Quartz Crystal Deposits of Southwestern Virginia and Western North Carolina

GEOLOGICAL SURVEY BULLETIN 1072-D

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By JOHN B. MERTIE, JR.

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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A detailed report on quartz crystals from 37 sources and an explanation of their origins

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QUARTZ CRYSTAL DEPOSITS OF SOUTHWESTERN VIRGINIA AND WESTERN NORTH CAROLINA

By JOHN B. MERTIE, JR.

ABSTRACT

The quartz deposits of southwestern Virginia and western North Carolina were investigated by the U. S. Geological Survey during 11 months of 1943. In Virginia, 89 informants and owners of quartz or deposits of quartz were visited, and 206 were visited in North Carolina.

Most of these deposits are on the plateau that forms the northwestern flank of the Blue Ridge, but others occur in the Piedmont province, about 30 miles southeast of the Blue Ridge. Three general sites are known in this Plateau province, and two in the Piedmont province. As it is impractical to describe all these deposits, certain ones have been selected that illustrate geologic, economic, or other features of special interest.

All the quartz deposits are in areas where the bedrock is dominantly schist or gneiss, in which are many veins and lenticular bodies of opaque white quartz; but it is believed that these veins are not the source of, and have no genetic relationship to, the deposits of quartz crystals. Three modes of formation of quartz crystals are recognized: first, primary fillings of fissures, vugs, solution cavities, and other open spaces; second, hypogene crystals, of primary or secondary origin, in pegmatites, particularly in vugs or in banded zones; and third, supergene crystals of quartz that grew in bedrock during or after the time when the latter was decomposed by weathering to saprolite. Many, if not most, of the quartz crystals in the areas studied are believed to have originated by the third method, and to such crystals, the designation "pocket quartz" is applied.

Both the quartz crystals and the vein quartz have been concentrated at the surface of the ground and in the upper part of the soil as a result of long continued residual weathering. Such concentrations do not necessarily indicate that other quartz of the same kind lies directly below in bedrock; on the contrary, such deposits are more likely to indicate that the veins, dikes, and supergene pockets have been eroded, to form the surficial deposits. This conclusion has been fortified by underground exploration at several sites and by the discovery of considerable subsurficial quartz at other sites where little or none appeared at the surface. These conditions make prospecting for pocket quartz a difficult and uncertain enterprise.

About 2,800 pounds of quartz crystals that might be of oscillator grade were shipped from Virginia and North Carolina to the National Bureau of Standards for testing prior to April 1944, and about 14 percent was certified to the Metals Reserve Corporation for purchase. More than half of this quartz was transmitted by the U. S. Geological Survey. Oscillator quartz of grades 1 and 2, weighing 17.18 pounds, and of grade 3, weighing 134.99 pounds, came from Virginia; and 71.86 and 165.03 pounds, respectively, were produced in North Carolina. The Metals Reserve Corporation paid $830.70 for the output from Virginia and $1,521.53 for that from North Carolina.

Most of the quartz crystals that are available in the Southeastern Atlantic States are of low grade, as shown by the preceding data. The reserves that are readily obtainable are small, and the outlook for future production is unfavorable. During World War II, however, much quartz was discarded because the users demanded oscillator plates with diameters ranging from a centimeter to an inch. These conditions have now changed, and much smaller plates are being cut. Hence, a part of the quartz of grade 3 that was formerly considered useless might now be utilized.

INTRODUCTION

Crystals of quartz are sliced into thin plates that are used extensively as oscillators, mainly in high-frequency electric circuits; but such plates are also used to a lesser extent as low-frequency oscillators, and as filters in high- and low-frequency communication systems. The principal function of oscillating quartz crystal plates is to stabilize the frequency of electric waves that are being radiated from transmitters, though they are also used in telegraphic receivers. According to R. A. Heising (1946) quartz crystals were first used commercially as frequency stabilizers by radio station WEAF in New York, in 1926. In recent years the congestion in radio transmission channels, and also in telephone circuits, has rendered imperative the use of many quartz crystals, so that a constantly increasing demand has resulted.

Most of the quartz thus utilized in the United States has come from Brazil, though other localities are known where smaller supplies are available. Prior to World War II, an adequate supply of crystals was not difficult to obtain, but the war quickly changed this condition. The fighting equipment of the United States armed forces was mutliplied many times within a short period; and much of this equipment required radio transmitters that used crystal oscillators. Moreover, some of these units, such as airplanes and tanks, required many crystal plates per unit in order that multiple communication channels might be made available. As a result of these unusual demands, a shortage of suitable crystals developed; and this shortage was rendered more acute by the submarine blockade of shipping between Brazil and the United States. This situation was met by measures that prevented the delivery of Brazilian quartz to our

enemies, by expansion of the Brazilian output, and finally by overcoming the submarine menace. In the meanwhile, however, every effort was made by the U. S. Geological Survey to discover and appraise the quartz deposits of the United States; and the present paper describes the results of this appraisal in the Southeastern Atlantic States, particularly in Virginia and North Carolina.

Certain commercial designations and descriptions of quartz require definition. Clear quartz that is free of inclusions, bubbles, veils, and other visible imperfections is known commercially as "eyeclear" quartz; and in this report such material is designated as high-grade quartz. Eyeclear, or high-grade, quartz may or may not prove to be oscillator quartz, depending on how free it is of twinning. Commercially, quartz is called faced if enough crystal faces are preserved to permit crystallographic orientation; otherwise it is unfaced. These definitions are amplified on p. 246–248.

PRESENT INVESTIGATION

The search for oscillator quartz in the Southeastern States was begun by E. W. Heinrich, who worked in North Carolina and Virginia from January to April 1943; and this investigation was continued by the writer, who worked mainly in these two States from May to November 1943.

This work was aided from the outset by publicity. Press notices were issued by the Geological Survey and the War Production Board, and as a result many persons were acquainted with the need for oscillator quartz. The responses of owners of quartz crystals and of others familiar with sites that merited examination, yielded a list of localities that served to guide the initial work. Fieldwork so greatly increased the number of these locations that many deposits in each district could not be investigated in the time allotted for this investigation.

Mr. Heinrich, in the course of this work, visited 23 informants and owners of deposits in Virginia and 75 in North Carolina. The writer visited 77 in Virginia, including 7 that had already been visited by Mr. Heinrich, and 141 in North Carolina, including 10 previously visited. Thus, 299 contacts were made with persons interested in, owners of, and potential producers of quartz. Some of these visits yielded information only and some led to the acquisition of quartz. Many such visits resulted in the examination of quartz deposits and the eventual transmittal of quartz to the National Bureau of Standards.

Most of the deposits visited in Virginia and North Carolina, including all those mentioned in this report, are located on figures 1 and

3–6, covering 1 area in Virginia and 4 areas in North Carolina. A small amount of oscillator quartz was produced in Georgia and Alabama, and some of these deposits were visited by the writer, but no quartz from any of them was transmitted by the Geological Survey to the National Bureau of Standards.

The search for oscillator quartz has two aspects. One of these has to do with the study of deposits, to determine if possible their geologic occurrence, size, and availability. The other is the testing of quartz to determine its possible value. The occurrence of quartz crystals in Virginia and North Carolina is such that few crystals or related croppings of country rock are found in place, and few opportunities exist for underground examination. Actually, therefore, most of the fieldwork consisted of visiting plowed (and preferably freshly plowed) fields in restricted areas where clear crystals were known to be present. Such visits led usually to a general determination of the size of the deposit, the examination and shipment of quartz crystals, and the recognition of associated minerals, particularly mica, that might have a genetic significance. As the season advanced and the fields became covered by crops or weeds, these examinations became progressively more difficult and less productive of information.

Quartz could not be tested in the field for twinning and other defects not visible to the naked eye. Therefore, all samples of quartz that satisfied a visual inspection were shipped by the writer to the National Bureau of Standards for further examination. If the quartz was found to be of usable grade, it was purchased by the Metals Reserve Corporation; otherwise, it was returned to the owner. The writer was informed by the Bureau of Standards within a few weeks of the results of all examinations.

Descriptions of all the deposits that were visited would be both impracticable and unprofitable because the number was large and because most such descriptions would be merely an enumeration of the areas in particular fields where crystals have been found. Instead, a limited number of localities are described that illustrate features of special interest. Such sites include those where high-grade quartz and quartz of oscillator grade were found, where large crystals or considerable quartz of lower grade is present, where features of genetic or general geologic interest are visible, or where factors of historic or controversial interest render a description desirable.

SITES OF DEPOSITS

The principal deposits of oscillator quartz of usable size and grade in Virginia and North Carolina are found in two general environments. The more important deposits are on the plateau that forms

the northwestern flank of the Blue Ridge, from its crest northwestward for about 15 miles. The other deposits are in the Piedmont province, about 30 miles southeast of the Blue Ridge. Still other deposits are known elsewhere in Virginia and North Carolina, particularly in the central and eastern parts of these States, but none of them is of sufficient importance or genetic significance to merit description.

The plateau deposits have been observed in three general areas, some of which are more localized and better defined than others. In Virginia most of these deposits are in Carroll, Floyd, and Patrick Counties, principally near the boundary between these counties, and at sites that are distributed from the crest of the Blue Ridge northwestward for about 7 miles. East of longitude 80°30′, the general course of the Blue Ridge is N. 55° E., but west of that longitude, its general trend is west for about 12 miles. West of longitude 80°42′, the trend is S. 55° W., as far as the Spruce Pine district. Most of the plateau deposits of Virginia are just north of the eastern break in the course of the Blue Ridge; and although scattered deposits occur in Floyd County northeast of the principal area, very few have been found west of this critical zone.

A few crystals of quartz were found adjacent to the Virginia-North Carolina line, between Galax, Va., and Edwards Crossroads, N. C. These localities were visited, but the crystals were found not to be of sufficient significance to merit description. Farther southwest, quartz deposits of considerable interest were found in the vicinity of Stratford and Sparta, Alleghany County, N. C., in an equidimensional area from 5 to 10 miles northwest of the summit of the Blue Ridge. Still farther southwest, many quartz deposits are known in Ashe County in an irregular area from 3 to 14 miles northwest of the crest of the Blue Ridge, extending northward and northeastward from Jefferson for about 10 miles. Taken together, however, all these localities in Alleghany and Ashe Counties define a second general belt that lies parallel to the Blue Ridge, from 3 to 15 miles northwest of its crest.

Quartz crystals have been found in Avery and Mitchell Counties, N. C., in an area here designated as the Clarrissa-Linville belt. Unlike the other two areas, this appears to be a narrow zone, about 2 miles wide and 15 miles long, that does not trend quite parallel the Blue Ridge.

Quartz deposits occur in the Piedmont province in two general localities. The more significant of these deposits are in Alexander and Iredell Counties, N. C., about 30 miles southeast of the crest of the Blue Ridge, in a narrow belt that extends from about 4 miles south-

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west of Taylorsville east-northeastward for 15 miles. The town of Hiddenite lies within this belt. Some outlying deposits are farther north, in the general vicinity of Vashti. A second area in the Piedmont province extends for 15 miles northwestward from Shelby, N. C., with some additional prospects in the vicinity of Toluca and Bellwood.

The localization of quartz crystals in five general areas, as shown in the accompanying sketch maps, may be partly fortuitous. Crystals of quartz suitable for oscillator plates were not sought by the Geological Survey in the Southeastern States until 1943, and the search lasted only a year, as by that time an adequate supply of Brazilian quartz had been assured. Moreover, eyeclear crystals occur mainly as residual accumulations in the soil and have been found in hardrock only at a few localities. Thus, they are hard to find, and in fact are visible to best advantage only in freshly plowed fields. It is therefore probable that more intensive search would reveal additional localities, particularly localities situated between those that are described in this report. The known deposits, however, have been adequately sampled, and it is believed that further work would not change the general conclusions that have been reached.

GENESIS OF QUARTZ CRYSTALS

BEDROCK AND QUARTZ VEINS

The country rock of the areas where quartz crystals have been found comprises a complex assemblage of metamorphic and igneous rocks. The metamorphic rocks include schists of several kinds, granitic gneisses of numerous types, and amphibolite; and the igneous rocks include intrusive granitic rocks, pegmatites, and basic and ultrabasic metaigneous rocks. The metamorphic rocks are parts of the Carolina and Roan gneisses; the intrusive rocks are younger. Much of the country rock is decomposed to great depth by weathering, and most crystals of clear quartz so far found occur either in such weathered bedrock or in soil derived therefrom.

These older rocks are cut by many veins and lenticular masses of quartz, most of which is the opaque white variety, often designated by mining men as "bull quartz." The age of such quartz is of the same order of magnitude as the schistose and gneissoid country rocks in which it occurs. Hereafter the opaque white quartz within these veins and lenses is designated as the older or ancient quartz.

A different and peculiar type of vein quartz occurs at numerous localities southeast of the Blue Ridge. Such quartz is commonly yellow to brown, but when freshly broken it is snow white to light

cream. It consists of many small crystals of quartz, ranging in length from ⅛ to ½ inch. This material is porous and vuggy, and the component crystals readily separate under weathering, so that the rock crumbles into many small grains when struck with a hammer. Residual cobbles of this granular vein quartz that were seen in many fields within the Piedmont province were, at some places, in association with residual quartz crystals, and northeast of Hiddenite such quartz was observed to form the sides of a vein and enclose a central zone of translucent to milky quartz.

WEATHERING OF BEDROCK

Deep residual weathering, though present under specialized conditions at all latitudes, is much more commonplace in southern regions. Thus the same metamorphic rocks that farther north show little surficial alteration are in the Southern States deeply weathered. On the plateau that forms the northwestern slope of the Blue Ridge in southwestern Virginia and western North Carolina and in the Piedmont province to the southeast, the bedrock is generally weathered to a depth of 20–100 feet, though at a few sites this weathered bedrock has been completely eroded, producing what are designated by the writer as hardrock pavements. Rock quarries are commonly started on such pavements.

Feldspathic rocks are very susceptible to chemical change by weathering, and all the granitic rocks, including the gneisses, and many of the schists are feldspathic. Such rocks do not disintegrate into rubble. Instead the feldspars alter to clayey products, and the rocks cohere sufficiently to retain most of their textural and structural characteristics. Such decomposed, earthy, but untransported rock is called saprolite. Some of the other rock-forming minerals, notably hornblende, also are altered by weathering, but most of the accessory minerals except apatite are relatively stable. On the other hand, well-indurated rocks of siliceous composition, such as quartzite and chert, are practically indestructible though they may be somewhat altered in tropical regions. The term "saprolite" is used in this report as synonomous with bedrock or country rock if they are weathered as described. The term "hardrock" is used to designate unaltered bedrock or country rock.

Saprolite is formed only in the zone of weathering. Most of the saprolite now present in the Southeastern States is believed by the writer to have formed under climatic conditions more favorable than those of the present time, possibly in the interglacial stages, and particularly in the last interglacial stage. Under present climatic conditions saprolite is believed to be forming very slowly. Saprolite is

thus a deposit whose volume is controlled partly by the petrographic character of the country rock and to a large degree by variations in temperature, precipitation, and topographic relief.

Active erosion in the Allegheny Mountains has been a deterrent to deep weathering, as streams with high gradients removed the weathered debris almost as fast as it formed; and under present conditions of minimum saprolitization, this effect is accentuated. Hence saprolite is generally scarce in the Allegheny Mountains and along the crest and steep southeastern slope of the Blue Ridge. But the northwestern side of the Blue Ridge in this latitude is a gently sloping plateau drained by streams of moderate gradients. Moreover, most of the farms along this plateau have springs, indicating an active subsurface circulation of ground water. Such conditions must accelerate the weathering and decomposition of bedrock, and this active circulation of ground water was, and possibly still is, an important factor in the formation of quartz in decomposed bedrock.

FORMATION OF CRYSTALS

Quartz is known to form and exist in many environments, but clear crystals can form only under certain physical conditions. The formation of quartz that is free of bubbles, inclusions, milkiness in its various forms, strains, and fractures is even more restricted. Yet regardless of these limitations, it is possible for such quartz to grow in various environments. R. B. Sosman (1927) has shown that low quartz is stable at atmospheric temperatures, as well as temperatures up to 573°C. He also has recorded the fact that low quartz has been deposited from water of a hot spring at a temperature ranging from 47°–51°C, and that quartz crystals have been found in cryptocrystalline silica that replaced wood whose fiber and structure were perfectly preserved. And Pardee and Park (1948, p. 49) have recorded the formation of crystals of quartz in open cavities from circulating ground water. Hence, quartz crystals may be formed throughout a wide temperature range.

Quartz may also develop within a considerable range of static pressure, but it is doubtful if untwinned crystals of quartz can form if they are subjected during their growth to much differential pressure, as in a mass of crystals that are growing from magma and mutually interfering with one another or in metamorphic rocks during their period of formation. It is certain that pressure which is applied differentially to crystals subsequent to their formation causes strains, gliding, and finally, rupture. It therefore follows that quartz suitable for oscillator plates and optical applications should grow either in open spaces, such as fissures, cavities, or vugs,

or in some medium incapable of transmitting stresses from one growing crystal to another and that such crystals should not be subjected to deformation after their formation. An environment of homogeneous pressure is therefore one of the indispensable conditions for the growth of untwinned crystals of quartz, and this condition is utilized at the Bell Telephone Laboratories and at other institutions where synthetic crystals of oscillator quartz are being prepared.

