottoms, but some are V-shaped, with steep walls. The relief where the rivers and larger streams are cutting through hard rocks is considerable, and the hillsides are steep and rocky.

Characteristic developments of the rolling upland country may be seen between Kings Mountain and Cherryville and on to the northwest beyond Floy. The relief for considerable distances along the ridges in these areas is low, and the side valleys are shallow. The cultivated lands are smooth fields with deep residual soil and only scattered outcrops of rock.

The plateau ranges in elevation from 750 to 1,050 feet above sea level, but most of it is between 850 and 1,000 feet. The highest parts are in general on the northwest, and there is a decided general slope to the southeast. The stream valleys are cut 50 to 200 feet below the general plateau surface, and the residual hills, or monadnocks, stand from 100 to 700 feet above it. The highest points are Kings Mountain Pinnacle, 1,705 feet, and Crowders Mountain, 1,624 feet above the sea.

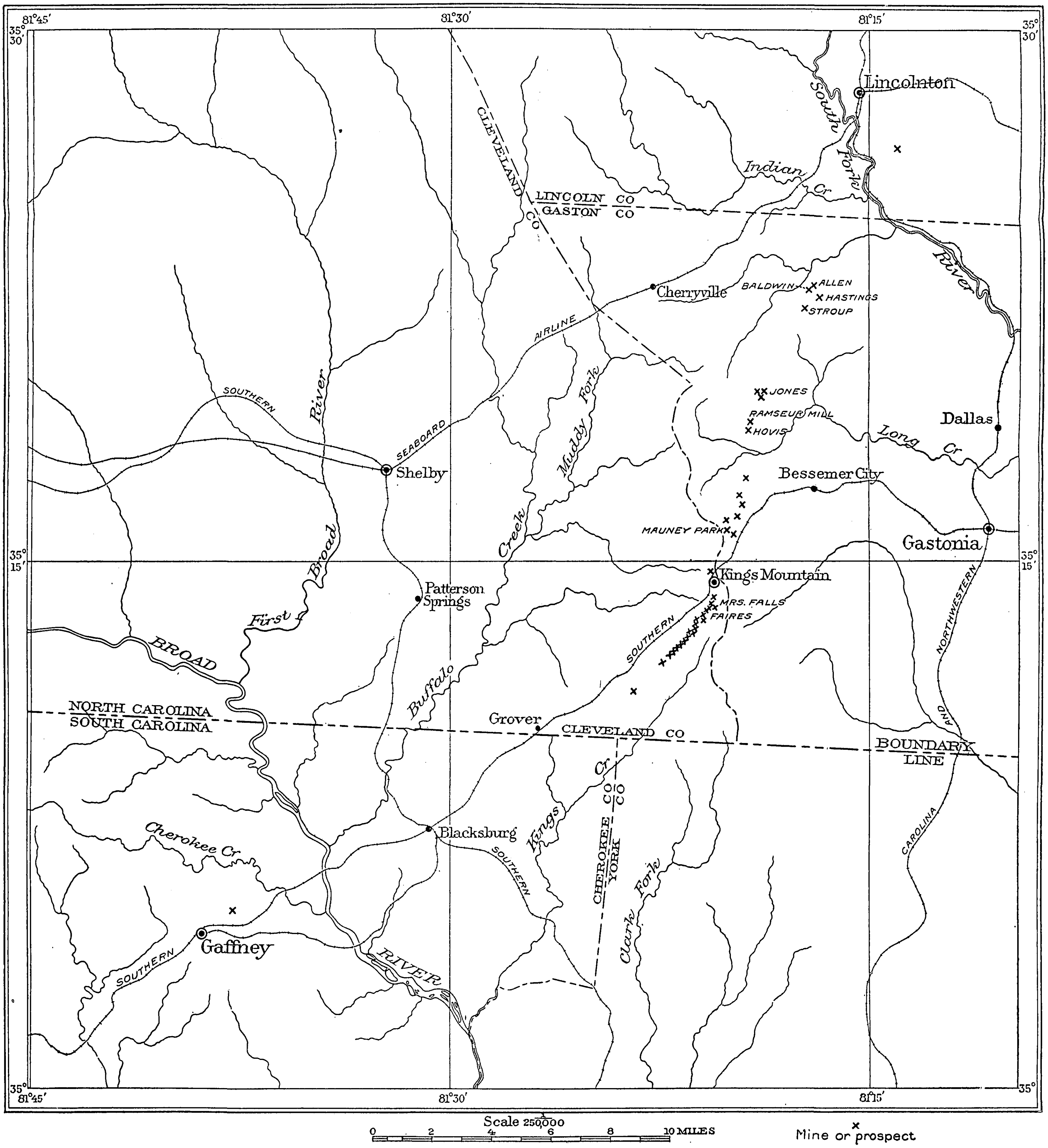
The town of Kings Mountain is situated at an elevation of 1,000 feet on the principal divide, which has a general northwest course between the drainage basins of Catawba and Broad rivers and separates the district into nearly equal parts. Broad River takes a southeasterly course through the Gaffney quadrangle and across a corner of the Kings Mountain quadrangle. Its principal tributaries are Kings, Bullocks, Buffalo, Cherokee, and Thicketty creeks and First Broad River. The chief tributaries of Catawba River are Indian, Crowders, Allisons, Clark, and Beaverdam creeks and the South Fork of Catawba River.

The Southern Railway runs from southwest to northeast through the middle of the district and connects most of the principal towns, including Gaffney, Blacksburg, Kings Mountain, Bessemer City, and Gastonia. The Kingville & Marion branch of the Southern Railway runs from southeast to northwest and crosses the main line at Blacksburg. A branch of the Seaboard Air Line Railway runs southwestward through Lincolnton and Cherryville. Between Bessemer City and Gaffney the Southern Railway passes within a mile or two of the tin belt, and no known deposit of tin ore in this belt is more than 3 miles from a railroad. (See Pl. IV.)

## DESCRIPTIVE GEOLOGY.

### PIEDMONT PLATEAU.

The rocks of the Piedmont Plateau are of both igneous and sedimentary origin. Both kinds of rock have been metamorphosed in many places. In some localities the metamorphic igneous and sedi-




MAP SHOWING LOCATION OF DEPOSITS OF TIN ORE IN KINGS MOUNTAIN DISTRICT, NORTH CAROLINA AND SOUTH CAROLINA.

mentary rocks are not sharply distinct, for the metamorphism has been so extreme that nearly all traces of original sedimentary or igneous nature have been obliterated. In many places also the metamorphic igneous rocks are not sharply separable from the ordinary igneous rocks, for a single intrusive mass may have become metamorphosed in some parts, especially near its borders, during processes of mountain building and may show little or no evidence of change in other parts, particularly in the interior.

