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No 13 of 15

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TRACE ELEMENTS RECONNAISSANCE IN ALABAMA, GEORGIA, AND NORTH CAROLINA

PRELIMINARY REPORT

by

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Trace Elements Investigations - Report No. 12

SECRET
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SECRET

Contents

SECRET

Illustrations

Illustrations at back of report

SECRET

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ABSTRACT

Between February 19 and April 28, 1945 the radioactivity of a wide variety of rocks was investigated at 83 localities distributed across parts of Alabama, Georgia, and North Carolina. The rocks selected were those with which the literature or data accumulated in the Trace Elements program indicated that uranium might be associated. Uranium and thorium were of chief interest. A portable Geiger-Mueller counter was used to test rocks at the outcrop and samples in the field. The most promising samples were tested further in the laboratories of the Geological Survey.

In most of the graphitic or carbonaceous schists, coal, asphaltites, and pegmatites, the content of equivalent uranium is small and rarely amounts to as much as 0.005 percent. Data on the most radioactive rocks are summarized in the list below. Of these only the Chattanooga shale and the monazite deposits are of possible present interest.

1. The Chattanooga black shale above drainage level in northeastern Alabama carries an inferred 25,000,000 tons of rock containing from 0.007 to 0.013 percent of equivalent uranium.

2. Monazite deposits tested in North Carolina have an inferred 10,000 tons of pegmatized gneiss containing from 0.010 to 0.021 percent of equivalent uranium, chiefly as thorium, and an inferred 10,000 tons of gravel containing 0.010 to 0.015 percent of equivalent uranium. Some stream channels are estimated to have about 500 tons of gravel per mile containing about 0.010 percent of equivalent uranium. Many streams remain to be examined, but

many deposits were exhausted years ago.

3. In the Stone Mountain Granite at locality B48-0,225 tons of rock containing about 0.012 percent uranium are indicated and inferred.

4. The Erin shale in Clay County, Alabama is inferred to have 2,500 tons of rock containing 0.009 percent of uranium. A much larger tonnage may be present.

INTRODUCTION

A Geological Survey party consisting of A. P. Butler, Jr. and C. W. Chesterman spent from February 19 to April 28, 1945 in Alabama, Georgia, and North Carolina (see index map, fig. 1) testing many different types of rocks for radioactive minerals. Interest was primarily in sources of uranium and secondarily in sources of thorium and other trace elements. The work was carried out as part of the Trace Elements program of the Geological Survey.

Examination of the literature and data accumulated during the Trace Elements program indicated that uranium is or might be associated with graphitic and carbonaceous rocks, coal beds, asphaltites, deposits of monazite, and some granitic rocks and pegmatites. The purpose of the investigation was to determine whether any such rocks in the areas examined were possible sources of radioactive and other elements that might warrant more detailed study. The investigation was, therefore, purely a reconnaissance and thorough appraisal was not attempted.

In general, localities where the various rocks might be examined were selected from the literature. Specific exposures, usually road or railway cuts and less commonly mines or stream courses, were selected in the field. The examination consisted mainly of preliminary testing at the outcrop and sampling of the most

SECRET

promising part of the outcrop for field and laboratory tests of radioactivity. In all, 83 localities were visited (see figs. 2, 3, and 4). These are listed in Appendix 11. The kinds of rocks investigated and the results are briefly described and discussed in the section on "Rocks Examined".

FIELD METHODS

Use of the counter

A Geiger-Mueller counter was used to test radioactivity of samples and rocks at the outcrop. The instrument registers discharges caused by cosmic rays and gamma ray emissions of radioactive substances as clicks in earphones. The cosmic ray discharges cause an ever-present "background" of clicks that has to be taken into account in appraising the radioactivity of substances that are tested. When counting at an outcrop, where primary interest is in the general relative intensity of radioactivity, the effect of the background is roughly estimated from a brief preliminary count made at a distance from the outcrop. In testing a sample, however, the background must be determined in order to obtain the true count of the sample. This is done by taking a background count for a period of five minutes before and after each sample count while the counter tube is removed from the influence of known radioactive material. The sample is counted for two periods of five minutes. A net count of the samples is obtained by subtracting the average background count from the average sample count. In sequence with the counts of background and sample a standard sample of known radioactive content is also counted for a period of five minutes. The ratio of the net count of the sample and the standard gives a factor by which the radioactive content of the sample can be estimated from that of the standard. This content is expressed as equivalent uranium, which is the amount of uranium in equilibrium with its disintegration products that would yield the same gamma ray activity.

The following are given as examples of field determinations of equivalent uranium by this procedure:

Sample	Bg. Count	Sample Count	Stand. Count	Sample Count	Bg. Count	Avg. Bg.	Avg. Samp.	Samp. Net	Stand. Net	Equiv. U Percent
B2-A No. 3	13	36	95	30	18	15.5	33	17.5	79.5	0.009
B75-NC No. 57	13	45	102	52	19	16	48.5	32.5	86	0.016

Counting interval is five minutes.

The standard sample contained 0.042 percent of equivalent uranium. The content of a sample is computed by the equation: $\frac{\text{Samp. Net}}{\text{Stand. Net}} = \frac{X}{0.042}$ where X is the equivalent uranium content of the sample.

The field test measures only total radioactivity. This may be due to the presence of thorium and its disintegration products and to the presence of radioactive potassium as well as to uranium. Thus, the actual uranium may be considerably less than the indicated amount of equivalent uranium. On the other hand, the loss of radon in crushing samples, or the leaching of any of the disintegration products of uranium by circulating ground water, or the lack of equilibrium between uranium and its disintegration products in geologically young deposits might cause the measured amount of equivalent uranium to be less than the actual uranium. In general, however, chemical analyses show uranium to be less than the equivalent uranium.

Brief preliminary counts were made with the counter placed against the rock at intervals across exposures or dumps that were tested. Counts were generally made for a period of three minutes and computed to the rate for five minutes for ease of comparison with the time interval used in sample testing. These counts were used as guides in selecting rock to be sampled. Data accumulated during the work showed that rock which gave less than 35 or 40 counts in five minutes, with the instrument used, usually contains less than 0.005 percent of equivalent uranium. At some places preliminary counts were so much less than these amounts that sampling for a more accurate determination seemed unnecessary. At most localities, however, the rock near the station having the highest count was sampled for further testing.