These conditions render unlikely the occurrence of oscillator quartz in the ancient quartz veins of this region, because such veins, regardless of their original character and modes of formation, have been greatly altered and recrystallized by diastrophism. It is true that nearly clear quartz has been found in large boulders of white vein quartz, on the farm of Ernest L. Bowman in Virginia, on the farm of John Coldiron in North Carolina, and elsewhere. But none of this material was found to qualify even as the lowest grade of oscillator quartz. It therefore seems certain that the old quartz veins may be disregarded as sources of oscillator quartz.

The origin of all the clear quartz formed in this region is not known, as it was found in hardrock at only a few localities. Three modes of formation, however, are considered possible. First, crystals of clear untwinned quartz may grow as primary fillings in fissures, solution cavities, or other open spaces; second, they may form in pegmatites as hypogene crystals of primary or secondary origin, particularly in vugs, though also in quartzose bands; and third they may develop as supergene crystals in any environment of low temperature and homogeneous pressure. The crystals of quartz described in this report are believed to have been formed mainly in saprolite under the third mode of formation; and in this environment, such crystals are designated as "pocket quartz." This term is also applied to crystals found in the soil, if the soil is believed to be essentially residual.

Definite examples of high-grade quartz that fills fissures or other cavities have not been seen in this region, though much quartz of this grade in other regions has originated in this manner. One of the well-known examples of crystals of quartz that grew in open cavities are those of western Arkansas, described by A. E. J. Engel (1946). These crystals are believed to have been deposited from ascending thermal solutions of magmatic or other origin. Two less well-known examples have been examined by the writer. The first comprises the numerous small crystals of clear quartz found on the north side of Chestnut Ridge, about a half mile east of Kunkletown, Monroe County, Pa. These have grown in numerous open fissures of the Oriskany sandstone, and many of the smaller of these crystals have

a high percentage of useableness. A second occurrence is at the Allentown State Hospital Farm, about half a mile southwest of Weaverville, Northampton County, Pa. Clear crystals of quartz have apparently been deposited here in solution cavities in the limestone country rock from aqueous supergene solutions.

Granular and porous vein quartz, as already noted, occurs commonly at many places in the Piedmont province of Virginia and North Carolina, southeast of the Blue Ridge. Clear quartz was seen at one locality intergrown with vein quartz of this kind, and at some places the two types of quartz are found together as residual material in the fields. The clear quartz found in this environment, however, has not proved to be of oscillator grade. Moreover, veins of this type are uncommon or absent in the Plateau province where most of the best quartz has been found. These veins postdate the general diastrophism of the country rock, but they do not appear to have constituted either a favorable or a general environment for the formation of oscillator quartz.

Clear quartz also occurs in vugs within or along the margins of pegmatite dikes, as at the Hiddenite mine, in Alexander County, N. C.; and the same type of quartz is also found as residual debris in the nearby fields, where its association with sheet mica and other pegmatitic minerals suggests its pegmatitic origin. Some of this quartz is unusually clear, but very little of it has proved to be of usable grade. At the Hiddenite mine for example, only 1 of 26 clear crystals which were picked from several hundred specimens, was found to be free of Brazil twinning.

Crystals of translucent to nearly clear quartz have been found in bands forming an integral part of some pegmatite dikes. A pegmatite of this type was seen about 2 miles southwest of Cashiers, in Jackson County, N. C. This dike, which is about 8 feet thick, consists largely of opaque white quartz, but narrow bands of feldspar, and of feldspar intergrown with quartz and mica, occur along the hanging wall and footwall. Within the main body of quartz are narrow bands of translucent to clear quartz that is ¼–3 inches thick, but none of this was found to be of salable grade; and in general, no quartz in this region that occurs as an integral part of pegmatitic dikes has been found to be either usable or salable.

Single crystals of clear or partly clear quartz, ranging from 5 to 200 pounds, have been found in soil and saprolite at numerous sites, but nests or pockets of smaller crystals are more common than are individual crystals. The larger crystals generally occur as single individuals with clear tips, which by cobbing may yield some salable quartz of low grade; but no crystals larger than 25 pounds have been

found to be entirely usable or salable. Smaller crystals that have been found in nests in saprolite or residual soil range from an ounce to 10 pounds and are commonly separated from one another by thin layers of clayey material. They generally show no preferred orientation, and from ⅓ to ⅔ of them are faced. Some are singly terminated, and a few are doubly terminated. Many of these crystals, particularly the unfaced ones, are spalled and surficially etched, showing the action of weathering and supergene solutions. Some etched crystals are so opaque that their transparency cannot be recognized until they are immersed in water, or better still in an oil bath.

Subsurface exploration that has a bearing upon the origin of oscillator quartz has been done at two principal localities: one on the farm of Clinton Jackson, in Carroll County, Va., and the other on the farm of T. L. Crouse, in Alleghany County, N. C. This work is described on p. 255–258 and 276–277. Many crystals were recovered from the soil and saprolite at both these sites, but at neither place were any veins, dikes, or other feeder channels found to be connected with individual crystals or with pockets of crystals. The same geologic environment has been observed in other exploratory pits and trenches, in roadcuts, and in the banks of gullies. These conditions will become more apparent in the following descriptions of quartz-bearing localities.

Practically all the high-grade and oscillator quartz found in this region occurs as residual debris in soil, in the underlying saprolite, or in the alluvium of nearby streams. Nowhere have such crystals been found in schistose and gneissic hardrock; and owing to environmental conditions heretofore specified, it is considered unlikely that they could have grown in such rocks and survived the process of regional metamorphism. Therefore, if such crystals existed in hardrock prior to its saprolitization, they must have occurred in veins or dikes that postdated the metamorphism. But crystals of oscillator grade have nowhere been found in this region in veins, either in hardrock or in saprolite; and only at Hiddenite has high-grade quartz been observed in pegmatitic vugs, and most of this was found not to be of oscillator grade. Finally, subsurface exploration and the examination of roadcuts and gullies show that the quartz actually identified in saprolite is not contiguous or connected with veins of quartz, dikes of pegmatite, or any other feeder channels. Therefore, the available field data lead the author to infer that these crystals of pocket quartz were never an integral part of the regional bedrock and that a hypothesis of magmatic or hydrothermal origin is untenable.

The character of the twinning in the pocket quartz of this region has some bearing upon the genesis. Dauphiné twinning in quartz is considered to be due to a molecular rearrangement, produced either by the inversion from high quartz to low quartz or by deformation after the crystals were formed. Clifford Frondel (1946), in fact, has described the development of such twinning as a result of sawing crystals in the preparation of oscillator plates. Brazil twinning, on the other hand, can readily develop as a result of changing conditions during growth, and at temperatures far below the inversion point. Dauphiné twinning appears to be uncommon in the quartz crystals of this region, though Brazil twinning is prevalent. The genesis cannot be proved by the nature of the twinning, but the conditions cited above are consonant with an origin at low temperature, with little or no deformation of the quartz after its formation.

The difficulty of explaining these crystals of quartz as original constituents of the country rock is obviated by a different genetic interpretation. The metamorphic and igneous rocks contain silicates, notably the feldspars, that are readily decomposed in the zone of weathering. As these are broken down, they lose by solution some of their original elements and become a porous and readily compressibly mass of saprolite. Hence, a favorable environment is created wherein crystals could make room for themselves and in so doing be subjected only to a homogeneous static pressure. The saprolite, lying between the soil and the underlying hardrock, thus appears to have been the most probable environment in which crystals of pocket quartz could have originated; and such crystals are believed to have grown in the lower zones of saprolite during or after its formation under conditions of temperature and pressure that were approximately atmospheric.

Saprolite is, however, present everywhere, and certain other conditions must have existed to produce the localization of quartz in the areas described in this report. These favorable conditions are unknown, but a possibility exists that the formation of crystals may have been related to the presence of warm or hot springs. Thus, the carriers of the silica could have been warm aqueous solutions that circulated locally in an ancient water table, or they could have been warmer solutions coming directly and entirely from hot springs. In this connection, it is noteworthy that the largest quartz crystal of oscillator-grade 16 so far found in North America came from the vicinity of Shatley Springs. N. C. Deposits of quartz may still be forming in the lower zones of the saprolite of this region, but this inference is somewhat doubtful.

The source of the silica and its mode of transference by solutions is less well understood. Laboratory experiments have shown that quartz has an exceedingly low solubility in water throughout a considerable range in temperature. It is doubtful, therefore, that the supergene solutions obtained their silica from older deposits of quartz, such as vein quartz in the country rock. More probably the silica was taken into solution in the decomposition of the silicates of the bedrock. But as the solubility of silica in water is small, it is inferred either that the ground-water solutions contained other elements that increased the solubility of the silica or that the silica may have been held in some different form, possibly as a colloid.

RESIDUAL CONCENTRATION

Residual accumulation and concentration of rocks and minerals at the surface is an important process in the Southeastern States. For such surficial accumulation, a rock or mineral must be less subject to alteration and decomposition than the other rocks and minerals with which it is intergrown. High specific gravity adds to the effectiveness of this process but is by no means necessary.

Quartz is one of the most indestructible minerals in nature, and where many veins or pockets of quartz are present in the country rock, this mineral is concentrated in the soil at or near the surface of the ground. Weathering and erosion, regardless of its speed, are continuous and immutable. The bedrock disintegrates into its component mineral grains; and some of these, particularly the silicates, are decomposed to other minerals. Subsequently, this material becomes a part of the soil and ultimately is bared to erosion. By surface waters and creep, the smaller mineral grains migrate down the slopes into the valley floor; and some of them are also taken into partial solution, thus aiding in their removal. Vein, pocket, and pegmatitic quartz, weather into large pieces and therefore accumulate on the tops and sides of the hills. The quartz crystals that occur in so many ploughed fields have thus been concentrated from earlier deposits in saprolite; and along with them is commonly a larger volume of white vein quartz that originated in hardrock but later became a part of the saprolite.

The presence of a well-defined accumulation of quartz crystals at the upper surface of the soil is not necessarily an indication that more of the same material may be found at the same site by digging. Most of the deposits of clear pocket quartz are small, and at few places do several such pockets lie close to one another. Hence the presence of a well-defined area or streak of quartz crystals at one

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spot, resulting from residual accumulation, is almost prima facie evidence that additional crystals will not be obtained by subsurficial exploration at this exact site. A nearby random site, within the general area where quartz appears at the surface, may be equally or more favorable. Prospecting within general areas where quartz shows at the surface has tended to confirm this thesis. Moreover, many random holes, trenches, and roadcuts, excavated where no quartz was present at the surface of the ground, have exposed large crystals or pockets of smaller ones.

Vein quartz and quartz crystals resulting from residual accumulation constitute a relatively large volume of quartz derived from bedrock that has been completely eroded, and a much smaller proportion of quartz that is currently being released from the underlying saprolite. Digging or plowing in a tract where surficial quartz is plentiful will generally reveal that the tenor of the soil in quartz decreases with depth, at first slowly, but within a few feet of the surface rather rapidly, and at a depth of several feet the white quartz is likely to disappear entirely unless the saprolite overlies a vein of the older quartz. From this condition it is inferred that most of the quartz in the soil originated in rocks that have been completely removed by erosion, and it further follows that only shallow excavations are likely to be productive of quartz crystals.

QUALITY OF QUARTZ CRYSTALS

The National Bureau of Standards, at the time of this investigation [1943–44], classified quartz crystals into 3 principal and 20 subordinate salable grades. Grade 1 material consisted of clear uncolored quartz in which the usable part was free of all defects that could be detected in an oil bath, both under the illumination of an arc light and under polarized light. Defects comprise inclusions, bubbles, veils, milkiness in its various forms, fractures of all kinds, and "optical" (Brazil) twinning. Crystals of grade 1, weighing 200 grams or more, were divided into 3 classes, depending upon their degrees of usability, the ranges being 30–45, 45–60, and 60–100 percent usability—these were designated as classes 13, 14, and 16. Crystals of grade 1, weighing 500 grams or more, were called optical quartz. Grade 1 quartz was further subdivided into faced and unfaced crystals, and faced crystals weighing between 100 and 200 grams were given a special rating, depending upon the ratio of crystal length to width.

Grade 2 material was similar to quartz of grade 1, except that it included smoky and amber-colored quartz and allowed certain imper-

fections, such as minute blue needles and specks, color phantoms, and the Tyndall effect. The subclassification of grade 2 quartz was similiar to that of grade 1 quartz, except that it included no optical quartz.

Grade 3 material included quartz of grades 1 and 2 that was less than 30 percent usable, and all optically twinned quartz that otherwise would qualify as grades 1 or 2. Crystals of grade 3 that were less than 45 percent usable were designated as grade 30 and were not salable; those having a usability in excess of 45 percent were designated as grade 34 and were salable. Later, grade 3 quartz was considered salable only if it had a usability in excess of 60 percent, in which case it was rated as grade 36. The rating 34 was in use at the time this work was done, and therefore this symbol is used in all but one of the descriptions of salable quartz of grade 3. Crystals that weighed less than one-half of a pound (200 grams) were not generally tested by the National Bureau of Standards and were described merely by the symbol BG, meaning below grade. A distinction was drawn between usable and salable quartz. Thus, quartz of grade 34 was bought by the Metals Reserve Corporation, but little of it was ever cut. Instead, it was stockpiled for use in an emergency, if quartz of better grade could not be obtained. Under such a contingency, a small percentage of high-grade quartz could have been obtained from such material by careful cobbing. Thus, grade 34 quartz was salable but not generally usable.

Another imperfection of quartz crystals is Dauphiné twinning, otherwise known as "electrical twinning." Intergrowths of this type, unlike the intricate Brazil twinning, occur commonly as volumes of fair size and regularity, so that by careful selection and cutting, a large part of such crystals could be used. This condition, however, is not universal, as crystals have been seen by the writer in which Dauphiné twinning occurred as intergrowths as small and intricate as any of the Brazilian type. Partly because of the general character of the electrical twinning and partly because it is not recognizable by the conventional optical tests, no penalty was exacted against Dauphiné twinning in the purchase of quartz. Quartz has been shown by H. R. Gault (1949) to be twinned by four other laws (called the Japanese, Esterel, Sardinian, and Breithaupt laws), but these are relatively rare and are of greater crystallographic than economic interest.

The grades of quartz that were in effect at the time this work was done and on which the value of the quartz was determined by the Metals Reserve Corporation are shown below.

Classification of oscillator quartz

Grade	Weight, 200 grams or more Usability (percent)			Weight, 100–200 grams Usability (45–100 percent)	
	30–45	45–60	60–100	Longs	Shorts
1, faced	13–F	14–F	16–F	14–L	14–S
1, unfaced	13–U	14–U	16–U	----	----
2, faced	23–F	24–F	26–F	24–L	24–S
2, unfaced	23–U	24–U	26–U	----	----
3, faced	----	34–F	36–F	----	----
3, unfaced	----	34–U	36–U	----	----

High-frequency oscillators during World War II were cut to diameters of 10–25 millimeters, but still larger plates were required for special purposes. The thickness of these plates ranged from a millimeter to a fraction thereof. Plates of this size had to be cut from homogeneous quartz that was free of twinning and all other imperfections. For this reason quartz of grades 1 and 2 was used mainly for cutting oscillator plates. If smaller oscillator plates could have been used, larger amounts of quartz of grade 3 could have been utilized. Even at the time of World War II, the Western Electric Co. cut plates on an experimental basis as small as one-eighth inch square and found that they functioned satisfactorily though the utilization of these smaller plates gave rise to other difficulties, such as the need for higher amplification in electronic circuits. Such difficulties, however, were overcome by improvements in tubes and the use of smaller plates is now commonplace.

The record of all the quartz that was submitted for testing from Virginia and North Carolina, the amounts that were accepted and purchased, and other statistical data are given in the following tabulation.

Statistical analysis of quartz production

	Virginia	*North Carolina*
Total quartz submitted for testing, lb	1, 156. 70	1, 656. 68
Total purchases of grade 1 quartz, lb	6. 28	25. 01
Total purchases of grade 2 quartz, lb	10. 90	46. 85
Total purchases of grade 3 quartz, lb	134. 99	165. 03
Percentage of grade 1 quartz, of total submitted, percent	0. 54	1. 51
Percentage of grade 2 quartz, of total submitted, do	0. 94	2. 83
Percentage of grade 3 quartz, of total submitted, do	11. 66	9. 96
Percentage of grade 1 quartz, of salable quartz, do	4. 13	10. 56
Percentage of grade 2 quartz, of salable quartz, do	7. 16	19. 77
Percentage of grade 3 quartz, of salable quartz, do	88. 71	69. 67
Total value of grade 1 quartz	$54. 89	$315. 35

Statistical analysis of quartz production—Continued

	Virginia	North Carolina
Total value of grade 2 quartz	$110. 83	$291. 57
Total value of grade 3 quartz	$664. 98	$914. 61
Total value of all salable quartz	$830. 70	$1, 521. 53
Percentage, by value, of grade 1 quartz, percent	6. 61	20. 73
Percentage, by value, of grade 2 quartz, do	13. 34	19. 16
Percentage, by value, of grade 3 quartz, do	80. 05	60. 11

Oscillator quartz was produced in the United States during World War II from only two general localities, western Arkansas and the Southeastern Atlantic States. A. E. J. Engel (1946) and the writer submitted many samples of quartz to the National Bureau of Standards for testing; and although the data in the files of the Geological Survey are incomplete, the following tabulation gives a rough comparison of the crystals from these two regions.