The metamorphic rocks of sedimentary origin in the Piedmont Plateau consist of gneisses and schists, the principal varieties of which are those characterized by muscovite or biotite, garnet, kyanite, staurolite, chlorite, sericite, ottrelite, and, in some rocks, quartz and calcite. All these varieties have resulted from the metamorphism of ancient sedimentary rocks such as conglomerates, sandstones, shales, limestones, and numerous intermediate kinds. By metamorphism sandstone became quartzite, impure or shaly sandstone became graywacke and gneiss, shale became schist, and limestone became marble. Variations in composition of the original sediments are represented by variations in the metamorphic rocks. Some of the sediments were in part of volcanic origin, such as volcanic ash or tuff laid down in water with varying amounts of detrital material derived from ordinary land waste. The metamorphism of these rocks has produced varieties of crystalline rocks transitional between those of purely sedimentary origin and those of purely igneous origin.

The metamorphism of some of these igneous rocks has been so extreme that they have become mica and garnet gneisses or schists that are indistinguishable from similar foliated rocks of sedimentary origin. Diorite and many basic igneous rocks have become hornblende gneiss, hornblende schist, chlorite schist, serpentine, soapstone, etc.

The igneous rocks of the Piedmont Plateau include a wide range of such rocks as are generally classed as granite, diorite, gabbro, pyroxenite, peridotite, porphyries, and diabase, with many intermediate varieties. Some have been intruded as batholiths, laccoliths, sills, dikes, or stocks; and others have been poured out as surface flows. The eruptions occurred during several epochs. The older intrusives have been more or less metamorphosed and, as stated above, are not everywhere sharply distinct from the metamorphosed volcanic and sedimentary rocks.

The strike of the formations of the Piedmont Plateau is generally northeast, or approximately parallel with the trend of the plateau and the bordering Appalachian Mountains, but locally the strike may be nearly at right angles to the prevailing trend. The dip of the formations is generally high but is variable, and as a rule it is southeast.

## KINGS MOUNTAIN DISTRICT.

The district here described contains both metamorphic and igneous rocks, and the metamorphic rocks include some of sedimentary and some of igneous origin. In age the rocks range from Archean to Triassic. The Archean rocks occupy most of the district, especially its northwestern and southern parts. Through the middle of the district from southwest to northeast extends a belt of probably Cambrian rocks, including schists, quartzites, conglomerates, and marble, and of probably Algonkian rocks, including schists and tuffs. The Archean rocks have been cut by masses of later igneous rocks—granites, diorites, etc.—some of which are of great size. The diorite and one body of granite are pre-Cambrian; two other granite masses are late Paleozoic, perhaps Carboniferous. The formations that are associated with the tin deposits are the Carolina gneiss and Roan gneiss, of Archean age; the Bessemer granite, of pre-Cambrian age; the Whiteside granite and, especially, tin-bearing pegmatites of late Paleozoic age. The other formations represented in the district are not associated with the tin ores and will not be considered here.

### STRUCTURE.

The rocks of the district have been extremely folded, to some extent faulted, and greatly metamorphosed. The structural features resulting from extreme compression run in general northeast, as is usual in the Appalachian Mountains and Piedmont Plateau. The Cambrian (?) and Algonkian (?) rocks lie in a corrugated synclinal trough between uplifted belts of Archean gneisses and later granites. This trough is double, having two major downfolds, between which pre-Cambrian rocks reach the surface. In the Archean rocks along the northwest side of this general trough, at distances of 2 miles or less from their border, lies the tin belt. In the area between Kings Mountain and Gaffney this boundary between the Cambrian (?) and Archean rocks coincides with a fault that dips about 45° NW. The folds of the rocks in the tin-bearing belt range in trend between N. 60° E. and N. 20° E. and are comparatively regular and straight, as are also the folds of the Cambrian (?) and Algonkian (?) formations. On both sides of this middle belt there are many and great local departures from this regular structure. In the tin belt the rocks dip northwest at various angles, usually high. Most of the minor folds are closed and overturned and are very difficult to detect. The faults, doubtless numerous, are likewise obscure, and comparatively few have been traced. The only one known to have affected the tin belt is the boundary fault mentioned above.

## CAROLINA GNEISS.

*Distribution.*—The Carolina gneiss, so named because of its extensive development in the Carolinas, is the most widespread formation in the district, as well as the oldest rock in the region. It is most prominently developed in the northwestern part of the district, and no large body of it is known southeast of the middle syncline of Cambrian (?) rocks. It has been cut into elongated and irregular-shaped bodies by masses of intrusive igneous rocks.

*Character.*—The Carolina gneiss consists of an immense series of interbedded gneisses and schists, prominent among which are mica gneiss and schist, garnet gneiss and schist, and kyanite gneiss and schist, with intermediate varieties and granitoid layers. Less abundant are gneisses and schists characterized by graphite or staurolite. Practically all the gneiss and schist contains quartz and mica, either muscovite or biotite, but rock that contains other minerals, such as garnet or kyanite, receives its name from these. Thus garnet gneiss or schist may contain either muscovite or biotite or both, quartz, feldspar, and numerous accessory minerals.

The mica gneisses and schists are so diverse in texture and composition that it is difficult to give a general description of them. The schists range in texture from coarsely crystalline to fine grained and in many places exhibit variations both in grain and in mineral composition within a thickness of a few inches. Most of them are composed of quartz and biotite or muscovite, with or without feldspar, magnetite, and various other minerals. In some the mica scales are fine to medium in size; in others they are as much as a quarter of an inch in diameter. The coarsely crystallized kinds are commonly associated with granite or pegmatite. The quartz and other minerals of the schists occur in aggregates showing about the same range in grain as the mica scales.

The schists are strongly foliated in consequence of the grouping of their mineral grains with their longer dimensions roughly parallel. The cleavage of the mica is parallel with the schistosity of the rock, and the scales wrap or fold around the ends of the other minerals or inclose lenticular masses of them. The quartz of the schists occurs in flattened or lenticular aggregates of small grains. These lentils may be separated or connected by small seams of quartz.

The structure of the schists renders them fissile, cleavage readily taking place both between the different mineral grains and through the more cleavable minerals, such as mica. In some schists cleavage in more than one direction has been developed by compression of the rocks in more than one period and in different directions. In some rocks the later cleavage, or "slip cleavage," is due to a parting or slipping developed along a series of small, close folds. In places mica scales have been formed along such slips, so that the structure closely resembles the original schistosity. Another variation in the mica schists is due to the development of scattered coarse mica crystals with the cleavage turned about at right angles to the schistosity. Such crystals have been developed by metamorphism later than that by which the schistosity was produced.

The mica gneiss of the Carolina is varied in texture and composition. In one sense it may be considered as composed chiefly of a large variety of interlayered schists, the gneissic structure being due to the association of numerous unlike layers. A portion of the Carolina gneiss, however, is composed of granitoid layers that consist of feldspar, quartz, and either or both muscovite or biotite with numerous accessory minerals. The texture of this variety is commonly much coarser and the foliation less pronounced than in the mica schists. Some of this gneiss has developed from homogeneous rocks and consequently has a rather uniform texture and banding. Other masses have been derived from rocks of diverse composition and consequently show strong banding with contrasts in texture.