Testing and sampling

In testing most of the layered or bedded rocks, counts at the outcrop were generally made at intervals of 5 feet, as it is believed that any significant amount of radioactive material would be detected with such an interval. At some places the interval was 3 feet, and at a few, in massive rocks, 10 feet. Rocks of different character adjoining those of primary interest were generally tested only by spot stations or short traverses. Dumps were tested by traverses with counting stations at intervals of not more than 10 feet. On bodies of pegmatite, stations were taken at intervals that ranged from 10 to 15 feet along exposures or as opportunity afforded. Placer ground was spot tested where opportunity afforded.

Most samples were obtained by cutting narrow channels across the appropriate interval, but in some massive rocks only chip samples could be cut. Samples were crushed to fragments having a diameter of about one-quarter inch, and about 700 grams of the material were placed in a coaxial cylindrical container for testing with the counter. In general, samples in which field tests indicated less than 0.007 percent of equivalent uranium were discarded, as the presence of large tonnages of rock that contains from 0.007 to 0.010 percent of uranium has been established by other projects of the Trace Elements program. Thus rock that contains less than 0.010 percent of uranium is of little prospective interest.[1] To allow for errors in testing, nearly all samples that contained more

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[1] Butler, A. P. Jr., and Chesterman C. W., Investigations of the Phosphoria formation in southwestern Montana: U. S. Geol. Survey Trace Elements Investigations Rept. 5, p. 14, unpublished, 1945.

_/Brill, K. G., Nelson, J. M., and Prouty, C. E., Preliminary report, Trace Elements Investigations, Hickman and adjacent counties, Tennessee: U. S. Geol. Survey Trace Elements Investigations Rept. 8, p. 14, and table 4, unpublished, 1945.

_/ Slaughter, A. L., and Clabaugh, S. E., Preliminary report on a Trace Elements reconnaissance in central and southwestern states: U. S. Geol. Survey Trace Elements Investigations Rept. 9, p. 48, unpublished, 1945.

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than 0.007 percent of equivalent uranium and a few others of particular interest because of the presence of uranium-bearing minerals were sent to the laboratories of the Geological Survey for additional tests and analyses.

Accuracy of field tests

The accuracy of tests with the field counter is affected by random variations in the intensity of cosmic ray bombardment and of gamma ray emission from the radioactive material, and by variations in the performance of the counters caused by changes of voltage in the counter circuits with use, and by changes in temperature. The effect of random variations of the cosmic and gamma rays is reduced by longer periods of counting and can be appraised by methods of statistical analysis; but the other physical factors that affect the counter and the time required to accumulate data rule out such rigid analysis as a satisfactory method of appraising most of the field data. Nevertheless, a comparison of counts of the standard sample and background supply a qualitative indication of the consistency and reliability of the field tests at different ranges of total radiation activity. The results of observations made each day, when the counter was first put into operation, are used in this appraisal and are summarized in the following table:

Comparison of the initial daily counts of background and the standard sample for intervals of five minutes

	Mean	Maximum	Minimum	Range: Above mean	Range: Below mean	Average half range as percent of mean
Background	16.6	29	10	12.4	6.6	± 57
Standard	102	125	80	23	22	± 22

Variations in the background affect the total count on the standard and have not been eliminated in the above table. It is evident from this comparison that the half-range of variation in counts for periods of five minutes is markedly less for the standard sample than for the background. This shows that, for any given period of counting, field tests of samples will be relatively more accurate and the consistency better where the content of radioactive material approaches that of the standard and still better where the radioactive content is larger. On the other hand, where the radioactivity is small the range of variation increases and the accuracy of any observation decreases. In very low-grade material the random variations of background and of the radioactivity of the material may combine either to mask the radioactivity or to greatly exaggerate it. By allowing a large limit of error for less radioactive material, the field tests are useful for screening out samples that are unworthy of further testing and for making a preliminary estimate of ranges of radioactivity.

LABORATORY METHODS

Samples believed, on the basis of field tests, to contain more than 0.007 percent of equivalent uranium and a few others have been tested by laboratory gamma ray or beta counts, and chemical analyses have been made of most of those that contain 0.010 percent or more of equivalent uranium. A comparison of field and laboratory counter determinations and the chemical analyses are given in Appendix I.

The amount of uranium as determined by chemical analyses is, in general, less than the equivalent uranium content indicated by counter determinations. In the samples from monazite deposits much of this difference is certainly due to the presence of thorium, and in other samples, although determinations of thorium are not available, much of the difference can probably be attributed to this element.

Samples were collected of most of the rock types examined and will be analyzed for other trace elements when time permits.

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SUMMARY OF RESULTS AND CONCLUSIONS

Most of the results of this reconnaissance are negative and are useful chiefly as evidence that many types of rock contain radioactive elements in amounts too small to be of interest. The pegmatites, deposits of coal and asphaltite, and most of the carbonaceous schists, slates, and gneisses are, at best, only slightly radioactive. The known area in which radioactive minerals are associated with the Chattanooga black shale was extended, and information was obtained on the distribution of radioactive minerals in some areas of granitic rocks in Georgia. Results for the rocks or areas investigated are summarized in decreasing order of merit in the following list.

Rock and Area	Tons Indicated	Tons Inferred	Probable uranium content in percent
Chattanooga black shale, Alabama		25,000,000	0.007 to 0.013*
Monazite deposits, North Carolina gneiss, 3 miles northeast of Shelby		10,000	0.010 to 0.021* mostly Th
Placer, Poundingmill Creek, Cleveland County		10,000	0.010 to 0.016* mostly Th
Stone Mountain granite, De Kalb County, Georgia	75	150	0.012
Erin Shale, Clay County, Alabama		2,500	0.009
Lithonia granite gneiss, De Kalb County, Georgia	xx	xx	0.000 to 0.006
Pegmatites, Georgia and Alabama	xx	xx	uranium-bearing mineral of mineralogic interest only
Graphitic or carbonaceous schist and gneiss, Alabama and Georgia	xx	xx	0.000 to 0.005*
Rockmart slate, carbonaceous, Polk County, Georgia	xx	xx	0.000 to 0.002*
Coal and asphaltite, Alabama	xx	xx	0.000
Tin-spodumene pegmatite, Lincoln and Cleveland Counties, North Carolina	xx	xx	0.000 to 0.003*

* Results marked in this manner are in equivalent uranium and are based mainly on laboratory gamma ray counts.

xx No estimate is made for quantity of rock containing less than 0.007 percent of uranium or equivalent uranium.