Comparison of quartz crystals, Southeastern States and western Arkansas

	Southeastern States	Arkansas
Total quartz submitted for testing, lb	2, 813. 38	4, 084. 22
Total salable quartz, lb	389. 06	3, 006. 94
Salable quartz of grade 1, percent	7. 9	14. 3
Salable quartz of grade 2, do	14. 6	14. 0
Salable quartz of grade 3, do	77. 5	71. 7

The comparative quality of the quartz cannot be judged by the first and second lines of this tabulation, because the degree of perfection of the material submitted, as gauged by the unaided eye, was dissimilar for the two areas. Many large crystals, for example, were submitted from Virginia and North Carolina that were obviously useless, except for tips, rims, or centers that appeared to be clear. Engel, on the other hand, appears to have submitted no crystals that were less than 75 percent "eyeclear." Of the usable and salable quartz from both areas, the percentages appear to be of the same general order of magnitude. The production of oscillator quartz from Arkansas, however, far exceeded that from the Southeastern States, so that the southern quartz may be said to be much scarcer, yet little inferior in grade to that of Arkansas.

POTENTIAL PRODUCTION

Much, if not most, of the clear quartz in the Plateau and Piedmont provinces of southwestern Virginia and western North Carolina is believed to have originated as pocket quartz. Such quartz is very irregularly distributed. The occurrence of a considerable volume of residual quartz at any one site does not indicate necessarily that deposits of the same kind will be found directly below the surface, and many pockets of quartz crystals have been found accidentally at

places where few or no crystals had previously been found at the surface. These facts imply that dependable indications of the exact locations of pocket quartz are not available. Nevertheless, the occurrence of many crystals of quartz in a field, and especially the occurrence of numerous localized deposits of crystals close to one another, constitute evidence that other deposits of the same kind may possibly be found in the same general neighborhood, though not necessarily at sites which can be accurately predetermined. Hence, prospecting for pocket quartz is a highly speculative enterprise; and if it becomes necessary, prospecting should be restricted to sites where quartz crystals are known to be strongly localized.

The need for quartz was made known to the farmers of Virginia and North Carolina for more than a year. To increase production, advertising publicity, personal visits, and the opportunity for profit were all tried; yet, comparatively little quartz was produced. The reasons for the small production are not hard to understand. A farmer will not hesitate to excavate a single pit, or several pits, on his property, if he is likely to obtain commercial mica that can readily be sold to some nearby governmental agency. But he obtains most of his quartz in small quantities by picking it up in plowed fields; and the packing and shipment of such material, together with the writing of a proper letter of transmittal to the National Bureau of Standards, was regarded by most farmers as a troublesome task that was likely to yield small returns. If he did make one shipment and the material proved not to be salable, he generally made no further shipments.

A still stronger deterrent exists. Farmers are practical men, and their own experience in digging for quartz soon teaches them, without any specialized geological advice, that hunting for crystals of pocket quartz is similar to hunting for a needle in a haystack. The work expended is not likely to pay for the results achieved. Furthermore, few farmers are willing to give the Government or any private agency a contract to hunt for quartz in their fields, for they know that the discoverey of any considerable volume of quartz may require so much digging that their soil will be permanently injured. They know, in other words, that the injury to their fields may far exceed the value of the quartz that may be found; and if none is found, they have no compensation whatever.

A great deal of the residual quartz that is readily obtainable has already been recovered from the fields, and sold, either to the Government, or to private laboratories and collectors. Moreover, it is unlikely that any serious efforts will be made, under present conditions, to recover quartz by subsurface operations. Finally, there is the com-

petition of Brazilian quartz, of which an adequate supply now seems to be available. Most of the southern quartz is of low grade; but if new processing techniques should develop a demand for quartz of this grade, material of similar quality now discarded in Brazil could be shipped to the United States more cheaply, and certainly in much greater volume, than any production from the Southeastern States. The outlook, therefore, both in regard to reserves and production, is unfavorable.

Another economic factor has developed in recent years. Quartz crystals are now being grown successfully in a number of laboratories, as for example at the Bell Telephone Laboratories. The process is slow, but if the equipment is multiplied sufficiently, a considerable volume of high-grade quartz may thus be produced, so that in the future less dependance will be placed upon natural crystals. High-grade seed quartz, however, is needed for such synthetic production; and the small high-grade crystals from the locality near Kunkletown, Pa., might be utilized for this purpose.

DEPOSITS OF SOUTHWESTERN VIRGINIA

The principal quartz deposits of Virginia occur on the plateau that forms the northwestern flank of the Blue Ridge. Fifty-six localities on this plateau were visited in Carroll, Floyd, Patrick, and Pulaski Counties, of which 41 are shown in figure 7; but only 17 are sufficiently significant to merit description. The writer also visited 23 other localities of which some were on the Plateau in Grayson, Smyth, Washington, and Wythe Counties; others are in the Piedmont province in Albemarle, Buckingham, Campbell, Henry, Loudoun, Nelson, and Pittsylvania Counties. None of these sites contain quartz crystals of any importance.

CARROLL COUNTY

MARVIN MARSHALL FARM AND VICINITY

LOCATION

The Marvin Marshall farm, about a mile northwest of the settlement of Laurel Fork, is described because it is one of the sites where considerable quartz was found in a small area. About half a mile west of Laurel Fork, an unpaved road leads northward from U. S. Highway 58 down the valley of Valls Creek, a tributary of Laurel Fork. The home of Marvin Marshall is on the west side of this road, about three quarters of a mile from Highway 58; and the principal quartz-bearing field of the Marshall farm lies about 1,800 feet northwest of his home.

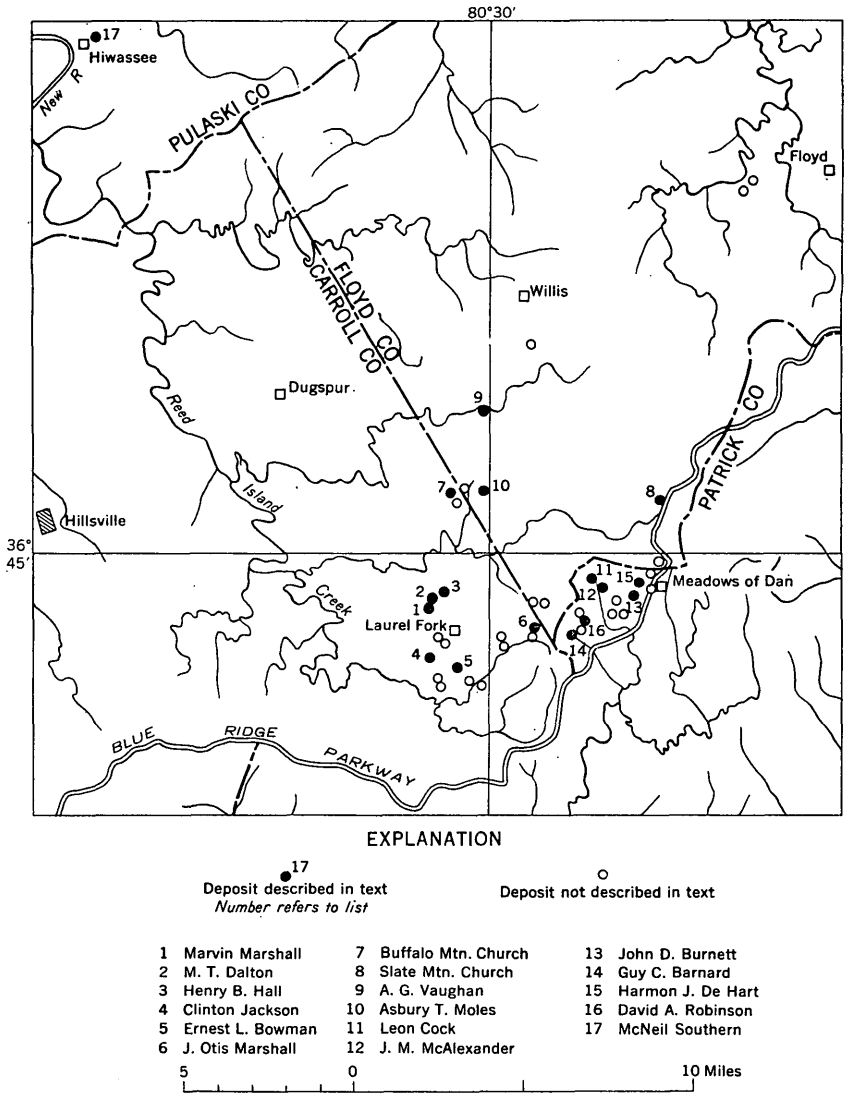

FIGURE 7.—Quartz crystal deposits of Carroll, Floyd, Patrick, and Pulaski Counties, Va.

OCCURRENCE

This field is along a divide between two forks of Valls Creek and slopes gently westward. It is about 650 feet long, from north to south, and has a width of about 400 feet. Residual quartz is distributed mainly in 4 streaks that trend N. 75° E., widening down the slope of the field. These streaks were not mapped, but by pacing from the south end of the field northward, they are approximately as follows:

South side of field

Feet	
0–200	Barren zone.
200–210	Narrow, poorly defined, streak of quartz.
210–290	Barren zone.
290–320	Widest, and most clearly defined, streak of quartz.
320–430	Barren zone.
430–445	Narrow, but fairly well defined, streak of quartz.
445–525	Barren zone.
525–550	Wide, and moderately well defined, streak of quartz.

Quartz may be found almost anywhere in this field, so that the designation "barren zone" is used in a relative sense. The 30-foot streak, which begins about 290 feet from the south end of the field, contains the largest volume of clear quartz but not necessarily the largest or best crystals. The writer dug 2 holes, about 50 feet apart along the trend of this streak near its eastern end, where the concentration of the quartz is greatest. Both holes reached saprolitic bedrock at a depth of 2 feet, but they exposed no clear quartz either in the soil or in the underlying saprolite though some white quartz was found in the soil. Such work was inadequate for determining the number and character of the quartz veins that may be present, but the available data suggests that much of the quartz at the surface has accumulated as residual material from deposits of saprolite that have been completely eroded. The bedrock is either hornblende schist or amphibolite, which is weathered to a sticky yellow clay.

A tract of land, covered by second-growth pine and sloping toward Valls Creek, is east-northeast of the field above described. This was cultivated 75 years ago, but the surface is now covered by moss and pine needles, so that small fragments of rocks are not visible. It was stated by Mr. Marshall that crystals of clear quartz were formerly found here; and the presence of many residual boulders and cobbles of white quartz, similar to those found with the clear quartz in the open field to the southwest, appears to indicate another residual accumulation of quartz.

Crystals have also been found east-northeast of this pine grove, along the southwest side of a small field at the junction of the western valley wall and valley floor of Valls Creek. At this site much white quartz is visible on the surface of the ground, and one crystal of clear quartz was found by M. T. Dalton, who lives nearby. Another crystal was found by Mr. Dalton northeast of Valls Creek, and still farther to the east and northeast are other crystal-bearing areas.

CHARACTER OF QUARTZ

White and clear quartz occur in streaks on the Marvin Marshall farm. The white quartz is similar to the quartz found as veins and

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lenses in the metamorphic country rocks of this and other regions. The clear quartz appears not to be intergrown with or attached to the white quartz, though the two types occur together in the same residual zones.

About 50 crystals of quartz were collected from the farm of Marvin Marshall by the writer. Most of these crystals came from the widest streak, but some clear specimens were also found in the other zones. Twenty-six of these were transmitted to the National Bureau of Standards, and 9 crystals with a total weight of 9.70 pounds proved to be of grade 34. The maximum and minimum weights of the salable crystals were, respectively, 2.24 and 0.40 pounds, and the mean weight was 1.04 pounds. Of these crystals 5 were unfaced, and 4 of these were surficially etched.

The 2 crystals found by Mr. Dalton on the west and east side of Valls Creek weighed 1.17 and 1.70 pounds and were rated, respectively as grades 34–F and 34–U.

HENRY B. HALL FARM

LOCATION

The farmhouse of Henry B. Hall is about 3,000 feet northeast of the principal quartz-bearing field on the Marvin Marshall farm. This tract, like the Marshall farm, contained considerable clear quartz. The property is reached by following a stone road northward from Laurel Fork about a mile and a half and turning thence westward on an unsurfaced road to the farm.

OCCURRENCE

This property was examined in the spring of 1943 by E. W. Heinrich; additional samples of the quartz were obtained by the writer from Mr. Hall and from a prospective purchaser of the farm, Mr. G. E. Musgrove. Clear quartz occurs in two principal areas—one southeast of the farmhouse, and the other to the northwest. White vein quartz is plentiful both in these areas and elsewhere on this and adjoining farms. Apparently the white quartz occurs in short discontinuous veins and lenses, one of which, about 1,000 feet west of the house, has a strike of N. 60° E., transecting the foliation of the schist. No clear quartz was seen in or attached to the white vein quartz.

CHARACTER OF QUARTZ

Twenty-three samples of quartz, with a total weight of 13.50 pounds, supplied by Mr. Hall, were transmitted to the National Bureau of Standards. None was found to be usable. Seven other crystals, however, were donated by Mr. Musgrove, and five of these were found to be usable or salable. The data on the salable crystals follows:

Weight (lb)	Grade	Weight (lb)	Grade
0.86	24–F	1.37	24–F
2.93	34–F	1.43	34–U
.72	34–F		

CLINTON JACKSON FARM

LOCATION AND INVESTIGATION

The quartz deposits on the Clinton Jackson farm are about a mile southwest of Laurel Fork. The Clinton Jackson farmhouse, to the northwest of these deposits, is reached by an unpaved road, 3,000 feet in length, that extends southward from a point on U. S. Highway 58 about two-thirds of a mile west of Laurel Fork.

A sketch map of these deposits was prepared by E. W. Heinrich and J. J. Norton in March 1943. Heinrich recommended that subsurface exploration of these deposits be undertaken as a strategic minerals project, and this work was done by J. E. Bell and R. C. Hickman (1950), of the U. S. Bureau of Mines. Mr. Hickman selected the sites for prospecting, and directed the excavation. The exploration comprised 61 test pits 4 feet wide, 5 feet long, and 4–7 feet deep; a few of these were elongated to trenches. The writer examined most of these pits and trenches while the work was in progress.

SUBSURFACE EXPLORATION

Quartz crystals are shown in figure 8 to be concentrated in eight principal areas, whose major axis are highly variable. These diverse trends are believed to be unrelated to the structure of the underlying country rock; instead they probably are determined by the surficial configuration of the ground, which controlled the movement of eluvial material.

The exploratory work revealed different stratigraphic sections. The soil ranges in thickness from 1 to 4 feet and is underlain by an undetermined thickness of saprolite derived from mica schist and gneiss. No hardrock was observed, except some veins of opaque white quartz. The foliation of the saprolitic country rock dips generally from 30° to 60° southeastward. Some of the quartz veins are parallel with the foliation; others transect it.

Opaque white quartz was found in two environments in these test pits. Most of it occurs in the soil, derived from quartz veins that existed originally in saprolite at higher altitudes and have been completely eroded. Quartz veins and stringers in saprolite, however, were exposed in several holes. Thus in area D, some thin stringers of quartz were found in several pits; and in hole 12, a vein of white quartz, striking N. 45° W. and dipping 70° SW., was uncovered. A nearly horizontal vein of white quartz about 1 foot thick was exposed in hole 23, and a vein of white quartz from 2 to 3 feet thick

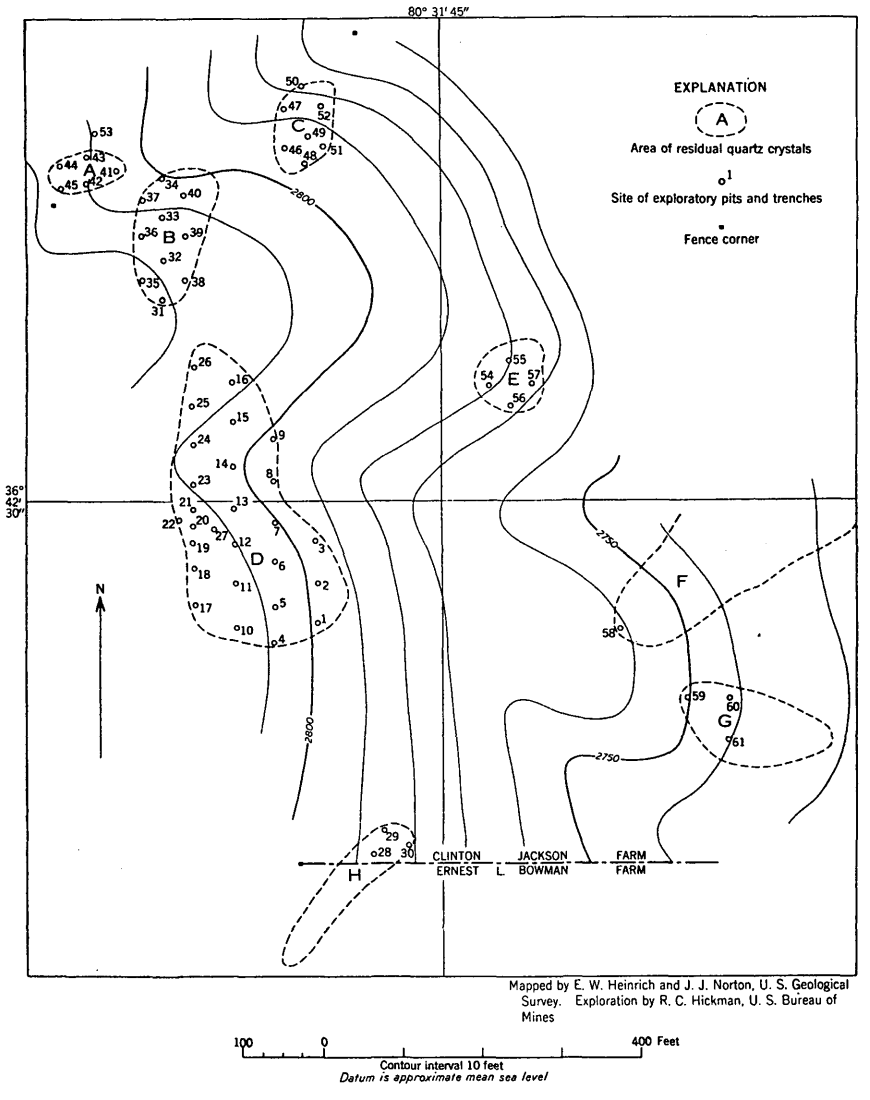

FIGURE 8.—Map showing areas of residual quartz crystals on Clinton Jackson farm, Carroll County, Va.

and striking N. 65° E. and dipping 45° N. was seen in hole 43. No clear crystals of quartz were found in or along the sides of any of these veins of opaque white quartz.