The ordinary gneisses and schists grade into other kinds by the addition of such minerals as garnet, kyanite, and graphite. Where garnet and kyanite are abundant and occur in large crystals the texture of the schists differs substantially from that of ordinary mica schist. Garnet and kyanite tend to crystallize with but little adaptation to the parallel arrangement of the other minerals of the schists and accordingly produce a porphyritic texture. Graphite, however, occurs in plates or scales parallel with the mica, and its presence does not change the general texture of the schists.

The interlayering of and gradations between mica schists and gneisses and those containing garnet and kyanite are so prevalent and intimate that it is practically impossible to show all varieties separately on a map.

### ROAN GNEISS.

*Distribution and name.*—The Roan gneiss, named from Roan Mountain, on the North Carolina-Tennessee border, where the formation is extensively developed, occurs in large masses and in belts or dikelike bodies cutting the Carolina gneiss in practically the whole of the district. It forms most of the surface at the south border of the district, and in the north-central part it occurs in areas 2 to 5 miles wide, most of which have very irregular outlines, especially near the intrusive bodies of Whiteside granite.

*Character.*—The Roan gneiss consists chiefly of hornblende schist, hornblende gneiss, schistose diorite, and diorite. In places there are intercalated layers of mica schist and gneiss and garnet schist and gneiss not essentially different from similar rocks of the Carolina gneiss. The hornblende beds are black or dark greenish black in color, and the other schists are light to dark gray. The hornblende rocks are of uniform composition, even in rather large bodies. Massive diorite occurs in some of the larger masses of Roan gneiss, but most of the rock is somewhat schistose. Very schistose varieties that are apparently composed almost wholly of hornblende are called hornblende schist but are as a rule merely modifications of the diorite. In places hornblendic layers are separated by layers of quartz or feldspar, and the rock is designated hornblende gneiss. The hornblendic rocks range from those of fine texture to those in which some of the crystal grains measure half an inch across. The mica and garnet gneisses and schists within the Roan gneiss are probably masses of the Carolina gneiss included in the original diorite at the time of intrusion or subsequently interfolded with the Roan gneiss. Pegmatite occurs through much of the Roan gneiss, as in the Carolina gneiss.

## BESSEMER GRANITE.

*Distribution and name.*—The Bessemer granite crops out in several broad bands in the central part of the district. The main band lies southeast of the general central trough of Cambrian(?) sedimentary rocks, and smaller bodies of the granite appear between its two main parts. One of these minor bodies expands to the north and in the Lincolnton quadrangle underlies Bessemer City, for which it is named.

*Character.*—The Bessemer granite is a medium to fine grained muscovite-biotite granite near quartz monzonite in composition. It is locally porphyritic. In all outcrops it has a strong schistose structure, and in many places it has been metamorphosed into white and gray quartz-sericite schists that bear no resemblance to the original granite. Only in certain favorable outcrops can the gradation from the schistose granite to sericite schist be seen. The porphyritic varieties of the granite have in some places been metamorphosed into quartz-augen sericite schists or "bird's-eye" schists.

In the less altered parts of the granite the constituent minerals are quartz, orthoclase, oligoclase, muscovite, biotite, and a little magnetite and zircon, with secondary clinozoisite and chlorite. In the metamorphism of the Bessemer granite to quartz-sericite schists the muscovite has been largely recrystallized into finer scales and the potash feldspar has passed into fine scaly sericite. The quartz has in part recrystallized, but the larger grains or phenocrysts retain more nearly their original size and position. Much silica has been set free in alteration during metamorphism and deposited in the form of quartz veins cutting the sericite schists. The Bessemer granite yielded more easily to processes of metamorphism than the granitic rocks of the Carolina gneiss.

### PEGMATITE.

Pegmatite is abundant in the area of Archean rocks, and a few small deposits have been observed in other formations. The rock is variant in composition but normally is composed chiefly of feldspar and quartz, with or without mica and other minerals. In some varieties feldspar is practically absent, and the pegmatite is composed chiefly of quartz and mica. Pegmatite is allied to granite in composition, but is of more varied and much coarser texture. In some of it individual minerals may measure more than a foot across.

The pegmatite occurs in sheets, lenses, and irregular masses ranging in thickness from a few inches to many yards and attaining half a mile in length. These masses may follow the bedding or the schistosity of the country rock or may cut across them at various angles. Most of the deposits are too small to be shown on any ordinary geologic map, but some of the larger ones and those of special interest because of their mineral associations have been mapped and will be shown in the folios describing this district, which are now in preparation. A few of the pegmatites have a pronounced schistose structure, but most of them are massive. Some of the pegmatites are probably of Archean age, but the majority are probably younger and are genetically connected with post-Cambrian granite intrusions, especially with the Whiteside granite. The mineral composition and variations of the pegmatites are given in considerable detail in the descriptions of the mines and prospects (pp. 135–146).

### WHITESIDE GRANITE.

*Distribution.*—The granite of this region that has been correlated with the Whiteside granite of the Pisgah and other quadrangles to the west covers large areas of the Kings Mountain district. It has been observed at many places in the region between this district and the Pisgah quadrangle, and it has been mapped in the Morganton, Mount Mitchell, and Saluda quadrangles of North Carolina. The name is taken from Whiteside Mountain, in the Cowee quadrangle, west of the Pisgah quadrangle, where the granite crops out in tremendous cliffs. Because of its relations to the associated rocks, the Whiteside granite is considered to be of later age than Cambrian, and possibly it was intruded during the mountain-building period at the end of the Carboniferous.

*Character.*—The granite is composed chiefly of orthoclase, microcline, and oligoclase feldspar, quartz, muscovite and biotite mica, and such accessory minerals as magnetite, apatite, and zircon. Minerals of secondary development are garnet, epidote or zoisite, chlorite, and kaolinite. The feldspars are the predominant minerals and the micas the most variable in abundance. Muscovite is more plentiful than biotite. Garnet is plentiful in some parts of the granite, especially those which have received a schistose structure through metamorphic processes; in some of these the garnets measure a tenth of an inch in diameter.

The granite is generally of light-gray color, and those varieties in which biotite is scarce are nearly white. Most of it has a medium to fine grain, especially in the smaller masses. In some places it shows a porphyritic texture, as in parts of the mass in the northeast corner of the Lincolnton quadrangle. The porphyritic forms appear much coarser grained because of the considerable size of the feldspar phenocrysts. Variations occur in different parts of the same bodies of the granite, some showing porphyritic phases and others the more even grain characteristic of the greater part of the Whiteside granite.