The estimates for deposits of monazite and granitic rocks apply only to the specific bodies of mineral-bearing rock examined. Because of the wide distribution of monazite-bearing stream gravels in North Carolina and the extent of granitic rocks in Georgia, a comprehensive reconnaissance could not be made in the time available. Therefore, the potential resources of the monazite deposits are probably much greater than indicated in the table, and the granitic areas, because of their size, possibly contain large tonnages of rock, chiefly in scattered bodies of the size indicated.

The foregoing summary shows that most of the rocks examined are unworthy of further attention. Some of the rocks may, however, be worth more detailed examination, if very low-grade uranium or thorium ore in the quantities here inferred becomes of interest. Conclusions with regard to the better deposits are summarized below:

North Carolina monazite deposits.--Alluvial deposits of radioactive minerals can be readily concentrated by placer operations. Detailed exploration of many stream beds and alluvial bottom lands would be necessary to establish quantities and content of uranium and thorium.

Chattanooga shale.--Exploration of the kind that has been carried out in Tennessee would be required. Trenching would be necessary in any additional work.

Stone Mountain granite and Lithonia granite gneiss.--The uranium-bearing minerals are concentrated in definite, but small, bodies and probably could easily be separated by milling. Ore bodies are small and widely scattered so that extensive and thorough detailed exploration would be needed to find them.

Erin shale.--Intensive detailed exploration would be necessary in order to trace and determine the extent of the beds now known.

SECRET

ROCKS EXAMINED

Introduction

Many types of rocks distributed over a considerable area from western Alabama through Georgia to south-central North Carolina were tested during the investigation. The individual localities and the kinds of rock are indicated on figures 2, 3, 4. The kind of rock and the optimum results are listed in Appendix II. Columnar sections of the stratified rocks at the localities of most interest show the stratigraphy, outcrop counts, and the results of field tests of equivalent uranium and chemical analyses of uranium.

For convenience of discussion the descriptions are grouped by rock types and will, therefore, depart from the order in the summary of results. Granitic rocks and pegmatites are discussed first, and sedimentary and metamorphic rocks are arranged approximately in order of age.

Granitic rocks

Introduction.--The Stone Mountain granite and granite gneiss of the Lithonia type were tested in Georgia. Attention was concentrated on pegmatitic parts of the rocks and on schlieren zones where minerals other than the common rock-forming type are most likely to be present. Seemingly unmineralized rock was checked by spot stations.

Stone Mountain granite.--The Stone Mountain granite was examined in the vicinity of the type locality, Stone Mountain, Dekalb County, Georgia, where it is well exposed. The rock is a medium-grained muscovite-biotite granite. Rosettes of tourmaline and biotite-rich schlieren are generally distributed through the mass of the rock, and pegmatite dikes that contain tourmaline and garnet are widely but sparsely distributed. Uranophane as an encrustation on joints

SECRET

in the granite was reported in 1902._/

_/ Watson, T. L., On the occurrence of uranophane in Georgia: Am. Jour. Sci., 4th Ser. vol. 13, pp. 464-466, 1902.

Two abandoned quarries, B46-G and B47-G (see fig. 3), and an operating quarry of the Stone Mountain Granite Corporation, B48-G, (see fig. 5) were visited. Only at the last place were appreciable quantities noted of a yellow, radioactive mineral, tentatively identified as uranophane, but a radioactive mineral, possibly uranophane, is present at the margin of a small pegmatite dike at locality B46-G. At locality B48-G, the uranophane is present on discontinuous, flat-lying joints that are exposed for a vertical range of about 10 feet, and together with calcite forms veins as much as 2 millimeters thick. The maximum extent of mineralization observed on an individual joint is 20 feet. Pegmatitic zones, schilieren, and areas of uranophane-bearing joints were tested by preliminary counts. Samples were cut from intervals with the highest counts and tested in the field. The chemical analysis of a sample 2 feet in length cut across rock containing a uranophane-bearing joint at locality B48-G shows 0.012 percent of uranium. Laboratory gamma ray tests of other samples from this locality show less than 0.010 percent of equivalent uranium. Laboratory test of a sample from a mineralized joint adjacent to a pegmatite dike at locality B46-G shows 0.018 of equivalent uranium, but the sample represents only the most highly mineralized rock about 0.1 foot thick.

At the quarry of the Stone Mountain Granite Corporation, locality B48-G, it is estimated that the richest uranophane-bearing area for about 30 feet adjacent to sample No. 37 contains about 75 tons of ore that would average from 0.010 to 0.012 percent of uranium. Because of the presence of uranophane on other joints in the quarry it is believed that as much as 150 tons of inferred ore is present in parts of the quarry where it is not exposed for testing.

Lithonia granite gneiss.--The Lithonia granite gneiss is widespread in Georgia,_/ but was tested only at the quarry of the Consolidated Quarries

_/ Geologic map of Georgia: Georgia Div. Mines, Mining and Geol., 1939.

Corporation, B49-G, about 3 miles north of Lithonia, where the rock is well exposed.

The rock is a well-layered biotite gneiss. Pegmatitic zones rarely as much as 2 feet in thickness and poorly defined zones of biotite schlieren parallel the gneissoid structure. Locally, a few of these contain a yellow mineral, probably uranophane, and an amorphous orange-brown, probably uranium-bearing, mineral that is associated with biotite, amethystine quartz, epidote, calcite, and sparse rounded grains of a black metallic-appearing mineral. The gneiss and the pegmatitic and schlieren zones were tested by preliminary counts of the rock along the sides of the quarry and on two loose blocks, of which one carried a pegmatite vein along one face. The block with the vein-forming minerals had the highest outcrop count and a sample 1.6 feet long cut from this rock contains, by chemical analysis, 0.006 percent of uranium. The outcrop count on the second block was comparable to the highest counts obtained on the quarry walls; and a sample cut from it contains, by laboratory test, 0.004 percent of equivalent uranium.

The ordinary gneiss of the quarry is not a potential source of uranium as the content is too small. Moreover, because of the nature of the mineralization, it is probable that even if some of the pegmatitic bodies contain greater concentrations of uranium than indicated by the preliminary sampling they would not exceed a few tens of tons in size.