Quartz crystals were recovered from the soil in several test pits, and one pocket of crystals was found in saprolite. Area D yielded the largest number and best grade of crystals. Seven crystals of quartz suitable for testing (total weight 3.9 pounds) and 13.5 pounds of opaque white crystals were recovered from holes 6 and 7. Hole 20

exposed 3 feet of soil, in the upper 20 inches of which a nest of crystals was found. These comprised 19 clear or partly clear crystals with a total weight of about 24 pounds and 82 milky and opaque white ones with a total weight of 33.5 pounds. The clear and partly clear quartz included 1 large unfaced 4-pound crystal that was broken in two by the pick, small faced crystals that were clear but smoky, and some still smaller unfaced ones. About 2 dozen crystals of quartz were also found in hole 23. The largest of these had a length of 6 inches, and the others were faced crystals of smaller size, of which none was clear enough to merit testing.

The smallest mapped area, called area A, is about 250 feet north-northwest of area D. Here the soil ranged in thickness from 12 to 18 inches and contained no quartz crystals, but in the underlying saprolitic schist a nest of clear and partly clear crystals weighing about 32 pounds was uncovered in the center of pit 43. Within a foot of this pocket of crystals, but not in contact with it, was the vein of white quartz earlier described. Many of these were singly terminated crystals ranging in length from 1 to 5 inches, though a few larger unfaced crystals were as much as 8 inches long. Most of these crystals were milky, and the few that were clear were smoky, with many bubbles, veils, and fractures. None was found to be salable. Pit 43 was extended as a trench to expose fully the vein of white quartz, but no crystals of quartz were found along its contact with the contiguous saprolite.

CHARACTER OF QUARTZ

Twenty-four crystals, with an aggregate weight of 34.32 pounds, were selected from the quartz recovered in these operations and transmitted to the National Bureau of Standards. Most of these came from pit 20, but the shipment included a few crystals from pits 6 and 7; two other crystals with an aggregate weight of 4.34 pounds that were found elsewhere on the farm are not listed below. Only 2 of the 24 crystals submitted were salable, and both of these were of grade 34–F. The results of this examination are shown herewith.

Quartz crystals from Clinton Jackson farm

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
5.93	30–F	2.97	34–F
5.59	30–F	.42	BG
.93	30–F	.90	30–U
3.10	30–U	.72	30–U
1.26	30–F	.55	30–U
1.05	30–F	1.47	30–U
1.78	30–F	.86	30–F
.77	30–U	.69	34–F
.95	30–U	1.11	30–F
1.00	30–U	.38	BG
.39	BG	.77	30–F
.43	BG	.30	BG

RESULTS OF EXPLORATION

This subsurface exploration has proved the fallacy of certain inferences regarding the surficial distribution and genesis of quartz and has suggested others that have a general application in Virginia and North Carolina. The points worthy of emphasis are the following:

1. The occurrence of streaks or other concentrations of quartz at the surface of the ground does not necessarily indicate that the sources of this material lie directly beneath the surface; on the contrary, such concentrations are more likely to be mainly residual accumulations from preexisting sources that have been completely eroded.
2. The linear elongations of such streaks of surficial quartz do not necessarily indicate the trend of present or preexisting veins or dikes; for surficial creep is a factor of importance in all residual accumulations, even where little relief is apparent at the present surface.
3. Clear crystals of quartz, particularly faced or singly terminated crystals, do not necessarily originate only in open veins, vugs, solution cavities, or other openings in bedrock. They may also originate in any medium that exerts a small but homogeneous pressure on the growing crystal. Bedrock decomposed by weathering provides such a suitable environment.
4. The presence of many quartz veins, or of a large volume of residual vein quartz, of the type commonly found in ancient metamorphic rocks, is not an indication that clear quartz of oscillator grade is likely to be present in any particular area. More residual white quartz exists in the fields of Floyd County than in Carroll County, or any other nearby counties; yet comparatively few crystals of highgrade quartz have been found in Floyd County.

ERNEST L. BOWMAN FARM

LOCATION

The Ernest L. Bowman farm is about a mile south of Laurel Fork and about one-fourth of a mile southeast of the Clinton Jackson deposits. The field in which the quartz crystals occur is about 1,600 feet southwest of the Bowman farmhouse.

OCCURRENCE

The quartz-bearing area is an irregularly shaped field about 750 by 480 feet; the major dimension trends N. 30° W. In the southeastern end of this field is a rounded area of about 1¼ acres, where considerable clear quartz has been found. At least 6 large masses of white vein quartz, mainly residual boulders, also show in this area. One boulder,

measuring 3½ by 2½ feet on its upper surface, showed traces of clear quartz and was broken in search for more material of the same sort. Some translucent quartz was found, but no significant quantity of clear quartz was discovered.

A second area of about one-fourth of an acre is a short distance north of the first, and the two may in fact be continuous. No boulders of residual white vein quartz occur here, but one of the best crystals so far found on the farm came from this site.

CHARACTER OF QUARTZ

More than 100 crystals, with an aggregate weight of about 75 pounds, have been collected by the Bowman family, mainly from the first locality. Eighteen of these, ranging in size from 0.23 to 4.55 pounds, were selected and transmitted to the National Bureau of Standards. Most of them were unfaced, and none was singly terminated, but five of them showed two or more prismatic or rhombohedral faces, suitable for orientation. Three of these crystals, weighting 3.50, 2.00, and 0.84 pounds, were rated, respectively, as grades 34–F, 34–U, and 34–F; but no quartz of grades 1 or 2 was found.

J. OTIS MARSHALL FARM

The farm of J. Otis Marshall is about 2½ miles east of Laurel Fork. Clear quartz has been found at 2 places on this farm, 1 of which is in the low cut bank bordering a small stream, about 200 yards south of the farm house. At this site a crystal found in saprolite measured 9½ by 5 by 5 inches and had remnants of 3 prismatic faces. This specimen weighed 10.19 pounds and was rated by the National Bureau of Standards as grade 34–F. Little or no white vein quartz is present in this vicinity, and none occurs in contact with or near the crystal. The second locality was not examined.

BUFFALO MOUNTAIN AND SLATE MOUNTAIN CHURCHES

LOCATION

The Buffalo Mountain Presbyterian Church is in Carroll County about 5¾ miles S. 61° E. from Dugspur and near the boundary line between Carroll and Floyd Counties. The Slate Mountain Presbyterian Church is in Floyd County, about 2½ miles north of Meadows of Dan and close to the boundary line between Floyd and Patrick Counties. It is about 7¼ miles east of the Buffalo Mountain Church.

OCCURRENCE AND CHARACTER OF QUARTZ

The walls of both these churches are built mainly of white vein quartz gathered from the surrounding fields, and some clear or partly

clear crystals of quartz contributed by church members have been cemented into the front walls. About a dozen such crystals are cemented in the wall of the Buffalo Mountain Church; and 1 of these, a singly terminated crystal 15 inches long and 6 inches wide, is embedded in a horizontal position in the wall, to the left of the door. Only the extreme tip of this crystal appears to be clear and flawless. Directly over the door is another crystal, about 8 by 5 inches, that appears to the eye to be clear and free of flaws.

About 2 dozen clear or partly clear crystals of quartz are cemented in the front wall of the Slate Mountain Church on both sides of the door. Close to the east side of the door are 2 nearly clear crystals that measure 8½ by 7 and 8 by 7 inches, and a large clear crystal has been placed high in the wall on this same side. West of the door are 2 clear singly terminated crystals, each measuring about 4 by 3 inches.

These buildings are of interest mainly because they exhibit some clear quartz from nearby fields. The areas around both these churches, however, were investigated by the writer, with the result that clear quartz was found to be relatively scarce and of low grade. In fact, the small number of the crystals in the churches tends to corroborate the scarcity, for if such quartz had been at all plentiful, the members of these churches would probably have contributed more of it. The fields around the Buffalo Mountain Church are strewn for miles with large and small boulders of white vein quartz, some of which is rutilated; but the presence of that kind of quartz appears to have little significance and indicates no direct relationship to the occurrence of clear quartz. The same statement applies to all of Floyd County, where more white vein quartz is probably visible than in any other county in Virginia.

FLOYD COUNTY

A. G. VAUGHAN FARM

LOCATION

The farm of A. G. Vaughn is in the valley of Burks Fork, about 6¾ miles north and about a mile east of Laurel Fork. In regard to quartz recovered or available, this locality does not merit mention; but from the standpoint of crystal genesis, it has considerable significance.

OCCURRENCE AND CHARACTER OF QUARTZ

Clear quartz was found originally as float along the south side of Burks Fork, but by digging in the vicinity of the float, crystals were found in place. The bedrock is a mica schist, the foliation of which

dips 30° southward. The schist is decomposed and softened by weathering, and no quartz veins are present in the vicinity of the deposit. Clear crystals of quartz occur in a seam of clay 2–3 inches thick that parallels the foliation of the bedrock and was evidently an argillaceous band in the schist. This clay was studded with small closely packed singly terminated crystals of quartz that were separated from one another by thin layers of clay. A few doubly terminated crystals were also found. Many of the crystals in the clay have their optic axes in a nearly horizontal position. Most of them are transparent, but nearly all are smoky and have inclusions and fractures. The largest crystal had a length of 3 inches. None was found to be salable.

The character and mode of formation of these crystals lead to the belief that they did not grow in the hardrock at the time of its formation. They were formed, therefore, either as secondary minerals in the schist or as secondary minerals in the saprolitic clay that developed from schist. Theoretically, either origin is possible, but it seems more probable that these crystals grew in clay than in hardrock.

ASBURY T. MOLES FARM

The farm of Asbury T. Moles, about a mile east of the Buffalo Mountain church, probably typifies the occurrence of much of the quartz in this general vicinity. Many milky and clear crystals of quartz have been found in an area about 200 by 100 feet just east of the farmhouse. The field that includes this area has not been ploughed for several years, and most of the crystals exposed at the last ploughing are known to have been picked up; nevertheless, the number that remain indicates that considerable quartz occurs at this site. Three crystals from this field, which were given to the writer by Mr. Moles, were transmitted to the National Bureau of Standards. The largest of these measured 4¼ by 2¼ inches, had 6 prismatic and rhombohedral faces, and was quite clear. Another crystal measured 4 by 2½ inches; and the third was still smaller. The first two of these were rated as grade 34–F quartz; the third weighed less than half a pound and was not tested.

RIDGE AREA

Outstanding examples of crystals that were found as isolated units, or nests, occur in an area that is known as the Ridge, which is an upland belt of undefined length and about 1½ miles wides trending east-northeastward. This belt is intersected by Highway 58, about 5½ miles east of Laurel Fork and about 1.3 miles west of the Blue Ridge Parkway. Numerous crystals of clear quartz have been found in

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saprolite and residual soil along the "Ridge." Examples of the quartz are those later tabulated under the names of Leon Cock and J. M. McAlexander in the section on "miscellaneous sources in Virginia." This belt is characterized by few veins of white quartz, and the clear crystals appear not to be related to quartz veins.

The largest of these crystals is reported to have weighed 200 pounds. A smaller singly terminated crystal that measured 18 by 14 by 14 inches and weighed 124.9 pounds was found in the roadcut of Highway 58 just west of the Blue Ridge Parkway. John D. Burnett, owner of this crystal, consigned it to the writer, who submitted it to the National Bureau of Standards. When cobbed, however, it yielded only 3 small pieces of salable grade. One of these weighed 1.04 pounds and was rated as grade 34–F, and each of the other two pieces weighed 0.58 pound and was rated as grade 34–U. Generally these larger crystals of pocket quartz, even if they are clear, have so much Brazil twinning and other imperfections that they have little value as oscillator quartz.

PATRICK COUNTY

GUY C. BARNARD FARM

LOCATION AND OCCURRENCE

The Guy G. Barnard farm is about 3¾ miles east and a mile south of Laurel Fork, Carroll County. The farmhouse is on the south side of a secondary road that leads westward from the Blue Ridge Parkway and is about 2½ miles southwest of the intersection of Highway 58 with the Parkway.

The Barnard farm is mentioned particularly because it was one of the few localities in southwestern Virginia where quartz of grade 1 was found. Clear quartz was found at two adjacent sites. One of these is an area about 20 feet square in a field about 500 feet N. 10° W. of the farmhouse. Here, after the ground is freshly ploughed, clear quartz is said by Mr. Barnard to be plentiful on the surface of the ground. A second site, about 50 yards to the west, is a brush-covered field, where crystals are few and scattered; but here at least one crystal of high-grade quartz was found.

CHARACTER OF QUARTZ

About 50 crystals, ranging in weight from ¼ to 10 pounds, were collected by the Barnard family from these 2 localities. Some of these were faced, and others unfaced, but nearly all were milky, fractured, or had bubbles and inclusions. Of these crystals 5, including 2 that weighed about a pound each, were transmitted to the National Bureau of Standards. Of the 5, 4 were unfaced, but 1 showed

traces of 4 rhombohedral faces. This crystal, weighing 0.99 pound, was found to be of the highest oscillator quality, grade 16–F. One other crystal, unfaced, and weighing 0.98 pounds, was rated as grade 34–U. The other 3 crystals were not salable.

HARMAN J. DeHART FARM

Another deposit that exemplifies residual quartz is on the farm of Harman J. DeHart about one-quarter mile north of the intersection of Highway 58 with the Blue Ridge Parkway and about 3 miles south and a little west of the Slate Mountain Church. The locality is in a small field about 500 feet S. 20° W. from the DeHart home. At the time of the writer's visit, a stand of oats rendered it impracticable to examine the deposit; but according to the owner's description, the quartz was found in a narrow streak, trending about north across the field.

Four samples of faced quartz, three of which were singly terminated, were submitted to the National Bureau of Standards. Two of these, weighing 4.20 and 4.88 pounds, were found to be of grade 34–F. The other two were not salable.

DAVID A. ROBINSON FARM

A large crystal of quartz was found on or near the farm of David A. Robinson, about a half mile northeast of the farm of Guy C. Barnard. This specimen measured 8 by 6½ by 5 inches, weighed 14.40 pounds, and had remnants of 3 prismatic and 3 rhombohedral faces. The crystal was found in a cutbank of saprolite and was not in the vicinity of any vein of quartz. The Robinson crystal, rated as grade 34–F, is the largest salable crystal located in Virginia by the writer.

PULASKI COUNTY

M'NEIL SOUTHERN PROPERTY

LOCATION

McNeil Southern lives on the north side of Highway 605 about half a mile east of Hiwassee. The site of his quartz deposit is about 1,200 feet N. 75° E. from his house and 140 feet higher. Mr. Southern prospected and mined in a small way for many years on this and adjoining properties, specializing particularly in feldspar, clay, and paint materials.

OCCURRENCE

Unlike all the other localities visited by the writer in Virginia and North Carolina, where the bedrock is schist or gneiss, the Southern quartz deposit occurs in an area of sedimentary rocks. Several

opencuts and drifts and one 35-foot shaft were opened up years ago in a search for paint materials, and in connection with this work, clear quartz was found. These openings are now entirely caved. Apparently the country rock is a weathered shale, possibly the Hampton shale, of Early Cambrian age. Mr. Southern stated that a "hard ledge," 2 feet thick, was intersected, both in the shaft and in a tunnel leading from one of the open cuts; one from the owner's description, it is inferred that the strike of this ledge is about N. 65° E. Pieces of the "ledge rock" lying on the ground near the shaft were found to be of granitic character, consisting of coarse-grained quartz and white feldspar, together with a small amount of an unidentified white heavy mineral. Some clear quartz was found along the margins of this pegmatitic(?) dike, but no precise description of its character could be obtained.

CHARACTER OF QUARTZ

Two samples of clear quartz from this site have been examined by the National Bureau of Standards. One of these, submitted by Lawrence A. Price, of Radford, Va., was a faced crystal weighing 2.67 pounds; it was rated as grade 26–F. The other, transmitted by the writer for Mr. Southern, weighed 1.03 pounds and was rated as grade 23–F.

COLLECTORS

W. H. Martin, an attorney of Leesburg, Va., was one of those who became interested in the collection of quartz in Virginia as a speculative enterprise. Ninety-two crystals, with a total weight of 185.93 pounds, were collected by Mr. Martin in Carroll County and adjacent counties in 1943 and submitted to the National Bureau of Standards. Nine of these were rated as usable or salable, as shown in the following tabulation.