The Whiteside granite has yielded to metamorphism to varying degrees. In many places there is a gradation from typical granite in the interior of a mass to strongly schistose or gneissic granite at the border. The bulk of the granite shows only moderate metamorphism.

In places the Whiteside granite exhibits flow banding marked by an arrangement of minerals in roughly parallel layers. This structure may have developed in two ways, either during the intrusion of the granite magma in which a partial segregation of the minerals had already taken place or by the mashing and flowing under pressure of granite which contained partly absorbed masses of other rocks. These processes have yielded rocks characterized by discontinuous irregular wavy bands of different minerals. The flow structure may be present in one part of a granite mass and absent in another a few feet distant.

*Relations.*—The Whiteside granite is intrusive into all the rocks with which it is in contact in these quadrangles except the Triassic diabase dikes. Intrusive relations are shown by the doming action of batholiths, from the borders of which the layers of gneiss dip away at various angles, by the inclusion of masses of the gneisses with which it is in contact, by the occurrence of dikes both conformable with and cutting across the layers of the inclosing gneisses, and by the relations of the granite to pegmatite that cuts other rocks.

The best illustration of batholithic intrusion is around Cherryville, where the Whiteside granite has invaded the gneiss as a great batholith and also as sills, especially to the southwest of the main mass.

The interlayered masses of gneiss and granite dip away from the main mass of granite to the south and southwest.

Sill-like dikes of the granite are abundant in the gneisses, especially near the batholiths, and in some places these dikes branch out or turn across the schistosity, cutting from one layer to another.

Irregular bodies of pegmatites occur in the granite and extend from it out into the surrounding rocks. The texture of these pegmatites varies from extremely coarse to that of a coarse granite. In places pegmatite appears to grade into the granite. The invariable association of the pegmatite with the granite and the gradation of the one into the other show that they are related in origin. In places the gneisses and schists have been intruded by dike after dike of granite and injected by so much pegmatite that, with the unsatisfactory outcrops in this region, it is impossible to determine which rock is the more abundant, the original gneiss or the granite and allied pegmatite.

*Inclusions.*—Within the Whiteside granite are included numerous masses of the rock intruded by it, but this relation is best exhibited where the hornblendic rocks of the Roan gneiss are intruded by the granite, especially in a large area 3 to 5 miles south of Cherryville, in the Lincolnton quadrangle. Many of the inclusions have been more or less absorbed by the granite magma, which they have changed in composition. The absorption of the schists of the Carolina gneiss has yielded streaks of highly micaceous granite grading into highly micaceous schist. When they were intruded the hornblendic formations were broken up into more blocklike bodies, which floated out into the granite magma. Such inclusions were more or less dissolved by the inclosing magma, so that the magma became more basic near them. Thus the composition of the granite may be changed over considerable areas, and gradations occur from diorite inclusions seemingly to quartz diorite, to hornblende-biotite granite, to granite rich in biotite, and to the normal Whiteside granite.

## THE TIN DEPOSITS.

### GENERAL FEATURES.

*Distribution.*—The presence of cassiterite, oxide of tin, at many places in the Kings Mountain and Lincolnton quadrangles, at one place near Gaffney, in the Gaffney quadrangle, and at one locality in the Gastonia quadrangle has led to much prospecting and to attempts at mining. In at least one place—the Ross mine, near Gaffney—placer mining was temporarily done at considerable profit. Several prospects have also been opened in the Lincolnton and Gastonia quadrangles north and northeast of the Kings Mountain quadrangle.

Practically all the work on cassiterite-bearing veins has been done at a loss, but this work has not been sufficiently conclusive to prove or disprove the value of some of the deposits.

The cassiterite deposits have been found in a belt extending from a point 2 miles northeast of Grover, about parallel with the general trend of the rock formations, through the town of Kings Mountain and northeastward to Beaverdam Creek, 6 miles from Lincolnton. So far as known the Ross tin mine, near Gaffney, is on an isolated deposit, but this lies in about the same belt of rock formations as those between Grover and Kings Mountain.

*Inclosing rocks.*—The tin deposits occur in pegmatite masses within Archean rocks, either the Roan gneiss or the Carolina gneiss along or near its contact with the Roan gneiss. The belt of deposits lies within a mile northwest of the belt of Cambrian (?) rocks in the Gaffney and Kings Mountain quadrangles. To the north, in the Lincolnton quadrangle, the tin deposits diverge more widely from the Cambrian (?) rocks, but in the Gastonia quadrangle, east of the Lincolnton, they approach those rocks again.

The rocks inclosing the pegmatite are hornblende schist, hornblende gneiss, diorite, mica schist, and mica gneiss, with or without accessory garnet and kyanite. These formations have steep dips along the tin belt.

*Occurrence of pegmatite.*—The pegmatite occurs in sheets and lens-shaped bodies cutting the gneisses and schists. Some of the pegmatite masses are conformable with the structure of the inclosing schists, but others cut across the schist layers with various dips and strikes. Inclosed in the same formations are many other pegmatite bodies which are more or less similar to those bearing cassiterite but in which this mineral has not yet been found.

There are great variations in mode of occurrence and character of the pegmatites of the tin belt, including those which contain cassiterite. The masses range from less than an inch to 100 feet in width and from a few inches to probably more than half a mile in length. Some are only little longer than they are wide; others occur as large thin sheets. Some of the pegmatites occur in more or less parallel position, others in a belt with overlapping ends or in line with one another, and others lying at various angles with one another. The occurrence, where exposures are poor, of several bodies of pegmatite lying parallel and a few feet apart has misled some observers in estimating the width of some of the deposits. The pegmatite masses may fork or have connecting branches. They may turn, swell, pinch out abruptly or taper down at the ends. These variations may occur in different planes. Some of the pegmatites are more regular than others and hold one direction of strike or dip for considerable distances. The greatest irregularities occur in those bodies which cut across the schists or gneisses, or in those which branch from deposits otherwise conformable with the schistosity of the inclosing rock.

*Origin of pegmatite.*—The relations of the pegmatites to the inclosing rocks are chiefly those of intrusives, modified in some places by the action of solutions or gases. It is possible that some of the pegmatites have been deposited from aqueo-igneous solutions, but probably the majority, especially of the larger massive deposits, were mass intrusions. To which class many of the different pegmatites belong is a matter of uncertainty. Both types are supposed to be the products of granitic magmas that contained an excess of water and possibly gases and other mineralizing agents under conditions of heat and pressure. In the crystallization of a granite magma water is expelled and in part accumulates in the portion of the magma that remains unsolidified. This remaining magma accordingly becomes more fluid and may be regarded as an extremely hot concentrated aqueous solution. The expulsion of this liquid magma or solution into surrounding rocks gives rise to masses of pegmatite, which grade between typical dikes and typical veins.