Conclusions and recommendations.--Uranium-bearing minerals in the Stone Mountain granite and the Lithonia granite gneiss are concentrated in definite but small bodies and probably could easily be separated by sorting and milling.

if the small quantities of rock containing 0.01 to 0.012 percent of uranium are of interest. Because of the wide extent of the host rocks it is also probable that the number of such bodies and the total tonnage of uranium-bearing rock may be large. The bodies are small and widely scattered, however, so that extensive and thorough exploration of a considerable area, where the rocks are not well exposed, would be necessary to find them, and they are of doubtful present interest.

Pegmatites

Introduction.--Of nine pegmatites visited during the investigation, seven in Georgia and Alabama are mica pegmatites, and two in North Carolina are tin-spodumene pegmatites. The degree of exposure available and the mineralogical composition as reported in Geological Survey reports, mostly unpublished, were the basis for selecting the bodies of pegmatite to be examined.

Dumps were tested by systematic counting traverses, generally at intervals of 5 feet on thick or high dumps and 10 feet on thin dumps. Exposures of pegmatite, either on the surface or underground, were tested at intervals ranging from 10 to 15 feet, or as exposure and accessibility afforded opportunity. Tests of the country rock adjoining pegmatite bodies were made at a few places.

Alabama pegmatites.--The M and G mica mine, B10-A, Clay County, and the Arnott mica mine, B23-A, Randolph County, were examined in Alabama. The pegmatite bodies at these two mines are simple in composition and consist mainly of quartz, potash and soda-lime feldspars, and muscovite. Pink garnet, black tourmaline, and green apatite are commonly present but sparse, and beryl is scarce.

Samples were taken from both dumps and pegmatite at the stations having the largest outcrop counts and checked on the field counter. The test of a check sample from the dump of the Arnott mica mine showed 0.005 percent of equivalent uranium, and by laboratory gamma ray count a grab sample of muscovite from the sorting bin contains 0.004 percent of equivalent uranium. A sample of pegmatite at the M and O mica mine contains 0.001 percent of equivalent uranium by field count.

Radioactivity of the rock on the dumps and of the pegmatite bodies at both mines is so small that they are of no further interest as a source of uranium.

Georgia pegmatites.--Five pegmatite mines were examined in Georgia (see fig. 3) and are listed below.

B43-G Corley mica mine, Upson County

B44-G Battles-Chatfield mica mine, Monroe County

B45-G Stevens or Rock mica mine, Upson County

B61-G Amphlett mica mine, Cherokee County

B65-G Merck mica mine, Hall County

The pegmatite bodies at these mines are very similar in mineralogical composition and in texture. Quartz, potash and soda-lime feldspars, and muscovite are the chief constituents, and garnet, tourmaline, and apatite are generally present. Torbernite (?) was found in a garnet-filled vug on the dump at the Amphlett mine, but none was observed in place, and it is the only radioactive mineral noted at any of the mines. Systematic testing of dumps and pegmatite at the outcrop supported by field tests of check samples failed to reveal any noteworthy radioactivity. The laboratory count of a sample, B44-G No. 34, from the rock at the station that had the largest outcrop count of all mines showed 0.005 percent of equivalent uranium.

Because of the small amount of radioactivity none of these mines is of further interest as a source of uranium, and the chances are small that other similar pegmatites would be a promising source.

North Carolina pegmatites.--Tin-spodumene pegmatites were examined at the abandoned quarries of the Ka-Mi-Tin concentrating Company, B76-NC, 2 miles

Southeast of Lincolnton, Lincoln County, and at the quarries of the Solvay Process Company at Kings Mountain, Cleveland County, North Carolina (see fig. 4). Several other pegmatites in North Carolina have been previously examined for the Trace Elements program._/

_/ Slaughter, A. L., and Clabaugh, S. E., Preliminary report on radioactivity of some North Carolina pegmatites: U. S. Geol. Survey Trace Elements Investigations Report No. 3, unpublished, 1944.

Potash and soda-lime feldspars, quartz, and spodumene are the chief constituents of the pegmatites. Tin and several other hypogene and supergene minerals are present, but sparse or scarce._/ On the property of the Ka-Mi-Tin

_/ Kesler, T. L., The tin-spodumene belt of the Carolinas: U. S. Geol. Survey Bull. 936-J, pp. 253-255, 1942.

Concentrating Company the bodies of pegmatite are of irregular shape and deeply weathered, whereas at the Solvay Process Company quarries the bodies are tabular and have been exposed below the zone of weathering by quarrying.

A field test of a sample from a pegmatite at the Solvay Process Company quarry showed 0.005 percent of equivalent uranium, but preliminary outcrop counts at other points on the pegmatites indicated less radioactivity.

The pegmatites tested are of no interest as a source of uranium, and the chances that other similar bodies would be of interest are small.

Graphitic schists and gneisses

Introduction.--Under this heading are grouped graphitic and carbonaceous schistose and gneissoid rocks of several formations of crystalline rocks that are widely distributed in the Piedmont provinces of Alabama and Georgia. These were examined at several places in both states. Attention was concentrated on the graphitic or carbonaceous parts of the rocks, but adjacent non-graphitic rock was tested by preliminary counts at the outcrop at spot intervals or by short traverses.

Ashland mica schist.--The Ashland mica schist extends across parts of Coosa, Clay, and Randolph Counties, Alabama, and eastward into Georgia. It was examined only in Coosa and Clay Counties.

Where examined the rock is a quartz-feldspar-mica schist, locally intruded by pegmatitic material. It contains graphitic zones from which the graphite has been recovered commercially. Numerous quarries expose the graphitic zones.

Graphite-bearing parts of the formation were examined and tested by preliminary counts at the outcrop at four localities (see fig. 2). The specific localities are given in Appendix II. At each locality the interval of rock that had the largest outcrop count was sampled and tested with the field counter. None of the rock contained more than 0.006 percent of equivalent uranium, and in general the rock contains much less than this.

Because of the sparse distribution of rock showing radioactivity too small to be of interest, further investigation of this formation is not recommended.