Salable quartz crystals submitted by W. H. Martin

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
1.72	13–F	0.48	34–F
.66	13–U	.60	34–F
1.29	34–U	.45	34–F
.76	34–F	1.26	14–F
.90	34–F		

Another person is known to have collected considerable clear quartz in Carroll, Floyd, and Patrick Counties, early in 1943. This collector took quartz from the farmers with a promise to remit payment, if the material proved to be usable. He never made any returns, nor was the quartz submitted to the National Bureau of Standards under his name. Possibly it was sold to some laboratory in the business of cutting oscillator plates.

MISCELLANEOUS SOURCES IN VIRGINIA

Quartz crystals from Virginia were submitted by many other persons. Some of these were farmers, and others were collectors or buyers of quartz. Most of the farmers who contributed this quartz were visited by the writer; yet the exact localities of most of these crystals were not ascertained. The following table, taken partly from the files of the National Bureau of Standards, gives all such quartz that proved to be usable or salable.

Miscellaneous quartz crystals from Virginia

Owner	Address	Weight (lb)	Grade
M. B. Bowman	Laurel Fork, Carroll County	1. 72	34–F
Wilcher Bowman	do	2. 25	34–F
James A. Cox	do	1. 17	34–U
Do	do	6. 05	34–U
L. R. Sutphin	do	1. 16	34–F
Do	do	2. 97	34–F
C. E. Turner	do	6. 06	34–U
M. A. Maybeury	Floyd, Floyd County	1. 07	34–U
Do	do	4. 84	34–F
Do	do	. 70	34–U
Do	do	4. 42	34–F
Do	do	. 99	34–F
Do	do	. 87	34–F
Do	do	1. 54	34–F
Sena Chatham	Meadows of Dan, Patrick County	1. 20	34–U
Harlow Cochrane	do	1. 72	34–F
Leon Cock	do	3. 39	34–F
L. E. Jessup	do	1. 95	34–F
J. M. McAlexander	do	3. 41	34–F
L. A. Price (buyer)	Radford, Montgomery County	. 47	34–U
Do	do	. 78	34–F
Do	do	1. 14	34–U
Do	do	6. 06	34–F
Do	do	. 81	34–F
Do	do	1. 54	34–F
H. K. Phillips	Newport News, James City County	. 85	23–F
A. B. Hancock	Clayville, Powhatan County	1. 41	23–F
H. L. Hutchins	Roanoke, Roanoke County	1. 65	14–U
Lewis Ware	Partlow, Spotsylvania County	1. 16	34–U
George O. Nye	Wytheville, Wythe County	. 80	13–U
Do	do	. 45	13–F

DEPOSITS OF WESTERN NORTH CAROLINA

The most important deposits of quartz crystals in western North Carolina occur in Ashe and Alleghany Counties, in the plateau area of the Blue Ridge province. Similar, though less important, deposits occur in Avery and Mitchell Counties, in the same province. Other deposits of quartz crystals occur in the Piedmont province, about 30 miles southeast of the Blue Ridge, principally in Alexander, Iredell, Cleveland, and Lincoln Counties.

Quartz crystals were investigated by the writer at 141 localities in North Carolina. A small percentage of these are described in the following pages. E. W. Heinrich and the writer also visited many informants, owners of quartz, and owners of quartz deposits, in 12 other counties of North Carolina.

PLATEAU DEPOSITS OF NORTH CAROLINA

ASHE AND ALLEGHANY COUNTIES

The quartz deposits of Ashe and Alleghany Counties, like those of southwestern Virginia, are in the plateau country that forms the northwest flank of the Blue Ridge; but in general they are farther from the crest of the Blue Ridge than some of those in Virginia. They also are separated into 2 fairly distinct groups—1 in Ashe County, north, northeast, and east of Jefferson and 1 is in the vicinity of Stratford and Sparta, in Alleghany County. No significant deposits or prospects were found in the 10-mile area between these two. The principal sites at which quartz crystals have been found in Ashe and Alleghany Counties are shown in figure 9.

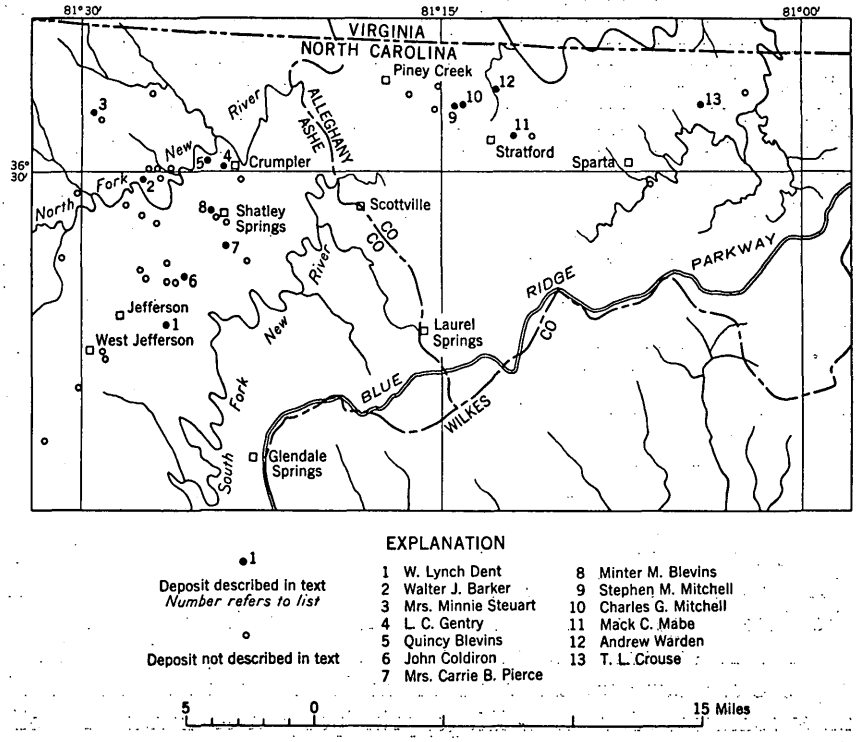

FIGURE 9.—Quartz crystal deposits of Ashe and Alleghany Counties, N. C.

W. LYNCH DENT FARM

LOCATION

The Dent farm is in Ashe County about 2 miles S. 80° E. of Jefferson and along the south side of Highway 88 about one-half of a mile east of the junction of Highways 88 and 221. This farm of 450 acres belonged originally to W. Lynch Dent, of Jefferson, but in recent years it has been acquired jointly by three new owners.

OCCURRENCE

The present owners know little of the mode of occurrence of quartz on their property, but according to Mr. Dent many clear quartz crystals have been found at widely separated localities over the farm. These deposits thus appear to be of the scattered type, wherein single crystals or nests of crystals occur in the soil and decomposed bedrock and are not particularly associated with any white vein quartz.

Most of the better crystals from the Dent farm were picked up years ago by tenants and others who have worked on the farm. Some have been held by neighbors as keepsakes, doorstops, and the like, but others have been carried off by people moving to different neighborhoods. Some crystals that were submitted by people in the vicinity of Jefferson are believed to have come from the Dent farm though some of these may possibly have come from adjoining or nearby farms.

CHARACTER OF QUARTZ

Seventeen crystals believed to have come from the Dent farm are known to have been shipped to the National Bureau of Standards, or to governmental agencies that referred them to that organization. Two of these were transmitted by the writer in behalf of Mr. Dent, but they proved not to be salable. Four others that may have come from the Dent farm have proved to be salable or usable. The data on these are given as follows:

Owner	Address	Weight (lb)	Grade
Clifford C. Marsh	Jefferson, Ashe County	2. 15	16-F
Do	do	. 80	26-F
G. C. Burkett	do	3. 76	34-U
R. F. Marsh	do	. 99	23-U

Some high-grade quartz apparently came from the Dent farm, but probably the supply was scant and scattered, and it is unlikely that this farm can be regarded as a potential source of many additional crystals.

WALTER J. BARKER FARM

LOCATION

The farm of Walter J. Barker is on the north side of the North Fork of New River about 5.1 miles N. 15° E. of Jefferson, in Ashe County. This farm of 16½ acres has been known for years as a source of quartz crystals, many of which have been recovered and sold.

OCCURRENCE

A small gulch drains southeastward through the farm directly into the North Fork of New River. About halfway to the head of this gulch and a short distance northwest of the farmhouse is a narrow zone or belt, trending N. 40° E., in which crystals of quartz have been found on both sides of the gulch. This belt is marked by ledges of opaque white vein quartz.

Four or five pits and one shallow trench recently have been excavated along the northeast side of this gulch, and there are signs of older excavations. Little is exposed in the pits, but the bedrock at the trench is clearly decomposed mica schist, which in places extends almost to the surface. The surface of the bedrock is very irregular, so that the soil ranges in thickness from 2 to 6 feet. The clear crystals are reported to have occurred in pods and lenticular nests, both near the surface in the soil and to a depth of 6 feet in the altered bedrock. A narrow seam of white vein quartz was uncovered in the trench, but no clear quartz was found in or adjacent to it; and the evidence indicates that the clear quartz is unrelated to the white vein quartz.

CHARACTER OF QUARTZ

Many clear crystals, weighing 1–3 pounds, are said to have been found on this property; and according to vague reports crystals weighing 500, 200, and 60 pounds were found in earlier days. It also is reported that a man named Pratt shipped 3 tons of crystals from this site about 1937, but these presumably were used for fusing. The same operator, as well as others, are reported to have taken away many of the best of the smaller clear crystals.

Many small imperfect crystals were bought in 1943 by an agent of a crystal-cutting laboratory in the South, so that no specimens were available. At a later date, however, the writer saw the employer of this buyer, who stated that the quartz acquired from the Barker farm had not proved to be of grades 1 or 2.

MRS. MINNIE STEUART FARM

LOCATION

The farm of Mrs. Minnie Steuart is about 8 miles N. 6° W. of Jefferson, Ashe County, at the forks of a small headwater branch of

Silas Creek. The quartz crystal deposits are on the spur between the two forks, about 200 yards S. 80° E. of the farmhouse.

OCCURRENCE

The crystals occur in a belt of biotite schist, about 50 feet wide, that is cut by granitic dikes, and both the schist and the dikes are cut by veins of opaque white quartz. This belt trends N. 10° W. and has been traced for at least 600 feet. The bedrock is not well exposed, but one structural observation of sheeted granite gave a strike of N. 10° W. and a dip of 45° E. An old tunnel that was driven to prospect this deposit is now caved. The crystals of quartz occur in pockets and in thin lenticular masses, which are both in the soil and in the underlying saprolite.

CHARACTER OF QUARTZ

E. Z. Powers, of Bina, Ashe County, transmitted to the National Bureau of Standards 30 samples, most of which are believed to have been collected on the Steuart farm. One of these crystals, weighing 0.83 pound, was of grade 23–F; and 4 others, weighing 3.33, 1.24, 0.82, and 0.45 pounds proved to be of grade 34–F.

P. H. HAYNES CRYSTAL

P. H. Haynes, of Warrensville, Ashe County, submitted a single crystal in March 1944; the exact locality is not known though it is supposed to have come from the vicinity of the Barker or Steuart farms. This crystal weighed 74.2 pounds and, when cobbed at the National Bureau of Standards, yielded 34 pieces of clear quartz with a total weight of 38.4 pounds. Seven of these pieces proved to be salable or usable, as follows:

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
1.57	36–U	1.65	23–U
.95	23–U	.83	23–U
.64	23–U	1.12	36–U
1.87	23–U		
		8.63 (total)	

These 7 pieces, comprising nearly 12 percent of the crystal, constitute a good yield (both as to quality and quantity) for a crystal of this size.

L. C. GENTRY FARM

LOCATION

The farm owned originally by L. C. Gentry, later by A. R. Vail, and since 1919 by others, is about a mile west of Crumpler, in Ashe County, and about 2¼ miles north-northwest of Shatley Springs. The original Gentry farm included a small tributary of Long Shoal

Creek, called Ben Branch; and the quartz was found mainly in the valley of this small stream.

OCCURRENCE AND CHARACTER OF QUARTZ

Ben Branch, formed by two headwater gulches, has a length of about one-half of a mile, flowing S. 70° W. The north wall of its valley is steep, leading to a divide between Ben Branch and a parallel stream on the north. This valley wall, together with the interstream divide, are the sites where many crystals of quartz have been found.

The bedrock in this valley is predominantly mica schist, the foliation of which strikes N. 25° E. and dips 40° SE. Numerous veins or lenses of opaque white quartz cut the country rock, but they contain no clear quartz. At the head of Ben Branch, the soil and underlying saprolite constitute a thin mantle in which no crystals were found; but farther downstream both the soil and the saprolite are thicker and contained numerous crystals. Near the lower end of the valley and along its north side, a clear crystal weighing about 30 pounds was found in 1891 by one of Dr. Gentry's workmen. Other clear crystals are reported to have been found along this northern valley wall, particularly about midway the length of the valley and about two-thirds of the distance from the creek to the interstream divide. In this general vicinity the writer picked up several crystals, weighing between 1 and 2 pounds, but they were translucent. One unfaced crystal, which was clear but frosted on its outer surface, was found by one of the sons of Quincy Blevins, who lives at the head of Ben Branch. This crystal, weighing 2.11 pounds, was shipped to the National Bureau of Standards, but it proved not to be salable.

JOHN COLDIRON FARM

LOCATION

The John Coldiron farm is in Ashe County along highway 221, and the site of particular interest on this farm is 3.0 miles N. 60° E. of Jefferson along the southeast side of the highway.

OCCURRENCE AND CHARACTER OF QUARTZ

Large residual boulders of opaque white vein quartz are found within an area of about 100 feet square in a grass field, and in the same area occur many small pieces of clear or partly clear quartz, most of which are unfaced. The large boulders contain also some translucent quartz, consisting of alternating bands of milky and nearly clear material. None of the clearer quartz was of salable grade.

This deposit is mentioned because of the similarity of these boulders with those found on the farm of Ernest L. Bowman, in Carroll

County, Va. Quartz of similar character also occurs on the S. M. Mitchell farm, in Alleghany County, N. C. Together, these and other similar residual deposits, prove that some of the old vein quartz of the metamorphic series may be translucent or partly clear; but no such deposit has yet been proved to contain any quartz of salable grade.

MRS. CARRY B. PIERCE FARM

LOCATION

The Pierce farm is about 5 miles N. 57° E. of Jefferson, Ashe County, on a road that turns northward from Highway 221, at the Dog Creek service station.

OCCURRENCE AND CHARACTER OF QUARTZ

This farm has been known for years as a locality of crystals. According to local reports crystals of quartz were first found here about 45 years ago by Mr. Perry, an Englishman who did considerable prospecting in this area. It is said that he recovered some large crystals, which he shipped to a museum in London. The size and clarity of the crystals are not known locally.

The old workings, consisting of 2 shallow pits and 2 opencuts, are along the valley wall, west of the house. The pits, now 3–4 feet deep, were originally deeper; and the opencuts are entirely slumped. The volume and character of the material on the dumps indicate that the soil is shallow and that the underlying reddish massive saprolite was probably derived from a hornblende schist. No white vein quartz was found in this vicinity, and all the available evidence indicates that the quartz occurred as isolated crystals or nests of crystals in the saprolite or in the overlying soil.

No quantitative data regarding the volume and grade of quartz are available. The owner, however, walled up a little spring about 150 yards north of the farmhouse and cemented into this wall some of the smaller crystals that had been recovered. These include 10 small crystals, some of which are faced, and 1 large crystal, perhaps 12 inches long, that is partly clear. A few small faced, but milky, crystals and one partly clear unfaced crystal were found on the dumps.

A large mass of opaque white quartz, probably residual, is exposed just south of the spring. Judging by the position of similar residual debris, a ledge of such vein quartz appears to trend S. 60° E. from this site, but this material includes no clear or translucent quartz and appears in no way to be related to the crystals that were mined.

SHATLEY SPRINGS AREA

LOCATION

Shatley Springs is a small watering place about 5.6 miles N. 48° E. of Jefferson, Ashe County. The buildings are on the south side of a road that leads about 1½ miles west-northwest from Highway 221; and the springs are the headwaters of a small westward-flowing stream called Long Shoal Creek. An inconspicuous unpaved road leads southwestward behind the buildings and goes about half a mile past several houses, finally reaching another fork of Long Shoal Creek, which runs north-northwestward to the main stream. This headwater fork is the site of many of the crystals found in this vicinity. Northwest of Shatley Springs, other crystals, however, have been found along and close to the road.

OCCURRENCE

The headwater fork of Long Shoal Creek flows about N. 30° W., and its valley floor slopes almost imperceptibly upward along its northeast side. The southwest wall, however, is rather abrupt and consists of a saprolitic bedrock that originally was probably hornblende schist. Little vein quartz is present; but in the gullies along this wall, particularly near the main branch of Long Shoal Creek, many clear crystals of quartz have been found.

The home of Minter M. Blevins is west-northwest of Shatley Springs and along the south side of the road that passes Shatley Springs; and 200 feet northeast of his house is a roadcut from which was excavated a crystal of the highest grade. No quartz is now visible at this site, and the crystal is said to have been found alone, within the saprolite exposed in the cut.