*Composition of pegmatite.*—The pegmatites of the tin belt, including those that carry cassiterite, are somewhat diverse in composition. Some are composed of the usual minerals, feldspar, quartz, and mica, without appreciable quantities of other constituents. Others carry spodumene and cassiterite. Cassiterite occurs both in pegmatites which contain spodumene and in those which do not. The other minerals observed in the cassiterite-bearing pegmatites are few and not important. Such minerals as wolframite and arsenopyrite, which are associated with tin ore in other regions, appear to be absent here. The variations in composition consist chiefly in variations in the proportion of the different minerals present. In some deposits feldspar predominates; in others quartz; in some mica is absent and in others abundant.

Great irregularities occur in the distribution of the minerals. Quartz is segregated into large separate masses in some deposits and mixed through the rock in coarse grains in others. Cassiterite in small deposits occurs in scattered grains through one part of the pegmatite body and is absent a number of feet distant in another part. In some of the large pegmatite bodies the cassiterite is irregularly scattered through large masses of the rock, and in others it occurs more or less irregularly concentrated along one wall of the pegmatite as a smaller vein but connected with the main mass. In some of the pegmatites rich in cassiterite feldspar is only sparingly present if at all. This kind of deposit, then, has the nature of greisen and has been observed as lenses or streaks in larger bodies of pegmatite and along the contacts of such bodies with the inclosing rocks.

The cassiterite appears to have been one of the first minerals in the pegmatite to crystallize. Its boundaries are sharp, although crystal outlines are rather rare. Nowhere has a gradation between cassiterite and quartz or feldspar been observed, as there would be if the cassiterite had been introduced by metamorphism after the pegmatite was formed; nor are there inclusions of other minerals in the cassiterite. Accordingly it seems clear that the cassiterite was an original constituent of the pegmatite—a view which has already been stated by Graton. In some places the concentration of the cassiterite in greisen along the pegmatite border indicates metamorphic action, during which there were mutual reactions between the dike and the wall rock. The cassiterite, the earliest mineral to crystallize, formed first near the wall. The reaction of wall rock and dike is also evident by the unusual coarseness of the mica schist of the wall in many places.

*Age of tin deposits.*—The rocks in the tin belt are of two classes—(1) the gneisses, etc., of Archean age, and (2) the granites, pegmatites, and quartz veins, which cut the Archean rocks. The Archean rocks are greatly altered by deformation, but the younger rocks show little or no alteration. The Whiteside granite was locally rendered schistose but for large areas is massive and unaltered. It is therefore concluded that most of that granite is younger than the mountain-building movements which deformed and altered this entire region. This conclusion assigns to the Whiteside granite a late Carboniferous age. Similar reasoning assigns a late Carboniferous or post-Carboniferous age to the pegmatites and quartz veins.

It seems probable that granite, pegmatites, and quartz veins form a cycle, the granite having invaded the Archean rocks nearly at the end of the Carboniferous period, the pegmatites representing a later stage of intrusion, partly in mass and partly by permeating solutions, and the veins being the final products of the cooling magma. The general distribution of the rocks favors this view, for the tin-bearing pegmatites are not in the granite but are near its general southeast margin, while the quartz veins, more or less mineralized, occupy a general belt southeast of and farther away from the granite.

## MINES AND PROSPECTS.

### GAFFNEY QUADRANGLE.

#### ROSS MINE.

The Ross tin mine is about 1½ miles northeast of Gaffney, on the northwest side of a small hollow that drains northeastward into a tributary of Providence Branch. The work consists of many open cuts and placer washings, pits, and trenches, and a shaft more than 130 feet deep, with levels, all within a space about 600 feet long from northeast to southwest and 100 feet wide. Placer mining has been done on the lower part of the slope, where water was available, and material obtained above this place has been carted down to the sluice boxes. In this way the greater part of the hill slope from a point near the shaft northeastward to the branch, a distance of about 400 feet, has been worked over.

The shaft and underground workings were not accessible at the time of visit, but portions of the vein were exposed in shallow workings, and these, with descriptions by Sloan and Graton, furnish material for the notes here given. A crosscut was driven from the shaft northwest to the vein on the 63-foot level, and winzes were sunk on the vein from this level to the 90-foot level and there connected by a drift. The shaft cuts the vein at a depth of nearly 100 feet.

The placer material consisted both of weathered vein material approximately in place and of hillside débris derived from the vein. Where the loose material only was washed, the work was carried only a foot or two deep, but where the weathered outcrop of the vein constituted the placer material, excavation was carried to depths of more than 10 feet.

The country rock consists of interlayered hornblende schist and fine biotite gneiss, probably belonging to the Roan gneiss. These rocks strike about northeast, and dips were measured ranging from 25° SE. in the branch to 60° SE. in the mine workings. Along the stream the rocks are only slightly altered, but in the underground workings the saprolite was found to extend to depths greater than 60 feet, passing gradually into less altered rock. From the lower workings hard, fresh wall rock was brought up but the vein material is partly altered to the bottom of the mine. The wall rock on the dump consists of rather coarse hornblende schist and garnetiferous biotite gneiss. The pegmatite in the upper workings is decomposed by kaolinization of the feldspars. Specimens examined from the lower workings are hard, compact, and schistose and contain an abundance of compact fine sericite or pinite and a fibrous mineral like sillimanite. Under the microscope were observed partly sericitized orthoclase, oligoclase, muscovite and sericite, sillimanite, cassiterite, a prismatic mineral that is probably staurolite, and iron ore.

In the upper workings the streaks of hornblende schist have weathered to dark yellowish-brown saprolite and the mica and garnet gneiss to dark-grayish saprolite. The pegmatite is represented by masses of white kaolin and a little intermixed quartz with some mica.

The cassiterite-bearing pegmatite occurs as a series of irregular sheets and lenses approximately conformable with the inclosing gneiss and schists—that is, it has a northeast strike and a dip of

50°–60° SE. The train of pegmatite bodies, or "vein," is from 1 to nearly 10 feet wide, and the individual masses measure from less than an inch to 4 feet in width. The tin content varies widely. Graton mentions a 100-pound sample taken across a pegmatite body on the 75-foot level which contained 9 pounds of cassiterite, or about 6.5 per cent of metallic tin.

Most of the ore taken from the Ross mine was decomposed and soft and could be readily concentrated in sluice boxes. The ore taken from the lowest workings, however, was hard and would require crushing before concentration. The concentrates obtained have generally averaged over 65 per cent metallic tin. Sloan states that the total shipments of cassiterite concentrates from the Ross mine to 1906 amounted to about 130 tons. The shaft was sunk to its present depth in 1907. Since that time only a little surface testing with some sluicing has been done, resulting in a production of a few thousand pounds of concentrates.