Carbonaceous or graphitic sericite schists.--Under this heading are included the Wedowee formation, Talladega slate, Hiwassee slate, and the Canton schist of Bayley,_/ as well as graphitic schist in Clay County, Alabama, associated with and similar to the Talladega, but which may be Erin, a formation that is discussed below (pp. 21-22). The rocks of these formations are very similar and make up parts of the area of crystalline rocks that extends across the Piedmont province of eastern Alabama and northwestern Georgia. The localities examined are shown on the maps, figures 2 and 3, and are listed in Appendix II under the respective formations.

_/ Bayley, W. S., Geology of the Tate quadrangle: Georgia Geol. Survey Bull. 43, p. 43, 1928.

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For the most part all the formations consist chiefly of quartz-sericite schist. At places all of the formations are garnet-bearing, and all of them contain graphitic or carbonaceous zones, generally accompanied by pyrite. The thickest graphitic zones, and those richest in graphite, are in the Wedowee formation in Cleburne County, Alabama, and in the Talladega in Bartow County, Georgia.

At 33 localities, mainly road cuts, a total stratigraphic thickness of 1860 feet in all the formations combined was tested by preliminary counts at the outcrop and by field tests of check samples. At a few places where outcrop counts were small no check samples were taken.

A thickness of 5 feet of rock in the Wedowee at localities B17-A and B19-A, Randolph County, Alabama, contains as much as 0.005 percent of equivalent uranium by field test. A sample from 5 feet of rock at locality B51-C, Bartow County, Georgia, which was tested by laboratory gamma ray count, contains 0.002 percent of equivalent uranium. In general, however, most of the graphitic zones and by far the larger part of the graphitic rock in all the formations are not radioactive.

Because of the wide extent of the graphite-bearing schists the results of this reconnaissance cannot be considered conclusive. Nevertheless, the relatively small amount of radioactivity that was detected, and the consistency with which large parts of the graphitic zones showed little or no activity makes these rocks unpromising for comprehensive investigation.

<u>The Nantahala slate and Valleytown formation</u>.--The Nantahala slate and the Valleytown formation extend from North Carolina across northwestern Georgia at least as far as the vicinity of Canton._/ Their age is believed to be

_/ op. cit., pp. 62 and 67, 1928.

Cambrian.

The Nantahala in Fannin and Gilmer Counties, where it was tested, consists of sericitic phyllite interbedded with sparsely to moderately carbonaceous or graphitic, sericitic phyllite. The zones of carbonaceous rock range from 10 to 55 feet thick. Farther southwest in Pickens and Cherokee Counties the formation is more highly metamorphosed, is a schist rather than a phyllite, and is less carbonaceous. Notably carbonaceous parts of the Valleytown were not located in the northern part of the area, but in Cherokee County, where one exposure was tested, the rock is sericitic schist carrying graphite in thin layers.

At three localities, B62-G to B64-G, (see fig. 3) a total stratigraphic thickness of 215 feet of Nantahala, and at B60-G, 15 feet of the Valleytown were tested by outcrop counts and check samples. A 5-foot thickness of Nantahala at locality B62-G contains 0.003 percent of equivalent uranium by field test, but on the whole the rocks are not appreciably radioactive at any of the places tested.

The reconnaissance testing, although not conclusive, indicated that the chances of finding significant amounts of radioactive material in these formations are so slight that additional work is not recommended.

<u>Carolina gneiss</u>:—The Carolina gneiss is widely distributed in the Piedmont of Georgia. Graphitic parts of the gneiss were examined near Clarksville, B67-G, and southwest of Royston, B68-G (see fig. 3).

At Clarksville the rock is kyanite-bearing mica schist that carries local layers of flake graphite. Southwest of Royston the graphite-bearing rock is gneissoid-appearing mica schist much veined by pegmatite. It carries abundant graphite in several layers as much as 5 feet thick, and has been quarried for the graphite.

Field tests of samples from 5-foot intervals of rock that had the largest outcrop counts showed 0.004 percent of equivalent uranium at locality B67-G and 0.002 percent at locality B68-6. At both places, however, most of the rock is not radioactive.

The radioactivity indicated is too small to make these rocks of any further interest.

Gold mine

A long-abandoned gold mine on the west side of Yahoola Creek, 0.85 mile northeast of the square in Dahlonega, Lumpkin County, was examined. An area about 700 by 1500 feet was formerly worked by numerous open cuts and some underground openings. Exposures are poor in all of the cuts and many of the underground parts of the mine are inaccessible.

Quartz veins and lodes are parallel to and crosscut the layering of biotite gneiss. The general country rock is shown on the state geologic map as hornblende gneiss associated with the Ashland mica schist._/

_/ Geologic map of Georgia: Georgia Div. Mines, Mining and Geol., 1939.

Quartz-pyrite and quartz-pyrite-carbonate veins and lodes that appear to be the rock that was mined for gold, and dump material were tested by 12 outcrop stations at available exposures. Outcrop counts of not more than 5 per minute were so small as to indicate no radioactivity and, consequently, no samples were taken.

Chattanooga shale

Black shale of the Chattanooga is present throughout much of Alabama north of the south part of Blount County._/ In much of this area the Chattanooga

_/ Adams, G. I., Butts, Charles, Stephenson, L. W., and Cooke, Wythe, Geology of Alabama: Alabama Geol. Survey Spec. Rept. 14, pp. 158-159 and geol. map, 1926.

SECRET

is concealed beneath younger formations, but from three to five long belts of the shale crop out along the limbs of folds that extend across the northeast part of the state. On the whole, exposures are poor.

At the places where it was examined, the Chattanooga is a dark, fine-grained, carbonaceous shale very similar to that more fully described in another report._/

_/ Brill, K. G., Nelson, J. M., and Prouty, C. E., op cit. Rept. 8, p. 10.

Only two exposures were found that were satisfactory for testing at the outcrop without an undue amount of excavation. Samples were taken only at locality B24-A on State Highway 38 about 1 mile northwest of Oneonta (see fig. 2). Field tests of the three samples from the intervals of rock that had the highest outcrop counts indicated from 0.007 to 0.009 percent of equivalent uranium. Samples were not cut from rock next to stations that had lower outcrop counts. At the other locality, field tests of check samples from the intervals having the two highest outcrop counts showed that the content of equivalent uranium ranged from undetectable amounts to 0.008 percent. The samples were not kept for additional testing as interest is primarily in rock that contains more than 0.010 percent of uranium. Laboratory gamma ray tests of the samples from locality B24-A show that 3.5 feet of rock contain 0.013 percent of equivalent uranium and that another 4 feet contain 0.010 percent. Chemical analysis of the best sample, No. 30, shows 0.006 percent of uranium; thus it seems likely that only locally may the Chattanooga contain more than 0.010 percent of uranium.