The home of Glen and Earl Blevins is about 0.2 mile northwest of the home of Minter M. Blevins and on the north side of the road. North of the road and about 500 feet west of this house is a grassy slope, were numerous crystals of quartz have been found. Considering together the three sites so far mentioned, it appears that a northwestward-trending zone exists, in which crystals are more than ordinarily plentiful.

CHARACTER OF QUARTZ

Most of the best crystals of quartz from the area close to Shatley Springs were purchased in 1943 by a representative of crystal-cutting laboratory in the South, and for this reason it was not possible to obtain representative samples. The writer, however, transmitted for Minter M. Blevins a faced crystal, weighing 5.72 pounds, that was rated by the National Bureau of Standards as grade 16–F, the highest

possible quality. This is believed to be the largest crystal of this grade so far found in North America. Owing to the rarity of crystals of this size and grade in the United States, this specimen was not cut into oscillator plates; instead, it was presented by the Metals Reserve Corporation to the U. S. National Museum.

A bucket of crystals recovered from the ground of Glen and Earl Blevins were offered by Francis L. Blevins, and three crystals were picked for examination. All proved to be of unsalable grade 30. In behalf of Hettie Blevins two other crystals were later forwarded to the writer by R. C. Blevins. The source of these crystals is not definitely known beyond the fact that they came from the area close to Shatley Springs. These weighed 12.36 and 7.03 pounds and were rated by the National Bureau of Standards respectively, as grades 34–F and 34–U.

THE MITCHELL FARMS

LOCATION

Two farms, one belonging to Stephen M. Mitchell and the other to Charles G. Mitchell, are in Alleghany County, about 1¾ miles northwest of Stratford. Both farms are in the valley of Walnut Branch, an east-flowing tributary of Elk Creek, which drains northward to New River.

The Mitchell farms, particularly the farm of Stephen M. Mitchell, attracted some attention in 1943 as possible sources of quartz crystals, because four shipments of crystals to the National Bureau of Standards were erroneously reported to have come from these farms. It should be recorded that this claim was not made by the Mitchells.

OCCURRENCE AND CHARACTER OF QUARTZ

The principal feature of interest on the farm of Stephen M. Mitchell comprises several large masses of white vein quartz that crop out intermittently for at least 300 feet, northeast of the Mitchell barn. It is not certain that all this quartz is in place, but the outcrops are so alined as to suggest an underlying vein, or at least several elongate lenses.

The general trend of this "vein" of quartz is N. 65° E., and an opencut 4 feet wide has been dug for 11 feet along the strike at the outcrop farthest to the northeast. The soil here is 6–8 feet thick, but traces of decomposed bedrock are visible below the soil on the southeast, southwest, and northwest sides of the cut. No quartz is visible on the 3 walls, but in the floor of the cut are 3 masses that if continuous may indicate that the "vein" might be from 24 to 30 inches wide. Most of the quartz is massive, opaque, and white, but some of it consists

of translucent to milky material that is banded and appears to have been sheared. A small amount of clear quartz is also intergrown with the white quartz, but none of this was found to be salable. It is reported by Mr. Mitchell that some milky crystals of quartz were found adjacent to this vein at the time when the cut was excavated.

The other features of interest are 3 areas on the 2 farms, where crystals of clear quartz have been found. One of these is a small elliptical area, with axes of about 200 and 100 feet, about 500 feet north-northwest of the Stephen M. Mitchell barn. A second area, about 700 feet northeast of this barn, is approximately 450 feet by 150 feet. The third, and easternmost site, is about 250 feet southeast of the Charles G. Mitchell farmhouse and is approximately 550 by 250 feet. The major dimension of the first trends about east; of the second, N. 70° E.; and of the third, N. 30° E.

The area northeast of the Stephen M. Mitchell barn is the site of greatest interest because it lies just south of, and is probably contiguous to, the "vein" of quartz above described. At the time of the writer's visit, only a small amount of clear residual quartz could be seen because corn and grass were in the field. Moreover, the owners had on hand no quartz of salable grade. The available facts indicate that some quartz of grade 34 was recovered from both Mitchell farms, but the total amount is believed not to have been large.

GEORGE WILES COLLECTION

SOURCES

George Wiles, now deceased, is reported to have been an eccentric collector of minerals, who was raised on a farm on Little River, about 2 miles southeast of Sparta, in Alleghany County. He developed a great zeal for collecting quartz and is said to have become eventually almost obsessed with mystical ideas regarding the origin and value of quartz crystals.

Mr. Wiles, during his lifetime, probably visited and collected from most of the localities where crystals of quartz were then known in Alleghany County. A few of the crystals in his collection may have come from the old Wiles homestead on Little River; some undoubtedly came from the Mitchell farms, but probably most of them came from scattered localities throughout this county. The principal localities where crystals of quartz are known to occur within this part of Alleghany County include the following:

1. Spur of Bakers Ridge, between two headwater forks of Walnut Branch.

2. Moxley farm, west of the Stephen M. Mitchell farm.
3. Stephen M. and Charles G. Mitchell farms.
4. Lonnie Southers farm, east of the Charles G. Mitchell farm.
5. Rex S. Warden farm, in the valley of Elk Creek, northeast of the Southers farm.
6. Wayne M. Reeves farm, northeast of the Warden farm.
7. Lawrence E. Reeves farm, northeast of W. M. Reeves farm.
8. Mrs. Dona Warden farm, northeast of L. E. Reeves farm.
9. Andrew Warden (deceased) farm, east of Dona Warden farm.
10. Johnson Wyatt farm, on Route 93, and northeast of Dona Warden farm.
11. W. M. Stidham farm, about a mile north of Reeves farms.
12. Mack C. Mabe farm, about a mile east-northeast of Stratford.
13. C. G. Fender farm, on Route 221, about 1½ miles east-northeast of Stratford.

Wiles is known to have collected quartz crystals from the 1st, 2d, 3d, 5th, 7th, 9th, and 12th of these localities, and he may also have collected at the others. The largest crystal in his possession, weighing 238.0 pounds, came from a 75-acre farm owned in 1943 by Mack C. Mabe, though originally part of a 500-acre farm owned by Frank and Wiley Warden.

None of these localities is known to have produced any considerable quantity of quartz crystals. Most of the residual quartz in this region occurs in 1 of 2 environments: it is either segregated in small areas, as on the Mitchell farms, or it occurs sparsely as single crystals or nests of crystals at widely scattered sites. Most of the localities mentioned above appear to belong in the second category, and therefore none of them is regarded as a favorable site for prospecting for any commercial deposits of quartz.

CHARACTER OF QUARTZ

Thomas A. Kiernan purchased the Wiles collection from Luther Wiles, the son of George Wiles, who lives near Stratford, and submitted these crystals to the National Bureau of Standards. The collection comprised 169 crystals which ranged in size from 0.12 to 238.0 pounds and had a total weight of 473.44 pounds. Forty-three crystals were faced, and 105 were unfaced; the remainder were so small that they were recorded as BG. Forty-six crystals and 8 pieces of quartz cobbed from 3 other crystals proved to be salable; and of these 17 were faced, and 29 were unfaced. The data on the salable crystals are given below.

Salable quartz crystals from Wiles collection

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
0.79	23–U	0.91	34–U
1.50	34–U	1.63	23–F
1.23	34–F	.64	34–U
.57	34–U	.57	34–U
.82	34–U	.86	34–U
1.14	34–F	1.36	34–U
1.55	34–U	.70	34–U
1.40	34–U	.85	34–F
6.52	34–F	.76	34–F
.49	34–U	.54	23–U
.72	34–U	.47	34–U
1.06	34–F	.57	34–U
.86	34–U	.63	34–U
.58	34–U	1.05	34–F
.89	34–U	24.98	34–F
.79	34–U	1.10	34–U
1.80	34–U	.50	34–F[1]
2.24	34–U	1.52	34–U
.52	34–U	.89	34–F
.78	23–F	2.94	34–F
.50	34–U	.44	34–F
4.68	34–F	2.31	34–F
2.57	34–F		
.65	34–U[1]	80.87 (total)	

[1] Cobbed from two larger crystals.

The largest crystal in the Wiles collection, found on the old Warden farm, measured 30 by 20 by 14 inches and weighed 238.0 pounds. It had two well-developed rhombohedral faces, the remnant of another, part of a prismatic face, but it was clear only at the tip. It was unsalable as a single crystal, but when cobbed it yielded six salable pieces, as follows:

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
1.00	34–U	0.62	34–U
1.04	23–U	.86	34–U
3.31	34–U	3.05	34–U

This is the largest crystal actually seen in North Carolina or Virginia by the writer, though larger ones have been reported. The largest salable crystal so far found in North Carolina, or elsewhere in the South, is the one of the Wiles collection that weighed 24.98 pounds and was rated as grade 34–F.

The preceding crystal data show that the salable quartz of the Wiles collection includes no quartz of grade 1, and only 4 crystals, or 4.6 percent by weight, of grade 2. This large collection is believed to be typical of the crystal-bearing area in Alleghany County; and it therefore follows that very little quartz of oscillator grade is available in this county.

T. L. CROUSE FARM

LOCATION AND INVESTIGATION

The Crouse farm is about 3 miles northeast of Sparta, in Alleghany County, and the quartz deposit on this farm is about 700 feet south-

east of the intersection of the Baywood road with the road that leads to the Bald Knob manganese mine.

A sketch map of the site of the quartz crystals and contiguous areas was prepared by E. W. Heinrich and J. J. Norton, of the U. S. Geological Survey, in March 1943. Shortly thereafter, the site of the original discovery was reopened by the U. S. Bureau of Mines under the direction of L. A. Dahners, and several trenches were also dug in a search for other deposits, though none was found.

OCCURRENCE

The bedrock on the Crouse farm is mainly a dark hornblende gneiss, with a foliation that strikes from N. 48° E. to N. 70° E. and dips from 52° to 80° SE. Lenses of biotite-hornblende gneiss are associated with stringers of quartz and pegmatite and constitute a small part of the country rock. Two veins of massive milky quartz are also present on the property, and residual white quartz shows in three localized areas.

A pocket containing about 1,000 pounds of quartz crystals was discovered and opened in 1933 by T. L. Crouse in a garden plot on his farm. This is the largest concentration of such quartz so far found in the Southeastern States. According to E. W. Heinrich (written communication, 1943) the crystals occurred mainly in the soil and partly in the underlying saprolitic gneiss. The pocket was completely excavated, but no veins of quartz, or feeder channels of any other kind, were found continuous with or in the near vicinity of this deposit. It is described by Mr. Heinrich as a discontinuous lens of crystals, with no discernible relationship to quartz veins. Clearly these are pocket crystals as heretofore defined.

CHARACTER OF QUARTZ

The quartz from this deposit is said to have been unusually clear though many of the crystals had frosted surfaces. Singly terminated crystals were of common occurrence, and some doubly terminated ones were also found. Thirty-one of the best crystals, weighing 123.41 pounds, were submitted to the National Bureau of Standards. These crystals ranged from 2 inches in length to several that weighed over 25 pounds (E. W. Heinrich, oral communication); 13 were faced, and 18 unfaced. No high-grade oscillator quartz was found among any of these crystals, but 3 unfaced ones, weighing 2.89, 2.20, and 1.09 pounds, were rated as grade 34–U.

AVERY AND MITCHELL COUNTIES

Pegmatites are plentiful in Avery and Mitchell Counties and notably so in Avery County, but such rocks in the Southeastern States

have not proved to be important sources of oscillator quartz. In the central part of these 2 counties, however, are 2 areas where a considerable number of crystals have been found. A line connecting the centers of these 2 areas may define a belt that trends about N. 75° E., but this assumed belt, here called the Clarrissa-Linville belt, diverges somewhat from the general trend of the Blue Ridge at this latitude. The principal localities where quartz crystals have been found in Avery and Mitchell Counties are shown in figure 10.

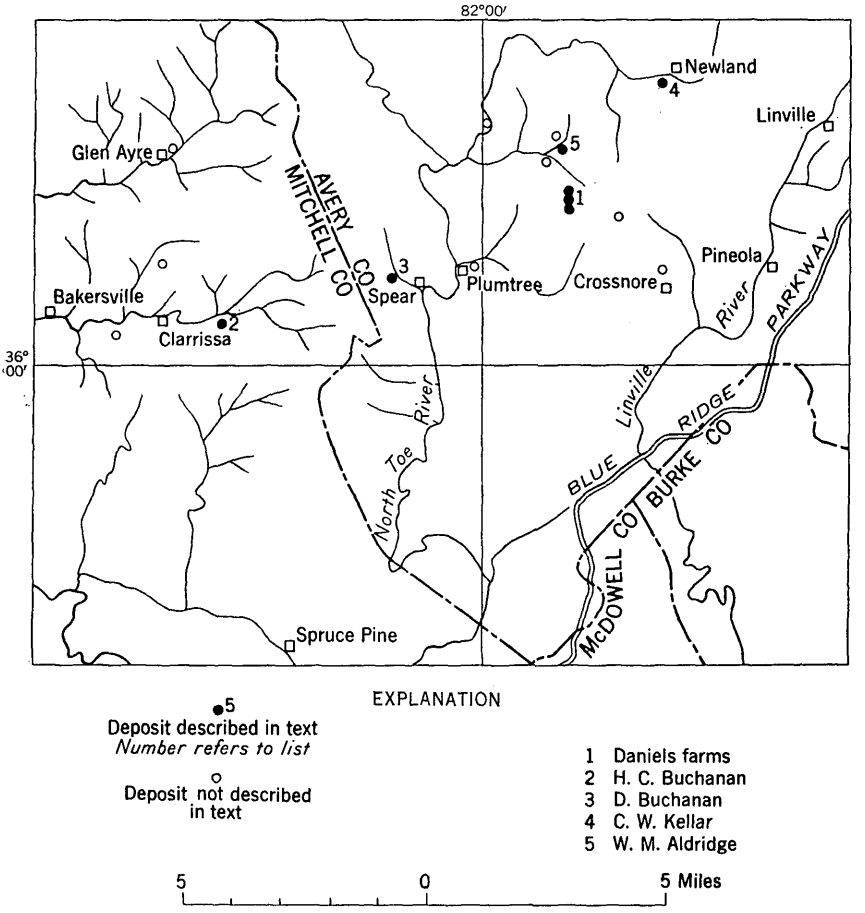

FIGURE 10.—Quartz crystal deposits of Avery and Mitchell Counties, N. C.

DANIELS FARMS

LOCATION

Clear quartz crystals have been found on 3 farms, owned, respectively, by Messrs. George A. Daniels, Mack M. Daniels, and Harrison

Daniels, near the headwaters of Plumtree Creek and about 2¼ miles northwest of Crossnore, Avery County.

OCCURRENCE AND CHARACTER OF QUARTZ

Small crystals of quartz have been found on the farm of George A. Daniels, about 25 yards northeast and about 100 yards southeast of the farmhouse. White vein quartz and some muscovite are also present. No clear crystals of usable size were seen by the writer, but 1 that measured 3½ by 3 by 3 inches was found to be free of twinning, though needles and specks were distributed throughout it.

The farm of Mack M. Daniels is about 200 yards to the north. Numerous clear crystals were found here over a period of years. Heinrich reported that crystals of clear quartz were found in an area about 80 by 30 feet in association with residual feldspar, mica, and pieces of pegmatite. Other crystals were found at scattered sites on the farm.

The farm of Harrison Daniels is still farther north. About 200 yards east of the farmhouse, a crystal of quartz weighing 19 pounds was found in sticky red saprolite about 2 or 2½ feet below the surface of the ground. No other forms of quartz were attached or adjacent to this crystal, and it seems probable that it exemplifies pocket quartz. This crystal was irregular in shape but measured approximately 10 by 8 by 6 inches. It had a light smoky hue, contained several veils, and was rated as unsalable. A crystal that weighed 200 pounds as well as others, was reported to have been found on this farm.

H. C. BUCHANAN FARM

LOCATION

The farm of H. C. Buchanan is near the western end of the Clarrissa-Linville belt, about 6⅔ miles N. 10° W. of Spruce Pine and about a mile east of Clarrissa, Mitchell County. Two crystals of quartz that came from this farm were submitted by Jeff Wilson, of Clarrissa.

OCCURRENCE AND CHARACTER OF QUARTZ

These crystals merit mention because they are typical of the pocket quartz found at so many other places, though they occur here within a pegmatitic province. The smaller of these, weighing 20.66 pounds, was found in the soil about 6 inches below the surface of the ground 60 yards N. 35° W. of the Buchanan farmhouse. The larger crystal, weighing 30.28 pounds, was found in saprolitic bedrock about 2 feet below the surface 100 yards N. 15° E. of Buchanan's house. The thickness of the soil at both these places is about a foot, and the bedrock is a decomposed hornblende schist or gneiss, nearly black were

freshly exposed but forming a reddish clay where it is greatly weathered. These 2 crystals were both unfaced, and measured, respectively, 9 by 8 by 6 inches and 14 by 9 by 7 inches. They were classed as grade 30–U—unusable and unsalable. Both looked fairly good to the unaided eye, and therefore they had either much twinning, or minute inclusions or fractures.

OTHER LOCALITIES IN THE CLARRISSA-LINVILLE BELT

Other localities are known in the Clarrissa-Linville belt where quartz crystals have been found; and some of these were visited by the writer. A clear but greatly twinned crystal, weighing 15 pounds, was found about a half mile from the Rose Mountain Church on the farm of Mrs. Mille Buchanan; and another, weighing between 40 and 50 pounds, is said to be in the possession of Jess McKinney, on the Young Cove road.