## KINGS MOUNTAIN QUADRANGLE.

### LOCALITIES.

Twenty or more places in the Kings Mountain quadrangle have been prospected for cassiterite. During 1907 the Blue Ridge Tin Corporation worked in the town of Kings Mountain and at several places southwest of the town along a line of prospects opened by Ledoux & Co. in 1888 and 1889. A promising prospect on the Faires place was tested by Capt. S. S. Ross and others, of Gaffney. Named in order from the north border of the Kings Mountain quadrangle to the south and southwest some of the mines and prospects are: The old Blue Ridge Tin Corporation mine, on the west side of the railroad tracks in the town of Kings Mountain; Mrs. Elizabeth Falls's prospect, two-thirds of a mile south of the town; the Faires prospect, eight-tenths of a mile west of south of the town; prospects tested by the American Tin Plate Co., adjoining the Faires prospect on the southwest; the Mike Plonk prospect, 1¼ miles southwest of the town; a series of openings made by Ledoux & Co., beginning 1½ miles southwest of the town and extending one-third of a mile southwest along a ridge; an old prospect opened by Ledoux & Co., 1¾ miles southwest of the town; the principal workings of the Blue Ridge Tin Corporation, 2 to 2⅓ miles southwest of the town, consisting of two shafts, drifts, and some placer work; three prospects of the Blue Ridge Tin Corporation, beginning west of the placer ground and within half a mile to the southwest; other prospects to the southwest and one two-thirds of a mile southeast of Crocker opened by Capt. Ross in 1903. Still other prospects farther

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southwest are reported but were not examined. Float tin has been found at other places in the town of Kings Mountain and along the belt southwest of the town.

#### KINGS MOUNTAIN MINE.

At the Kings Mountain mine of the Blue Ridge Tin Corporation three shafts were sunk from 50 to 75 feet deep and some drifts run from them. Two of the shafts were about 50 feet apart and near the railroad tracks. A mill for treating the ore was erected close by. The third shaft is about 150 feet west of the mill and on a different "vein." The workings were not available for examination at the time of visit and little could be learned of the result of the operations. Rich ore was found in pegmatite débris on the surface and similar rich ore was reported from parts of the underground workings.

The country rock is strongly folded coarse mica schist with a body of similarly folded hornblende schist less than 100 feet to the south. The strike of the schistosity of these rocks is north to west of north and the dip about vertical, but the contact of the two formations runs as a whole nearly east, although jagged in detail. This is due to rather close folding with a strong northward pitch in the folds. The cassiterite-bearing pegmatites are nearly conformable with the schistosity of the inclosing rocks, and the ore shoots would probably be found to pitch northward in conformity with these folds. The pegmatites are variable in width, ranging from less than a foot to several feet as exposed near the collar of the western shaft. Most of the pegmatite, especially that rich in feldspar, is weathered and soft in the upper part of the workings, but some of the greisenlike ore rich in cassiterite is but little altered, even at the surface.

Cassiterite-bearing pegmatite crops out about 150 yards southeast of this mine in the gutter of one of the side streets of Kings Mountain and is reported to have been found in a well about 300 yards farther south. A number of loose cassiterite crystals were found one-third of a mile west of the railroad on both sides of the street leading toward Shelby.

#### FALLS PROSPECT.

The Falls prospect is on the east side of a small hollow in the south part of the town of Kings Mountain. It was tested a number of years ago by trenching along the hillside and sinking some shafts. Large pegmatite bodies were exposed in the hillside workings, but little cassiterite was found in them. A shoot of rich greisen was found in a shaft on top of the hill east of the trenches. Here the cassiterite-bearing greisen formed a pocket or shoot about 2 feet wide in a body of pegmatite about 8 feet wide. The pegmatite is inclosed between chlorite schist on the northwest and mica schist on the southeast. A ledge of tourmaline-quartz rock crops out in the branch about 75 yards southeast of the place where the tin lead crosses it. This ledge is composed of gray to smoky quartz penetrated by a large number of long, thin crystals of black tourmaline. In some parts the tourmaline composes about half of the vein.

### FAIRES PROSPECT.

Development work on the Faires property, a quarter of a mile southwest of the Falls prospect, consists of several pits and a 40-foot shaft with 200 feet of drifts, now badly caved in. A 10-foot pit at a place where rich float was found exposed a cassiterite-bearing pegmatite dike 3 feet wide striking N. 30° E. with a high northwest dip. The vein was cut on the 40-foot level by a crosscut from the shaft on the southeast. Here the pegmatite, it was reported, is about 3 feet thick and carries cassiterite. A drift to the northeast showed the pegmatite to be wider and to carry more cassiterite. Another pegmatite dike was prospected 33 feet southeast of this "vein" but did not carry cassiterite. The pegmatite from the underground workings is badly decomposed, most of the feldspar being kaolinized. The parts richest in cassiterite contain less feldspar and are harder. Some of the ore taken out was very rich, and in one section exposed the rock was estimated to carry about 10 per cent cassiterite. The country rock is hornblende schist, badly decomposed. A tourmaline-quartz vein is inclosed in the schist a few yards southeast of the pegmatite.

Other prospects were opened southwest of the main workings, on other outcrops of pegmatite. Cassiterite was found in some of these also, and in one of the exposures appears to be in promising quantity. About 300 or 400 yards southwest of the main deposit a large body of spodumene-bearing pegmatite over 40 feet wide crops out prominently in the north side of a small valley. No cassiterite was observed in this rock. Similar outcrops of spodumene-bearing pegmatite occur within half a mile to the southwest, but most of them lie northwest of the belt in which tin ore has been found.

### PLONK PROSPECT.

On the Plonk property a long trench was cut across the formations, exposing both spodumene pegmatite and cassiterite-bearing pegmatite inclosed in hornblende schist. The formations strike N. 35° E. and dip 75° NW.

### OLD LEDOUX PROSPECTS.

Considerable prospecting has been done along the ridge adjoining and to the southwest of the Plonk property, first by Ledoux & Co. in 1888 and 1889 and later by the Blue Ridge Tin Corporation. At the northeast is an old crosscut trench, where little is to be seen at present. Next is a trench about 200 feet long and 5 to 20 feet deep along the east contact of a large pegmatite. At the surface the contact strikes N. 25° E. and dips 80° NW., but at a depth of 20 feet the dip is 60° NW. Coarse garnetiferous mica schist forms the footwall of the pegmatite. Cassiterite was found in a greisen-like phase of the pegmatite along the footwall. The cassiterite-bearing portion is from 1 to 3 feet wide and is rich in some places and poor in others. It is reported that a vertical diamond-drill hole bored over 100 feet west of the "vein" cut 5 feet of ore at a depth of 275 feet. The pegmatite dike at this place is probably at least 25 feet wide. To the northwest are other large masses of pegmatite separated from one another by several feet of schist. These bodies do not crop out distinctly, and pegmatite bowlders have rolled between them, giving an appearance of one large deposit several hundred feet wide. Some of them carry considerable spodumene but apparently no cassiterite. The cassiterite-bearing mass is inclosed in mica schist, but most of the other masses are in hornblende schist.