The reconnaissance greatly enlarges the known area in which the Chattanooga is probably radioactive. In conjunction with the extent of the radioactivity already determined by other trace elements projects_/ the new data make it appear

_/ Brill, Nelson, and Prouty, op. cit. Rept. 8, Pl. 4.
_/ Slaughter, A. L., and Clabaugh, S. E., Eastern Black shale reconnaissance, preliminary report: U. S. Geol. Survey Trace Elements Investigations Rept. 1, p. 7, unpublished, 1944.

probable that a 3-foot thickness of the formation contains more than 0.007 percent of equivalent uranium throughout much of northeastern Alabama where carbonaceous character prevails. The formation crops out for about 120 miles on the sides of long continuous ridges in this part of the state, and it is probable that an average of at least 200 feet of the formation would be accessible above drainage level. Assuming a factor of 15 cubic feet to the ton, it is inferred that more than 25,000,000 tons of reasonably accessible rock that contains from 0.007 to 0.013 percent of equivalent uranium are present in northeastern Alabama. A much more comprehensive investigation would be required to determine content and distribution of actual uranium, but from the data obtained by others_/ it is believed

_/ Brill, Nelson, and Prouty, op. cit., Rept. 8, p. 15.

that the actual uranium would range from 50 to 60 percent of the equivalent uranium.

Further work necessary to establish the reserves in detail is recommended only if additional reserves of the Chattanooga type are of interest. Trenching would be required in any additional exploration.

Erin shale

The Erin shale is confined to the west part of Clay County, Alabama. It is of upper Paleozoic and possibly Carboniferous age_/ and closely associated

_/ Smith, E. A., Carboniferous fossils in "Ocoee" slates: Science, new ser., vol. 18, pp. 244-246, 1903.

with the Talladega slate, but may be in fault contact with that formation_/

_/ Park, C. F., Jr., Notes on the structure of the Erin shale of Alabama: Wash. Acad. of Sci. Jour. vol. 25, No. 6, pp. 276-279, 1935.

The characteristic beds of the formation are black, carbonaceous, pyrite-bearing quartz-mica phyllite.

A total stratigraphic thickness of 510 feet was examined and tested at three localities (see fig. 2) about half a mile apart. Field tests of two samples from the interval that had the highest outcrop count at locality B2-A showed 0.009 percent equivalent uranium for a thickness of 7.25 feet. Chemical analysis showed that the best sample, which represents a thickness of 3.5 feet contains 0.009 percent of uranium. Field tests of samples from other intervals at this locality that had lower outcrop counts and from intervals at the other localities that had the highest outcrop counts showed not more than 0.003 percent of equivalent uranium. The relatively rich zone indicated by the two best samples from locality B2-A is not present at other exposures and can probably be followed only by detailed exploration.

Reserves may be large, but from present data not more than 2,500 tons of rock containing 0.009 percent of uranium can be inferred within a distance of 100 feet from the sampling point.

The uranium content of the Erin shale is no better than that of several other formations already investigated in the Trace Elements program. The absence of stratigraphic guides to the position of the best beds and the consequent detailed exploration required to trace them in closely folded rocks in an area of poor exposures suggests that detailed investigation be delayed until work on more easily explored formations of similar worth is completed.

Rockmart slate

According to the geologic map of Georgia_/ the Rockmart slate underlies

_/ Geologic map of Georgia: Georgia Div. Mines, Mining and Geol., 1939.

considerable areas in the south part of Polk County. The slate was investigated at only one locality, B32-C, 0.17 miles southeast of the Seaboard Airline Railway station in Rockmart (see fig. 3).

In the quarry where the rock was tested, the slate consists of dark gray, fine-grained slate in masses at least 50 feet thick interbedded with dark gray, quartzitic slate that contains some pyrite.

A stratigraphic thickness of 220 feet was tested by preliminary counts at the outcrop. Laboratory gamma ray test of a sample taken from the interval having the highest count indicated 0.002 percent of equivalent uranium.

The radioactivity shown by outcrop counts and test of the sample is so low that the Rockmart slate is unlikely to be of prospective interest.

Asphaltites

At many places in the northwestern part of Alabama, especially in Lawrence and Colbert Counties, oolitic limestone of the Gasper formation and the Bethel sandstone are impregnated with asphalt._/

_/ Adams, Butts, Stephenson, and Cooke, op. cit., pp. 184, 186.

Asphaltic parts of the formation were tested at one locality each. These are quarries where the rocks are well exposed. At locality B26-A (see fig. 2) 11.5 feet of the Gasper oolite were tested by preliminary counts at the outcrop, and at locality B27-A nine feet of the Bethel sandstone were similarly tested. Outcrop counts were relatively small, less than five in a minute. Check samples showed no radioactivity.

Although the investigation was not comprehensive, the rocks tested were at those localities where the asphaltic rocks are reported to be present in the largest quantities. The chances that these rocks contain appreciable quantities of radioactive minerals are, therefore, so small that further work is not recommended.

SECRET

Coal

Coal is present in extensive areas east and west of Birmingham, Alabama. Of these areas, the Cahaba field southeast of Birmingham and the Warrior field northwest of Birmingham are the largest. In them the upper part of the Pottsville formation contains numerous seams of coal._/

_/ Adams, Butts, Stephenson, and Cooke, op. cit., p. 211.

In the Warrior field, four exposures in road cuts and mines and one grab sample from a dump were tested (see fig. 2). At locality B28-AIII the coal tested forms the Jagger seam. The names and stratigraphic position of the other seams are not known. In the Cahaba field, the Wadsworth and another unidentified seam exposed at the entrances of abandoned mines were tested.

Outcrop counts were so low in relation to background counts that no samples were taken. The coal tested is essentially non-radioactive.

Coal seams in both fields are numerous, and the investigation included only a few of them. The points tested are, however, fairly well distributed geographically and to some extent stratigraphically. Thus, although the testing was not comprehensive or conclusive, it is believed that the Alabama coal fields are unpromising as a source of radioactive minerals.