Otis L. Buchanan, of Hawk, Mitchell County, contributed 1 crystal, weighing 2.54 pounds, that was rated as grade 23–F. He also submitted 31 other crystals, which were too small to be acceptable though 4 were optically satisfactory. The exact sites from which these crystals came is not known.

A crystal belonging to John Clark, of Pineola, weighed 16.89 pounds and is said to have come from a site near the North Fork of Toe River, in the general vicinity of Plumtree, Avery County. It showed remnants of two crystal faces, but it was rejected by the National Bureau of Standards because of incipient and gross fractures throughout. A large unfaced crystal, measuring 16½ by 10 by 4½ inches, that was probably of pegmatitic origin was translucent with a very narrow zone of transparency, but this crystal was greatly fractured and was not submitted.

A crystal submitted by E. C. Guy, of Newland, came from the farm of W. M. Aldridge at a site about 0.8 mile south-southeast of Hughes, Avery County, and not far north of the Daniels' farms. This crystal, which weighed 4.14 pounds, was singly terminated, with well-developed prismatic faces; and to the naked eye, it appeared to be a perfect specimen of quartz. Under the beam of an arc light, however, it was seen to be filled throughout with minute specks.

The additional crystals in the following table have been submitted from the Clarrissa-Linville belt, but their localities were not recorded. The Keller crystal is of some interest, not merely on account of its size, but also because its locality, if close to Newland, extends to the Clarrissa-Linville belt farther to the northeast. The crystal from Spear would lie along the south side of this belt.

Other salable quartz crystals, Clarrissa-Linville belt

Owner	Address	Weight (lb)	Grade
Buchanan, Brach	Clarrissa, Mitchell County	0. 61	14–U
Buchanan, D	Spear, Avery County	5. 94	34–F
Carpenter, C. A	Spruce Pine, Mitchell County	1. 97	24–F
Do	do	. 40	24–S
Do	do	. 79	26–F
Green, L. B., collector	do	. 83	34–F
Keller, C. W	Newland, Avery County	18. 53	34–U

Few of the larger of these crystals have proved to be salable. From their general character, together with fieldwork on some, and second-hand information on others, it is inferred that most of the quartz crystals so far found in the Clarrissa-Linville belt belong to the pocket type of quartz, and in this respect are similar to most of the quartz crystals found farther northeast along the northwest flank of the Blue Ridge in North Carolina and Virginia.

PIEDMONT DEPOSITS OF NORTH CAROLINA

ALEXANDER AND IREDELL COUNTIES

The quartz deposits of Alexander and Iredell Counties occur in a somewhat irregular belt that is between 2 and 3 miles wide and extends about 15 miles approximately N. 75° E., or roughly parallel to the Blue Ridge, which is about 30 miles to the northwest. The settlement of Hiddenite is about in the center of this belt, and most of the crystals so far collected have come from localities close to Hiddenite. A few scattered localities also have been found farther north in an area east-northeast of Vashti. The principal sites where quartz crystals have been found in Alexander and Iredell Counties are shown in figure 11.

HIDDENITE MINE

LOCATION

The Hiddenite mine is on the south side of Highway 90 and about two-thirds of a mile west of the road junction at the town of Hiddenite. The mine is marked by several old dumps, where work was done in earlier years. The property is now part of a 300-acre farm owned by Mr. and Mrs. J. Thomas Adams.

HISTORY OF MINING

Hiddenite, the emerald-green gemstone variety of spodumene, was discovered at this locality in 1879; and this mineral, first identified by J. Laurence Smith, was named for W. E. Hidden, of New Jersey.

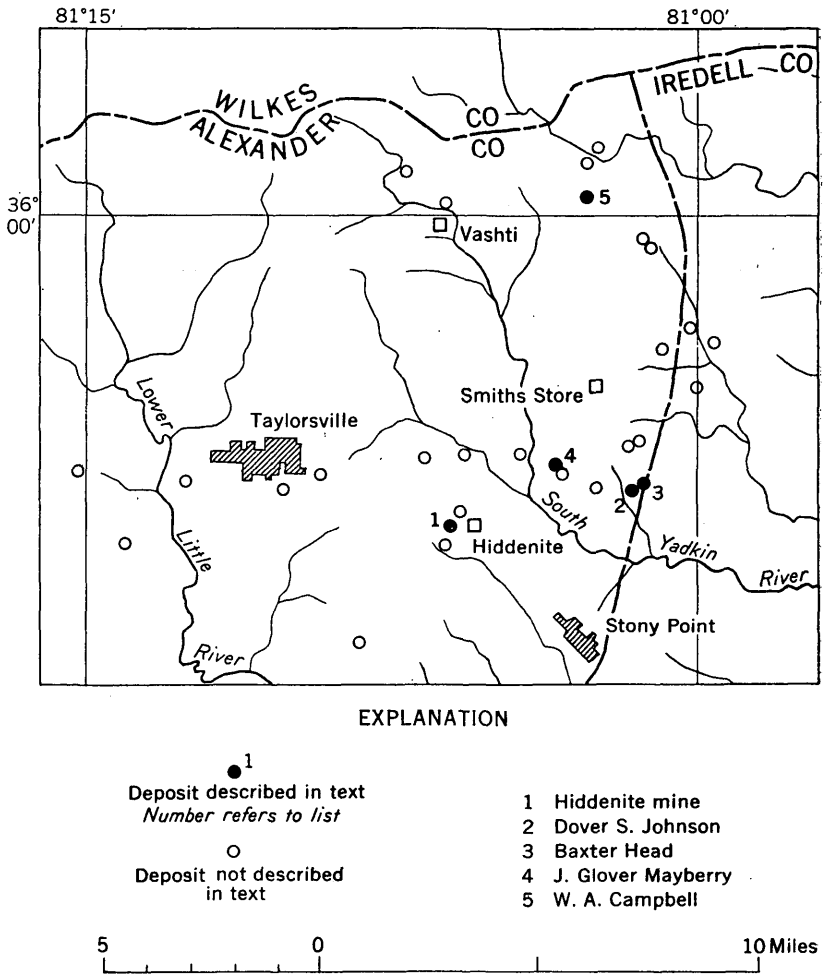

FIGURE 11.—Quartz crystal deposits of Alexander and Iredell Counties, N. C.

The Emerald and Hiddenite Mining Co. was organized in 1881 by Mr. Hidden, who worked this deposit for several years for precious stones, mainly hiddenite and emerald. The property was again worked in 1907 and 1908 by the American Gem Mining Syndicate. In 1918, the property was purchased by J. E. Turner, father of Mrs. J. T. Adams, and since that time has remained in the Adams family. In 1926 the mine was leased by the Hiddenite Mining Co., controlled by Burnham S. Colburn, a banker of Asheville, N. C. This company operated for 1 year and recovered 450 carats of hiddenite. No subsequent mining has been done.

The mine was operated mainly from a glory hole, which trends N. 60° E. and which at the end of mining activity was 400 feet long,

50–125 feet wide and about 55 feet deep in the center. Water now fills the bottom of this hole to a depth of 30 feet. One drainage tunnel connected with this pit, and many shallow pits were also sunk in this vicinity. Another large but shallow excavation, called pit No. 2, likewise trending N. 60° E., is about 400 yards S. 70° W. of the main mine. This is about 400 feet long and from 50 to 75 feet wide.

GEOLOGY AND MINERALOGY

The country rock at the Hiddenite mine was originally a dark gray, hard, vitreous quartzite. It was intruded by a granitic magma, which produced numerous granitic dikes, and also impregnated much of the country rock, producing a laminated contact-metamorphic rock that resembles, and has been called, a gneiss. In addition to quartz and feldspar, this contact rock also contains much biotite.

Hiddenite and emerald (beryl), together with muscovite, quartz, dolomite, siderite, apatite, tourmaline, rutile, monazite, and other minerals, were found in cavities or vugs within or alongside the granitic dikes. According to Hidden and Washington (1887), 1 of these pockets measured 10 by 6 by 2 feet. Another vug, reported by Mr. Adams, measured 6 by 6 by 5 feet. The dominant structural trend of the country rock is N. 60° E., dipping steeply northwest; and the two major dimensions of the vugs corresponded generally with this strike and dip.

OCCURRENCE OF QUARTZ

Many crystals of quartz were attached to the walls of vugs in this mine. Evidently some of these crystals were formed and remained under pressure until the vugs were opened up, for it is stated by Mr. Adams that some of them broke when exposed to atmospheric pressure, and others disintegrated after they were brought to the surface. Many crystals of quartz were found in these cavities, most of which were clear at the tips and shattered elsewhere, or became so later. A drive near the mine was at one time lined with about 100 partly clear crystals from the mine, weighing from 10 to 100 pounds each. Most of these, now carried away, were singly terminated, with clear tips; but with them were unfaced crystals that came from nearby fields.

Many quartz crystals have been found in the fields surrounding the Hiddenite mine. It is estimated that thousands of crystals, of all types and sizes, have been recovered from the mine and surrounding fields. Many of these have passed into the hands of collectors and curio hunters.

The best known sites for quartz crystals in the fields were visited by the writer, under the guidance of Mr. Adams. One area, lying about one-fourth of a mile N. 70° W. of the mine, is about 100 by 30

feet, with its major dimension trending about N. 65° E. Sheets of mica, together with straight or geniculated rods of rutile and a little beryl, occur here with the quartz. Some of the quartz is rutilated and is evidently of pegmatitic origin. For a distance of 50 feet south of this area, much residual white quartz shows on the ground; but at the south end of this zone is another narrow belt, parallel to the first, where clear crystals are found. No mica or rutile shows in the soil, but a little beryl is reported to have been found. The crystals of quartz recovered at this site are fairly clear and free of flaws.

Another mineralized area is about 100 yards still farther south of these localities. It is about 50 feet square and contains much white quartz, and some clear crystals of quartz. Such crystals are not plentiful, and most of them are faced. No mica is present, but four crystals of beryl are known to have been found here.

A fourth locality is approximately 600 yards N. 87° W. of the mine. Here, in an area about 100 by 50 feet, is a streak of residual quartz trending N. 65° E. Most of this quartz is white and opaque; some is translucent; and a little consists of clear crystals. Boulders of quartz, containing vugs lined with quartz crystals, were seen at this site, suggesting that the clear quartz originated in such cavities within quartz veins or pegmatitic vugs.

A shallow drain with gently sloping sides is about 500 yards west of the mine, and trends S. 20° W. Scattered clear quartz crystals have been found on both sides of this drain, though not in the drain itself, probably because they are covered by alluvium. Crystals also occur in a field at the head of this drain. No digging has been done along the southeast side of this gulch, but 8 pits were once sunk along its northwest side and 3 or 4 more in the field at its head. Crystals of quartz were found in some of these, and also elsewhere at scattered sites. Mica with the quartz crystals is present in the soil at some of these places but not at others.

A field about 400 yards S. 82° W. of the mine is another site where large unfaced crystals of quartz, and also smaller faced crystals, have been found. No mica is present, and the quartz has few flaws or cracks. The writer picked up two crystals here, each weighing about a pound. A short distance farther east is a large area, about 300 by 200 yards, where crystals have been found at scattered sites.

A seventh area is about S. 55° W. of the main mine and 250 yards east of pit No. 2. This measures about 100 by 50 feet, the major dimension trending N. 65° E. Both faced and unfaced crystals of clear quartz have been found at this site. A very little mica also shows in the soil.

An eighth locality is about 75 yards S. 55° W. of the main dump. Many small subparallel quartz-bearing spots trending N. 25° W. exist at this locality, coalescing at their southeastern ends in a larger crystal-bearing area. Many small well-faced crystals of quartz, in part amethystine, occur at these sites, and a little hiddenite was also found.

A ninth area, about 100 feet square, is about 200 yards S. 5° E. of the main mine dump. The finest small residual crystals so far found on the Hiddenite property have been recovered at this place, and more doubly terminated crystals occur here than elsewhere. A little mica shows in the soil.

Some rather poor crystals were found in the vicinity of a south-flowing drain about a quarter of a mile east and a little south of the mine. A similar area lies about 300 yards southeast of the mine.

The localities mentioned above constitute the more important quartz-bearing sites on the Adams farm, though others are also known. From the description given, it seems probable that quartz occurs here in two principal environments—first, and probably foremost, as crystals that grew in pegmatitic vugs; and second, as crystals that formed in vein quartz, more recent than the ordinary vein quartz of the metamorphic rocks, and probably related genetically to the intrusive rock at th Hiddenite mine. It is possible that pocket quartz also exists on the Adams farm, but no direct evidence of this was obtained.

CHARACTER OF QUARTZ

Much of the high-grade quartz at this, as well as other localities in the Hiddenite area, has been taken away by collectors and speculators. It is therefore difficult to obtain representative samples of such quartz. Mr. Adams, however, had 4 or 5 boxes of crystals that were found on the Hiddenite property, mainly in the fields surrounding the mine. From this collection of several hundred crystals, the writer selected 26 that were visually perfect and were equal by this criterion to the best ever found on the property. They ranged from 0.27 to 2.89 pounds, with a total weight of 23.77 pounds. About two-thirds of them were faced crystals, and some were singly terminated. One of these crystals, which weighed 0.45 pound, was rated by the National Bureau of Standards as grade 13–U. The remained showed optical twinning or other imperfections that rendered them neither usable nor salable.

Hiddenite is the only locality in Virginia or North Carolina where a large number of clear crystals of quartz have been found that originated without doubt in pegmatitic vugs; and this environment is certainly a more favorable one than any other in pegmatites. The

unsuitability of most of these crystals suggests rather strongly that the pegmatites of the Southeastern States are not favorable sites for the growth of oscillator quartz.

DOVER S. JOHNSON FARM

LOCATION

The former Joseph Lackey farm, owned in 1943 by Dover S. Johnson, is 3.8 miles N. 78° E. of the town of Hiddenite. Two localities of interest were found on this farm, both of which are northeast of the farmhouse.

OCCURRENCE AND CHARACTER OF QUARTZ

The more significant site is about 250 yards N. 60° E. of the farmhouse, where a vein of quartz is exposed in an old pit. The vein is about 5½ feet thick and stands vertical, striking approximately NE. Along the northwest and southeast sides of the vein are, respectively, 18 and 12 inches of granular quartz, and between these is coarsely crystalline milky to translucent quartz. The unaltered peripheral quartz is snow white, but it is commonly iron stained, ranging from cream to brown. It resembles greatly a coarse-grained quartzite and has been observed as residual material in many fields.

The medial zone of the vein consists of coarsely crystalline milky to translucent quartz, a part of which occurs as alternating bands a few inches thick parallel to the walls of the vein. This material includes some faced crystals, of which the smallest are clear. It seems probable either that the central part of the vein represents a late stage in its formation or that all the quartz in the vein was originally like that in the medial zone and that the peripheral quartz has been recrystallized. This is the only vein quartz seen by the writer in Virginia or North Carolina that contains any clear crystals, but no quartz was found that was either usable or salable.

A second locality of lesser interest is at the south end of a field of 2 acres north and northeast of the Johnson farmhouse. Only small pieces and chips of clear quartz were observed in this field, but one singly terminated crystal, which measured 5 by 3 by 3 inches, is known to have been picked up at this site.

BAXTER HEAD FARM

The Baxter Head farm is about 4 miles N. 78° E. of the town of Hiddenite and about a quarter of a mile northeast of the Dover S. Johnson farm. About 200 yards northwest of the Baxter home, on the north side of a road, is a field in which some crystals of quartz have been found. Mr. Head had 1 large mass of quartz, terminated by 3 crystals, of which the largest was 10 by 5 by 5 inches. The upper

4 inches of this crystal were clear but badly flawed. A second crystal of this mass was 8 by 4 by 3 inches and was clear in its uppermost 3 inches, though with 1 major flaw through its center. The origin of this quartz is uncertain.

Numerous other crystals have been found on the Johnson and Head farms, as well as elsewhere in this vicinity, and these are probably the sites from which W. A. Campbell, of Iredell County, obtained some of the crystals that he submitted to the National Bureau of Standards.

J. GLOVER MAYBERRY FARM

LOCATION

The J. Glover Mayberry farm is about 2¼ miles N. 55° E. of Hiddenite, along the west side of the South River Church road, also called the Smith's store road. The quartz-bearing field is about 300 yards west of this road.

OCCURRENCE AND CHARACTER OF QUARTZ

Many clear crystals are known to have been recovered from a quartz-bearing streak about 200 by 50 feet trending N. 60° W. The soil is from 6 to 12 inches thick and is underlain by a reddish saprolite. Judging from the residual detritus in the field, the country rock is schist, intruded by a dioritic rock. Cobbles of white granular quartz, with individual grains up to a quarter of an inch across, are also plentiful, indicating that the country rock is cut by veins of this material.

Much white quartz, considerable translucent quartz, and some clear quartz were seen in this field. The crystals are both faced and unfaced and both clear and smoky. The writer found 1 large smoky singly terminated crystal, 10 by 6 by 6 inches, which had numerous inclusions and veils and was also fractured. Many faced crystals and crystal aggregates were observed, but all of them were more or less milky or if clear were veiled. Much granular white vein quartz is also present in this field. No samples of quartz that seemed to merit optical examination were obtained possibly because all the better crystals had already been collected.

Clear quartz has also been seen at several other localities along and east of the road that passes east of the Mayberry farm. At one place a streak of residual quartz crosses the road diagonally, trending N. 50° W.; and at this site pieces of clear quartz may be found in the roadbed for a distance of 300 feet. Most of the clear quartz, as well as that found at several sites east of the road, is believed to have originated as pocket quartz.