About 50 yards southwest of the long trench a shaft 85 feet deep, called No. 1 by the Blue Ridge Tin Corporation, was sunk near a pit where good ore had been found. A 60-foot crosscut from the shaft cut three "veins," one of which carries cassiterite. These pegmatite veins are in interlaminated hornblende schist and garnetiferous mica schist. Further southwest is a trench 100 feet long and 3 to 12 feet deep on a contact similar to that just described. This contact strikes about N. 25° E. and dips 80° W. Cassiterite was found in part of this trench, and some of the material was promising-looking ore. A short distance to the southwest two shafts have been sunk, one on spodumene pegmatite. Cassiterite was reported in both of these shafts.

Near the end of the ridge a trench was made along the southeast contact of another large body of spodumene-bearing pegmatite, which carries cassiterite along the southeast wall. The wall rock on this side is chloritic mica schist.

About 200 yards west of this trench, on a knoll across a small valley, is another old shaft, 60 feet deep, in a large pegmatite dike carrying spodumene. A little cassiterite was found at this place and also at another pegmatite outcrop opened by two pits about 200 yards southwest. The inclosing rock is hornblende schist at both of these prospects.

**BLUE RIDGE TIN CORPORATION MAIN WORKS.**

At the northeast end of the outcrops on the property of the Blue Ridge Tin Corporation a shaft 80 feet deep (No. 4) was sunk, with a 60-foot drift to the southwest on the 60-foot level. A 20-foot prospect shaft was sunk south of the main shaft. Two "veins" were found—one in the 20-foot shaft and the other along the northwest side of the drift on the 60-foot level. The material of these "veins" consists of schistose greisen-like pegmatite and is reported to be badly crushed in the underground workings.

About 200 yards to the southwest is shaft No. 5, 130 feet deep. Underground workings cut two "veins" carrying cassiterite. One of these veins that crops out 15 feet southeast of the shaft was cut a few feet from the shaft in a crosscut to the southeast on the 85-foot level and in the shaft near the bottom. This "vein" is said to contain fine-grained ore at the surface but coarser ore underground. The outcrop of the other vein was not found, but the ore was cut in the crosscut on the 85-foot level. It is said to have been coarse-grained and rich ore. Another cassiterite-bearing pegmatite body was opened by a 25-foot shaft about 60 yards west of the main shaft.

A large spodumene pegmatite mass about 15 feet wide crops out between shafts No. 4 and No. 5. Débris of cassiterite-bearing pegmatite or greisen was found near this mass, and a little cassiterite was observed in the spodumene-bearing part.

The country rock at these workings consists of interlaminated hornblende schist and bluish mica schist having a northeast strike and high to nearly vertical northwest dip. The "veins" seem to be at least approximately conformable with the inclosing schist.

Placer deposits have been worked in the bottom land along the valley southwest and south of the mine. The ground favorable for this work is from 50 to 100 yards wide at the lower end and tapers northwestward to shoals where the tin lead crosses the stream. It has a length of over 200 yards. Water is available, and parts of the placer ground are reported to have been tested with encouraging results. At one time some of the alluvial material was hauled up an incline track to a concentrating mill on the hillside, but although several thousand pounds of concentrates were washed out the work was not profitable with such equipment.

On the hill on the southwest side of this same valley a 25-foot shaft was sunk and a 10-foot crosscut run. A body of spodumene pegmatite, 5 feet wide, was found inclosed in hornblende and chlorite schist. A little cassiterite is reported to have been taken out. In two prospects within half a mile southwest similar spodumene-bearing pegmatite masses were opened. They are in hornblende and chlorite schist. Cassiterite is reported to have been found in both. A mass of tourmaline-quartz rock occurs about 10 feet southeast of one of these pegmatite masses.

#### ROSS PROSPECT.

At the old prospect two-thirds of a mile southeast of Crocker, opened by Capt. S. S. Ross in 1903, a pit was sunk on the southeast side of a body of pegmatite about 20 feet wide. This pegmatite is said to contain considerable cassiterite in a streak several inches thick along the southeast wall but only a few scattered grains within the mass. Bluish mica schist forms the wall rock, but 45 feet to the southeast there is a belt of hornblende schist. A vein of tourmaline quartz is inclosed in the hornblende schist about 50 yards southeast of the pegmatite.

### LINCOLNTON QUADRANGLE.

#### PROSPECTS ALONG CHESTNUT RIDGE.

The Mauney Park prospect is on the south side of a small valley cutting eastward across Chestnut Ridge, about 1 mile north of the north edge of the town of Kings Mountain. The deposit is near some springs which have been walled up and around which the grounds have been cleared as a park. It was discovered by the presence of a number of boulders of greisen, rich in cassiterite and weighing from 30 to 150 pounds each, loose in the surface soil. A small amount of prospecting was done during the "tin excitement" of 1904. This work consisted in clearing out undergrowth and digging pits and a crosscut trench. The pits are on the north side of a small ridge pitching east and the trench is on the south side of the ridge, 65 yards due south of the pits.

The country rock consists of kyanite-mica schist and gneiss with a narrow belt of hornblende schist close to the tin-bearing pegmatite. The schists strike north and have a vertical dip, and the pegmatite is approximately conformable with them. The pegmatite exposed in one of the pits is nearly 8 feet wide. Of this width 2 feet along the west wall consists of cassiterite-bearing greisen. The remaining 6 feet of pegmatite is highly feldspathic and carries but little cassiterite. This portion of the dike is soft and crumbling owing to the kaolinization of the feldspar. The feldspar-free greisen portion is fresh and hard and shows a few iron oxide and clay stains. Part of the greisen is rather fine-grained, and part is coarse containing muscovite crystals an inch across. In places at least 10 per cent of the greisen is cassiterite, some of which occurs in crystals an inch long and half an inch thick.

Pegmatite was cut in the trench on the south side of the ridge, apparently in direct line with the cassiterite-bearing pegmatite on the north side. No cassiterite was observed at this place, however. From 20 to 30 yards east of this an outcrop of spodumene-bearing pegmatite extends in a west of north direction across the ridge. No cassiterite was seen in the prospects opened on this spodumene pegmatite.

Cassiterite-bearing greisen is found in a cultivated field a quarter of a mile due north of the Mauney Park prospect, on the west side of Chestnut Ridge. Boulders of this rock have been plowed up, but no prospect work has been done.

The Horton shaft, 122 feet deep, was sunk in 1893 on the east side of Chestnut Ridge half a mile northeast of the Mauney Park prospect by residents of Kings Mountain. Crosscutting was started, and cassiterite-bearing pegmatite is reported to have been found. This prospect is not in line with the Mauney Park lead but is in line with other prospects on the east side of Chestnut Ridge and east of Long Creek Church. At one of these, on the land of J. J. Ormond, a quarter of a mile east of the north end of Chestnut Ridge, cassiterite-bearing greisen was found in surface boulders and in a prospect shaft. A little cassiterite has been found between the Horton shaft and the Ormond prospect along the east side of Chestnut Ridge.