Monazite deposits

Introduction.--Monazite has been recovered from many places in several counties of North Carolina and South Carolina._/ The deposits examined in this

_/ Sterrett, D. B., Monazite deposits of the Carolinas: U. S. Geol. Survey Bull. 340, p. 274, 1907.

investigation are in Rutherford, Cleveland, McDowell, and Burke Counties, North Carolina. Monazite is a source of thorium and, in this region, was recovered commercially, chiefly from placer deposits, until about 1915. Interest in the present investigation was primarily in determining whether uranium-bearing minerals are present as well as monazite.

Monazite is present in the gneissic rocks at many places in this general area and these rocks are the primary source.—/ It is most abundant in pegmatized

_/ Sterrett, op. cit., Bull. 340, p. 281.

phases of the Carolina gneiss—/ but is generally present in amounts too small

_/Pratt, J. H., Zircon, monazite and other minerals used in the production of chemical compounds employed in the manufacture of lighting apparatus: N. Car. Geol. Survey Bull. 25, p. 46, 1916.

to make recovery feasible.—/ It is also present as detrital grains in gravels

_/ Sterrett, op. cit., Bull. 340, p. 281.

of the stream courses and of the alluvial deposits adjacent to them.

Deposits in pegmatized gneiss.--Pegmatized gneiss and pegmatite bodies in the gneiss were tested at three localities, B69-NC, B74-NC, and B75-NC (see fig. 4). At B74-NC, outcrop counts of a pegmatite that has been mined for mica indicated no radioactivity. At B69-NC, a thickness of 30 feet of gneiss, of which some is intensely pegmatized, was tested by outcrop counts and a sample from the best interval contains, by laboratory count, 0.003 percent of equivalent uranium. At B75-NC, where the rock was formerly mined from open cuts for monazite, 22.5 feet, in several different layers from 3 to 5 feet thick, out of a total of 54 feet tested by outcrop counts contain, by laboratory count, more than 0.010 percent of equivalent uranium. The best thickness of 3 feet contains 0.21 percent of equivalent uranium, probably mostly thorium as the chemical analysis of this sample shows only 0.003 percent of uranium. The richer parts of the rock make up several bodies that range from 3 to 6 feet in thickness. The other dimensions are not known. The most intensely pegmatized gneiss is estimated to constitute

SECRET

from 30 to 80 percent of the thickness of the rock examined and tested. It is believed that the richer parts would be proportionately no greater laterally than they are across the gneissic structure.

About 10,000 tons of ore in several bodies of pegmatized gneiss containing from 0.011 to 0.021 percent of equivalent uranium are inferred within 100 feet laterally and down the dip from the sampling points. Exposures are limited to old cuts so that the lateral extent of the most abundantly mineralized rock is not known, and the potential tonnage may be very much larger. As the property was formerly worked for monazite, and as chemical analyses of samples 56 and 57 show that actual uranium ranges from 10 to 15 percent of the equivalent uranium, most of the radioactivity must be attributed to thorium.

Placer deposits.--In the stream courses the monazite is probably most abundant in the gravel bars of streams near areas of source rock. In the alluvial deposits adjacent to the streams it appears to be most abundant in gravel beds at the base of the flood plains. The upper part of flood plain deposits consists chiefly of sand. The thickness of the sand ranges from 3 to 5 feet. At some places slope wash, which mantles the stream deposits near the foot of some slopes, also contains monazite._/

_/ Sterrett, op. cit., Bull. 340, p. 280.

The top of the gravels underlying the sand of the flood plains appears to be mainly at or near the level of the present stream beds, and the gravel is rarely well exposed. From the position of the gravel, it is believed that it was deposited essentially at the present grade of the streams as they migrated over their valley bottoms and was buried by the overlying sand, which is deposited adjacent to the main channels in periods of flood. It is probable, therefore, that the composition of the gravel adjacent to the present stream courses is very similar to that of the stream channels themselves, and that it constitutes only a part, probably from 30 to 50 percent of the lower portion of the stream deposits.

At some places where the alluvial deposits are thin the gravel consists of a single layer of pebbles, but gravel is reported to be as much as 8 feet thick._/ Commonly it ranges from 1 to 3 feet in thickness._/ Observations for

_/ Sterrett, op. cit., Bull. 340, p. 280.

_/ Pratt, J. H., op. cit., pp. 51-52.

this reconnaissance were limited to natural exposures, and no exploration was attempted. At many places no gravel was observed, but it was not determined whether this is due to the absence of gravel or to the fact that it is at or below the present stream grade.

Exposures were good enough to permit systematic testing at the outcrop only at locality B69-NC. Elsewhere observations were made as opportunity afforded. Along some streams only one outcrop test was made, and on a few streams tests were made at as many as four stations on exposures of gravel bars or gravel in the banks. In addition, heavy minerals were concentrated by panning at five localities. At three localities tested in McDowell County (see fig. 4), outcrop counts were so low that no samples were taken. The deposits near those localities are at best only slightly radioactive. At most other localities in Rutherford and Cleveland Counties, outcrop counts and field tests of samples indicated that the equivalent uranium content is less than 0.010 percent. Some of the gravel, however, both of the stream bars and adjacent flood plain deposits at locality B80-NC contain as much as 0.016 percent of equivalent uranium by laboratory test. Chemical analysis of one sample, number 71, shows that actual uranium is only 0.004 percent. The amounts of heavy minerals concentrated by panning were too small to test quantitatively with the field counter, and laboratory beta ray counts are not yet available. The heavy minerals represent from 0.36 to 1.5

percent of the material panned, and visual inspection shows that monazite forms a large part of all the concentrates. The largest amount of concentrates was obtained at locality B80-NC. Outcrop counts of flood plain sand showed that in most of it the concentration of radioactive minerals is too small to be of interest.

Gravel deposits of many of the stream courses in this general area were formerly worked for monazite. Some of these deposits such as localities B77-NC and B78-NC, where outcrop counts of tests of samples indicate a content ranging from 0.005 to 0.009 percent of equivalent uranium, appear to have been at least partly replenished by stream deposition since operations ceased. The present investigation shows only that stream course gravels in some streams are a potential source of radioactive minerals, chiefly monazite. The examination was not comprehensive enough to indicate the distribution and extent to be expected along the stream courses. It is estimated, however, that the more promising stream gravels would yield on the order of 500 tons of gravel per mile that would contain from 0.010 to 0.018 percent of equivalent uranium, chiefly as thorium.