Some of the dozen or more other quartz-bearing sites within a radius of 3 miles to the east, north, and west of the Mayberry farm

were visited. It was impracticable to obtain representative samples of any of this quartz; but in the opinion of Dewey D. Moose, the gem cutter at Stony Point, Alexander County, who is familiar with most of the local sources, this general area has been the source of some of the most perfect quartz crystals found in the Hiddenite district. Other localities, south and west of Taylorsville, are known.

W. A. CAMPBELL, COLLECTOR

LOCATION

W. A. Campbell owns a farm about 13 miles N. 25° W. from Statesville, in Iredell County, on which a few crystals have been found. Mr. Campbell, however, began buying quartz early in 1943 as a speculative enterprize; and as a result of these operations, he made six shipments to the National Bureau of Standards. The exact localities from which all these crystals were obtained are not known to the writer, but it was learned from Mr. Campbell that most of them came from the belt that passes about N. 60° E. through Hiddenite.

SOURCES AND CHARACTER OF QUARTZ

Clear quartz has been found at eight or more localities on the Campbell farm and the adjoining farm of his son. Pegmatitic dikes are at these sites because sheet mica is present at all of them and tourmaline and rutile at several of them. One of these places is of particular mineralogic interest, because here have been found several crystals of quartz with mobile liquid inclusions. None of the quartz found on the Campbell farms has proved to be salable.

Mr. Campbell, however, in collecting and shipping quartz from many sites in the Hiddenite belt, contributed greatly to our knowledge of the quantity and quality of the quartz available in this district. His 6 shipments comprised 376 crystals, ranging from 0.08 to 4.08 pounds, with a total weight of 180.43 pounds. About 6 percent of these crystals proved to be usable or salable. The detailed record is shown below.

Salable crystals submitted by W. A. Campbell

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
1.31	26–U	0.47	13–U
.85	34–F	1.30	23–F
.84	34–F	.96	16–F
3.87	34–F	.35	14–F
1.59	34–F	1.33	34–U
.38	13–F	.73	23–F
.95	34–U	.26	23–F
.73	34–F	.67	23–F
.65	34–F	.25	23–F
.57	34–U	.53	13–U
.52	13–U		
		19.11	

These collections include 6 crystals of grade 1, with a total weight of 3.21 pounds; 6 of grade 2, weighing 4.52 pounds; and 9 of grade 3, weighing 11.38 pounds. The percentages by weight of grades 1, 2, and 3 are, respectively, 16.8, 23.7, and 59.5; and these proportions of grades 1 and 2 are nearly twice as great as the general average for the Southeastern States, given on page 248.

Mr. Campbell made a determined effort to locate and buy the best crystals of quartz available in Alexander and Iredell Counties; in fact, his prior activities in such work made it difficult for the writer to collect representative samples. The Campbell collections may therefore be taken as an index of the quantity and quality of quartz that was obtainable in this area during 1943. Probably 95 percent of the quartz in these collections was residual and was recovered from the surfaces of fields; it is therefore improbable that the quantity and quality of the material could be duplicated in this area.

CLEVELAND AND LINCOLN COUNTIES

The quartz deposits of Cleveland and Lincoln Counties are more irregularly distributed than those found in the belt that passes through Hiddenite. Most of the prospects where clear quartz has been found are west and northwest of Shelby in Cleveland County, but a few prospects are known in the northeastern part of the county, extending over into Lincoln County. The principal sites at which quartz crystals have been found in Cleveland and Lincoln Counties are shown in figure 12.

CLIFF C. BLANTON FARM

LOCATION

The Cliff C. Blanton farm, comprising 145 acres, is about 5¾ miles N. 30° W. of Shelby, in Cleveland County. The site of the quartz deposit is in a field about 200 yards west of the Blanton farmhouse.

OCCURRENCE

The soil is light gray and about 1 foot thick. It is underlain by a hard reddish residual clay, believed to have been formed by the decomposition and weathering of biotite schist. The general site of the quartz deposit is an area about 100 feet square, in which are found numerous small cobbles of coarsely granular vein quartz, which are stained brown on their outer surfaces. This is a porous rock consisting of grains of quartz up to one-half inch in diameter; and though somewhat coarse grained, it is otherwise similar to that found at many places in the Hiddenite district. Within this general site is an area about 50 by 20 feet, the major dimension trending northeast, where crystals of quartz are the most common, though nowhere in this field

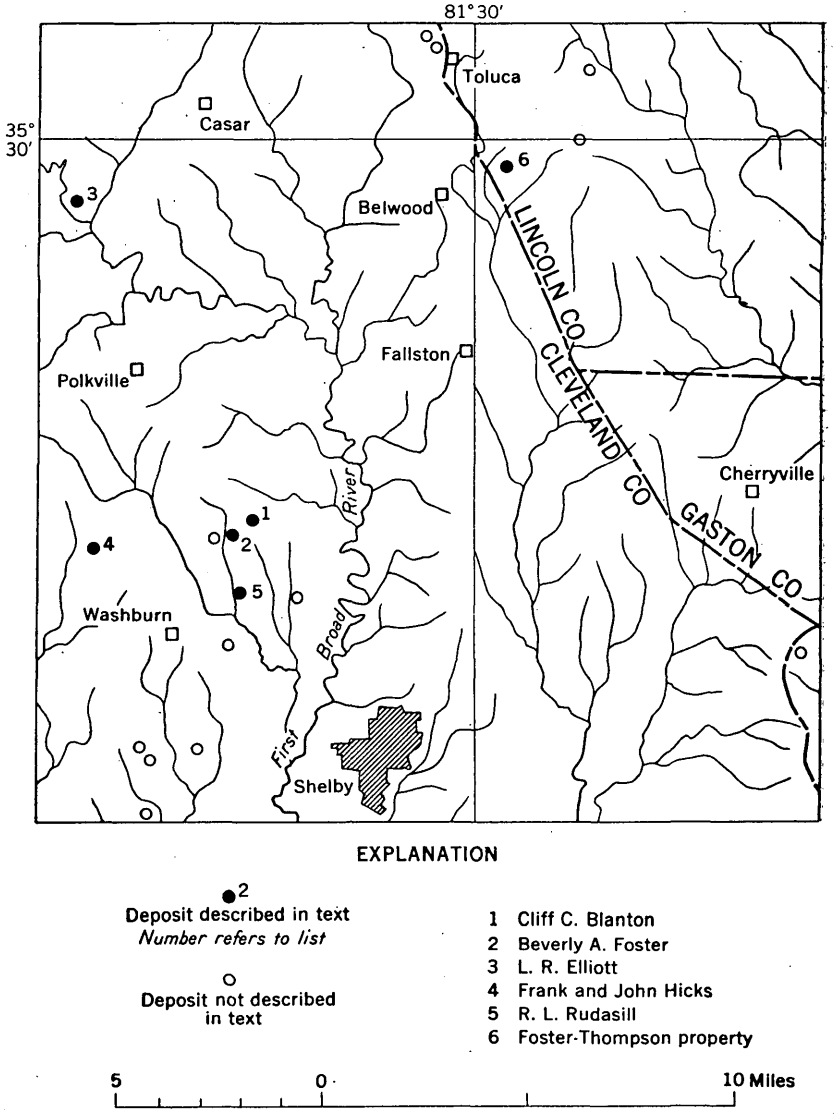

FIGURE 12.—Quartz crystal deposits of Cleveland and Lincoln Counties, N. C.

are they plentiful. The quartz crystals have been found only in the soil, but no search for them has been made in the underlying clay. A little tourmaline, some magnetite (partly altered to hematite), and sillimanite also occur with the quartz crystals.

CHARACTER OF QUARTZ

Most of the quartz crystals so far found in this smaller area are unfaced, though faced crystals are also present. Owing to their

scarcity, Mr. Blanton submitted to the National Bureau of Standards only 5 crystals, of which 4 proved to be either usable or salable. They comprised 2 crystals of grade 16–U weighing 1.14 and 0.61 pounds, 1 of grade 23–U weighing 1.52 pounds, and 1 of grade 34–F weighing 1.43 pounds. In 1947 the writer personally purchased from Mr. Blanton 4 crystals of quartz, of which 2 were too small to be usable. All proved to be of grade 1.

The absence of sheet mica in the soil, and the presence of the other minerals mentioned above, indicate that this quartz is not of pegmatitic origin. It probably is quartz of the pocket type.

BEVERLY A. FOSTER FARM

LOCATION

The Beverly A. Foster farmhouse is about three-quarters of a mile west-southwest of the Blanton farmhouse, the two being on adjoining farms. The principal locality is about 125 yards south of the house, but another locality is about 60 feet south of the house.

OCCURRENCE

The principal locality is a small area about 30 feet square where numerous small crystals of quartz have been found. Here Mr. Foster dug a shallow pit, which exposed 1 foot of soil, which was underlain by a reddish decomposed mica schist with a foliation striking N. 15° W. and dipping 35° W. In this pit a pocket of crystals was found in the decomposed bedrock, about 3 feet below the surface of the ground, unconnected with any vein of quartz or dike of pegmatite. Moreover no white vein quartz is present in the neighborhood of this pit, and no granular white quartz was observed on the Foster farm. These crystals appear to represent pocket quartz.

A few small crystals of quartz have been found at the second locality, together with much white vein quartz. This occurrence has little significance.

CHARACTER OF QUARTZ

Most of the crystals removed from the pocket at the principal site were no longer available for examination. By digging around the sides of the pit, however, the writer was able to obtain a few small low-grade crystals. From the appearance of these, together with one in the possession of the General Minerals Corporation, at Shelby, and others subsequently submitted by Mr. Foster, it is known that most of them were faced, that some of them were singly terminated, and that many of them were smoky.

One singly terminated smoky crystal from the original pocket of quartz, probably the best one, was sold by Mr. Foster to the General

Minerals Corporation. This crystal, which weighed 3.98 pounds, was submitted to the National Bureau of Standards and was found to be of grade 23–F. Another smaller crystal, submitted by the same company, may or may not have come from the same deposit. It weighed 0.64 pound and was likewise rated as grade 23–F. In January 1944 Mr. Foster submitted 5 additional samples of his quartz, probably from the same or from some nearby pocket. These were also faced crystals, but none of them proved to be salable, owing principally to the presence of gross fractures.

L. R. ELLIOTT FARM

LOCATION

The farm of L. R. Elliott is about 4¼ miles N. 20° W. of Polkville, in Cleveland County. The principal interest of the owner in 1943 was in mica mining, and his principal mica pit, which contained no clear quartz, was a few yards from his house. A second mica pit that contained quartz, however, was about 250 yards S. 25° W. of the house; and a field where clear crystals were found is about 150 yards N. 20° E. of the farmhouse.

OCCURRENCE AND CHARACTER OF QUARTZ

This deposit is worthy of mention principally because it illustrates the occurrence of quartz crystals in saprolitic pegmatite. Some nearly clear to smoky, though badly fractured, crystals of quartz were found in a pocket, or vug, in altered pegmatite at the second pit. Most of these were faced, and a few were singly terminated. They weighed up to 10 pounds. In addition to gross fractures, these crystals contained numerous bubbles and inclusions, so that none appeared possibly to be usable. No samples were submitted for testing.

Crystals of clear quartz had been picked up in earlier years within the third area, N. 20° E. of the farmhouse. Several were collected by the writer, but none of salable size was obtained. Most of the crystals found by the writer, as well as those owned by Mr. Elliott, were faced, and a few were singly terminated. No sheet mica was seen in the field, and therefore the quartz crystals are probably of nonpegmatitic origin.

FRANK AND JOHN HICKS FARM

LOCATION

The farm of Frank and John Hicks is about 8 miles N. 57° W. of Shelby, in Cleveland County. Clear quartz is known to occur at several places on this property, though no usable quartz was found. The locality seems worthy of mention because of the occurrence of one crystal of pocket quartz.

OCCURRENCE AND CHARACTER OF QUARTZ

The first locality found by the writer is a small area partly in a field and partly in a nearby gulch, about 200 yards S. 30° E. of the farmhouse. The quartz at this place was unfaced and fractured, and some mica was also present. Probably the quartz is of pegmatitic origin.

A second locality is 300 yards south of the farmhouse. One small faced crystal was found here, with little other quartz and no mica. Probably this is of nonpegmatitic origin.

A third area, about 250 yards S. 30° W. of the farmhouse, showed mainly white quartz, some of which was somewhat translucent. Some mica was also present, and the quartz may have come either from a vein or a pegmatite dike.

A fourth area is about 400 yards S. 45° W. of the farmhouse and along the banks of a gulch trending S. 18° W. Considerable partly clear quartz was seen at this locality. Bedrock was exposed at a few places, and at one place a thin vein of white quartz, from 1 to 2 inches thick and striking N. 25° W. is parallel to the foliation of the schist. Most of the bedrock is decomposed, and from one bank of the gulch a good sized smoky crystal was dug from reddish clay of schistose origin. In excavating the crystal, it broke into several pieces of a pound or more each, of which only two were moderately clear. This crystal was probably pocket quartz.

A fifth locality, about 300 yards S. 35° W. of the farmhouse, is a small patch of ground containing much sheet mica but little clear quartz. This area trends northeast for about 100 feet. The residual material was probably of pegmatitic origin.

R. L. RUDASILL, COLLECTOR

R. L. Rudasill lives on the Washburne Siding road, in Cleveland County about 2 miles from Highway 26 and about 5¼ miles northwest of Shelby.

SOURCES

Mr. Rudasill collected crystals of quartz, both as specimens for his own collection and as a commercial enterprise. Most of the crystals that he himself found came from the gravels of Little Brushy Creek north of his house, but crystals of quartz were also found by Mr. Heinrich near the northwest corner of his farm.

Little Brushy Creek drains an area where numerous quartz crystals have been found, including the farms of Cliff C. Blanton and Beverly A. Foster, already described. Many crystals are said to have been

found among the gravels of this stream, including 1 with a maximum dimension of 6 inches. All these were well rounded and appear to have been greatly abraded by stream action. The crystals found by Mr. Heinrich on the Rudasill farm were small, well faced, and doubly terminated.

CHARACTER OF QUARTZ

Mr. Rudasill made 1 shipment of quartz crystals to the Western Electric Co., at Kearny, N. J., but the report on this shipment is not known. He also made 2 small shipments to the National Bureau of Standards. These comprised 16 crystals, ranging from 0.28 to 8.78 pounds. Six of these crystals proved to be usable or salable; data on them are given below. The sources of these crystals are not known to the writer.

Quartz crystals collected by R. L. Rudasill

Weight (lb)	*Grade*	*Weight (lb)*	*Grade*
0.99	26–F	0.51	34–F
.28	24–S	.50	13–U
2.93	23–U	.52	13–U

FOSTER-THOMPSON PROPERTY

LOCATION

The Foster-Thompson property adjoins the W. T. Foster Mica Mine, which is in Lincoln County, about 1¾ miles east-northeast of Bellwood, in Cleveland County. The mineral rights of the land were, in 1943, the property of W. T. Foster.

OCCURRENCE AND CHARACTER OF QUARTZ

The Foster-Thompson property was primarily a mica mine, but according to Heinrich three small areas are known where some crystals of quartz were found. Two of these are south of the mine; the other is northeast of it. A pit sunk in the southernmost area exposed a dike of pegmatite 7 feet wide, in which some small scattered masses of milky quartz occurred. Some small distorted crystals of quartz, intergrown with mica, were found between two such masses; but numerous other faced crystals were reported to have been recovered from this pit. They are believed to have grown in vugs within the pegmatite. No crystals found at this or at the other two areas proved to be salable.

MISCELLANEOUS SOURCES IN NORTH CAROLINA

Quartz crystals from North Carolina that were usable or salable were also submitted by the following persons. The localities have not been recorded.

Miscellaneous salable quartz crystals from North Carolina

Owner	Address	Weight (lb)	Grade
D. D. Moose, collector	Stony Point, Alexander County	0. 45	13–F
Coleman Brooks	Shelby, Cleveland County	. 75	34–F
J. T. Powell	Charlotte, Mecklenburg County	2. 22	24–F
Do	do	. 69	24–F
Do	do	. 46	24–F
Do	do	. 67	13–F
Do	do	6. 87	13–U
Do	do	. 73	34–F
C. B. Sutton	Whittier, Swain County	. 60	34–F
Sprunt Wortham	Union Mills, Rutherford County	2. 00	34–F
Do	do	. 79	23–F
Do	do	. 44	24–F

OTHER SOURCES

Quartz crystals may be as widespread in South Carolina, Georgia, and Alabama as in Virginia and North Carolina. The farmers of these three States, however, were not so well informed regarding the search for oscillator quartz, and the Geological Survey did not extend its investigation into these States.

Some salable crystals, however, were submitted to the National Bureau of Standards, as shown on the following list.

Miscellaneous salable quartz crystals from Georgia and Alabama

Owner	Address	Weight (lb)	Grade
Newt E. Spence	Carrollton, Carroll County, Ga	3. 83	34–U
Do	do	1. 67	34–F
Do	do	1. 68	34–U
Do	do	. 72	34–U
Do	do	. 95	34–U
Do	do	. 90	34–F
Perry Brothers	Wedowee, Randolph County, Ala	. 82	34–F

In addition, 5 purchase orders record the shipment from Newt E. Spence to the Metals Reserve Corporation, at Hot Springs, Ark., of 23 pounds, 14 ounces of salable quartz, probably of grade 3.

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