### ORMOND-CARR PROSPECT.

The Ormond-Carr prospect is a quarter of a mile east of Long Creek Church. A shallow shaft and a few pits were made in a north-south direction along an outcrop of pegmatite. The country rock is hornblende schist of the Roan gneiss. A narrow belt of staurolite schist crops outs a few yards east of the deposit. The formations strike about north and have a high westerly dip, and the pegmatite is approximately conformable with them. The pegmatite exposed is from 5 to 8 feet wide and carries cassiterite in places.

### HOVIS PROSPECT.

The M. V. Hovis prospect is 1⅝ miles N. 12° E. of Long Creek Church. Cassiterite is found in loose crystals and in small boulders of greisen scattered over a field and along the public road. A 35-foot prospect shaft was sunk a few yards west of the road, and decomposed pegmatite was encountered in it, but no cassiterite was seen at the time of examination. The country rock is evidently chiefly hornblendic schist weathered to a dark-brown soil.

### RAMSEUR MILL PROSPECT.

The Ramseur Mill prospect is about a third of a mile east of north of the Hovis prospect, or nearly 2 miles east of north of Long Creek Church. A shaft and a trench were made here during the first tin excitement, and some very promising cassiterite-bearing greisen was thrown out. The country rock is hornblende schist with varied strike and dip. The attitude of the pegmatite is not plainly evident, but the trench made along the northeast contact showed this to have a N. 30° W. strike. The pegmatite body is large, at least 15 feet wide, and crops out through a distance of about 75 feet. The cassiterite was found in a greisen streak 1 to 2 feet thick along the northeast wall.

### JONES MINE.

The Jones mine is about 3½ miles N. 30° W. of Bessemer City. It was first prospected in about 1892 or 1893, but the principal work was done between 1903 and 1904. The following description is partly taken from a report by Graton,[1] supplemented by notes of D. B. Sterrett. The early workings consisted of a shallow shaft and some pits on a pegmatite vein striking north of west with a nearly vertical dip. At one place this vein was 2½ feet wide and very rich in cassiterite. About 70 feet west it contained only a small quantity of cassiterite, and 70 feet still farther west cassiterite was absent.

Later work was rather extensive. Shafts and trenches were made along the vein first opened through a distance of about 200 feet. A shaft 175 feet deep was sunk about 150 feet N. 70° W. from the west end of the workings along this vein, and still another shaft 150 yards west of this. A second pegmatite vein 100 yards south of the first one was opened by prospect pits through a distance of about 100 yards in a northwesterly direction. In all, about 500 feet of underground work is reported to have been done. A small amount of placer mining was carried on in the branch east of the deposit. A mill was erected at the mine, and a carload of concentrates is reported to have been shipped.

The deposits occur near the contact of interlaminated hornblende schist of the Roan gneiss and mica gneiss of the Carolina gneiss. The strike of these formations ranges from east of north on the east side of the deposit to nearly west near the middle of the workings and northwest near the west workings. The dip ranges from 50° N. to nearly vertical. The first vein opened cuts across the bedding of the country rock, having a north of west strike and a nearly vertical dip. Along the contact of this pegmatite the mica gneiss contains a quantity of small black tourmaline crystals and needles. Pegmatite also occurs in small offshoots from the larger bodies and in lenses and stringers near them.

The pegmatite mass is variable in character. In some places it has about a normal mineral composition. In others the feldspar is subordinate, or almost absent, and cassiterite may or may not be present.

[1] Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 46–48, 1906.

Some of the pegmatite from the 175-foot shaft contains spodumene. Where cassiterite is plentiful the pegmatite does not carry so much feldspar, and in places where there is more than 10 per cent of cassiterite feldspar is practically absent.

Some of the richest ore was found in the vein first opened. A small sample of ore from the earlier workings yielded cassiterite equal to about 5 per cent metallic tin when crushed and panned. Graton states that the average of all the pegmatite broken in the mine is said to have been about 0.7 per cent of metallic tin.

#### STROUP AND RAYFIELD PROSPECTS.

Prospects were opened in 1904 along the boundary line between the places of Nora Rayfield and John Stroup, 2½ miles S. 60° W. of Landers Chapel, but these pits are now filled up. The country rock is hornblende schist, and a belt of kyanite gneiss lies a few yards west of the tin deposits. Cassiterite-bearing pegmatite was found in the prospects, but only a few pieces of this ore, of medium grade, were left on the surface at the time of examination.

#### HASTINGS PROSPECT.

The H. P. Hastings prospect is about half a mile northeast of the Stroup and Rayfield prospects, or 2 miles S. 65° W. of Landers Chapel. It was opened by a 14-foot shaft and a crosscut trench. Cassiterite-bearing pegmatite was found on the surface for a distance of about 100 feet in a northeasterly direction. The country rock consists of interbedded hornblende schist and kyanitic mica gneiss, which strike northeast and have a high northwest dip. The pegmatite is approximately conformable with the bedding of the inclosing rock. The ore is medium grained and carries a large percentage of quartz, a little feldspar, mica, and fine cassiterite.

#### BALDWIN AND ALLEN PROSPECTS.

The prospects of J. Baldwin and J. R. Allen are a third of a mile northwest of the Hastings prospect, or 2 miles S. 73° W. of Landers Chapel. They are on opposite sides of the public road, the Baldwin prospect about 80 yards southwest of the road and the Allen prospect about 150 yards N. 55° E. from the Baldwin prospect. A 45-foot shaft was sunk at the Baldwin prospect, and a few blasts were made in the outcrop. Two pits, now partly filled up, were made at the Allen prospect.

The country rock is diorite and hornblende schist of the Roan gneiss. The schist strikes northeast and has a high northwest dip. The prospects are in lenticular-shaped outcrops of spodumene-bearing pegmatite which forms a small oval knoll. These pegmatite outcrops are 10 to 20 feet wide and 50 feet or more long. Some of them are in line with one another, and others overlap at the ends. In texture the pegmatite is about medium-grained, the feldspar crystals ranging from less than 1 inch to 4 inches in thickness and the spodumene crystals being 1 or 2 inches long. The spodumene is mostly opaque and gray, but a few crystals with transparent yellowish-green portions were observed. The mica of the pegmatite is yellowish green and occurs chiefly in small crystals half an inch or less in diameter. The cassiterite is present in rather small grains and crystals scattered through parts of the pegmatite. Pieces of medium-grade ore, 10 to 12 inches across, were left on the dumps. Cassiterite was not found in all the outcrops of spodumene pegmatite.

Four ledges of decomposed spodumene pegmatite are exposed in a space of 100 feet along the road and about 100 yards east of the tin-bearing lead, but no cassiterite was seen in them.