Many of the best deposits of bottom land alluvial gravel were probably exhausted by the time monazite mining ceased. Unlike deposits in the stream courses, these deposits have not been replenished. Outcrop tests show that most of the radioactive minerals were removed from the rock that was placered. Much land that was once worked has been returned to farm, and without adequate excavation it is difficult to determine what deposits of gravel have been worked. Only on Poundingmill Creek, B80-NC, was apparently undisturbed bottom land gravel containing more than 0.010 percent of equivalent uranium found. On the assumptions that the gravel of the flood plain deposits constitutes about 30 percent of a layer 2 feet thick in the lower part of the deposit, and that this deposit extends 2,000 feet along the stream and averages about 200 feet wide, it is inferred that, in round numbers, about 10,000 tons of gravel containing from 0.010

to 0.016 percent of equivalent uranium are present.

Because one of the primary objectives of the investigation was to determine whether uranium-bearing minerals as well as monazite are present in the gravels. It seemed better to investigate several streams rather than any one in detail. All possible streams could not be investigated. Consequently, it is impossible adequately to appraise the resources of the region. Systematic sampling of stream courses and exploration of the bottom lands by test pitting would be necessary to make any reasonable estimate of the volume and grade of gravel that is present. Alluvial bottom land of Poundingmill Creek is the only deposit of possible promise detected in the investigation for this report. Here, as is probably also true of the other placer deposits, the chief radioactive element is undoubtedly thorium. Most of the richer deposits are undoubtedly exhausted, but thorough investigation probably would still reveal additional deposits.

Although much exploration would be required, the relative ease with which minerals can be concentrated from placer deposits would make this region worth more attention whenever concentration from relatively small deposits containing from 0.010 to 0.020 percent of equivalent uranium is of interest.

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Appendix I

List of samples tested for uranium by laboratory gamma ray count and chemical analysis

Locality and sample No.	Description	Thickness Feet	Percent Equivalent U by field count	Percent Equivalent U by lab. count	Percent uranium chemical
B1-A - 2	Graphitic Ashland mica schist	5.0	0.006	0.003	
B2-A - 3	Graphitic phyllite of Erin shale	2.5	0.009		0.009
- 4		2.75	0.009		0.005
B23-A- 20	Scrap mica	grab	0.004	0.004	
Ceylon graphite mill-25	Mill head of graphitic Ashland mica schist	grab	0.005	0.003	
B24-A- 28	Chattanooga shale	4.0	0.007	0.010	
29		4.0	0.007	0.009	
30		3.5	0.009	0.013	0.006
B44-G- 34	Mica pegmatite	3.0	0.001	0.005	
B46-G- 35	Pegmatite in Stone Mountain granite	0.1	0.010	0.018	
B48-G- 36	Stone Mountain granite veined with uranophane	3.0	0.005	0.009	
37	Stone mountain granite veined with uranophane and pegmatite	2.0	0.015	0.021	0.012
38	Stone Mountain granite and pegmatite	1.7	0.006	0.006	
B49-G- 39	Lithonia gneiss and pegmatite	1.5	0.006	0.011	0.006
40	Lithonia biotite gneiss	2.0	0.006	0.004	
B51-G- 42	Graphitic mica phyllite of Talladega slate	5.0	0.004	0.002	
B52-G- 43	Dark gray Rockmart slate	5.0	0.005	0.002	
B54-G- 48	Graphitic, sericitic phyllite of the Nantahala slate	5.0	0.006	0.002	
B57-G- 50	Graphite-kyanite-mica schist of the Carolina gneiss	5.0	0.004	0.003	

SECRET

Appendix I (continued)

Locality and sample No.	Description	Thickness Feet	Percent Equivalent U by field count	Percent Equivalent U by lab. count	Percent uranium chemical
B69-NC - 52	Pegmatized gneiss	5.0	0.005	0.003	
53	Stream bank gravel	2.2	0.005	0.005	
54	Black sand, magnetic reject (?)	grab	0.027	0.017	0.006
55	Pan concentrate	3 cu. ft.			
B75-NC - 56	Pegmatized gneiss	3.0	0.011	0.021	0.003
57		3.0	0.017	0.019	0.002
58		3.0	0.016	0.013	
59		3.0	0.009	0.014	
60		2.0	0.009	0.013	
61		3.0	0.013	0.014	
62		3.0	0.008	0.008	
63		3.0	0.008	0.009	
64		3.0	0.012	0.011	
65		2.5	0.013	0.011	
66	Pan concentrate of heavy minerals from gravel	1 cu. ft.			
B77-NC - 68	Gravel of stream bar	grab	0.009	0.009	
69	Pan concentrate of heavy minerals from gravel	0.25 cu. ft.			
B78-NC - 70	Pan concentrate of heavy minerals from stream gravel	0.25 cu. ft.			
B80-NC - 71	Gravel from stream bank	1.4	0.015	0.016	0.004
72	Pan concentrate of heavy minerals from stream gravel	0.25 cu. ft.			
B83-NC - 73	Spodumene pegmatite	4.0	0.005	0.005	

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Appendix 11

Localities where rocks were tested

The results of field and laboratory gamma ray counts are expressed as equivalent uranium; chemical analyses in percent of actual uranium.

The best sample or the best thickness of rock is governed by chemical analysis where available; by laboratory gamma ray count, if no chemical analysis is available; and by field count, if tests were not made by other methods.

The data for granitic rocks and pegmatites give the number of stations where outcrop counts were made. This serves as a rough index of the amount of work done, because, in general, stations were taken at intervals along the length of prominent lithologic or structural features or at intervals across homogeneous material such as dumps and massive rock. For much the same reason, in stratified rocks the thickness that was tested is given.

Information is listed by rock types in the order in which they are discussed in the text.

Locality	Number of stations	Number of samples	Best sample: Thickness feet	Percent uranium: Equivalent U Field	Equivalent U lab.	Chemical analysis
Stone Mountain Granite						
B46-G.--Central part of idle quarries on south side of Stone Mountain, Dekalb Co., Georgia	15	1	0.1	0.01	0.018	
B47-G.--Abandoned quarries on north and northwest sides of Stone Mountain, Dekalb Co., Georgia	29	0	0	* **		
B48-G.--Quarry of Stone Mountain Granite Corporation, about 0.3 mile southeast of Stone Mountain, Dekalb Co., Georgia	33	3	2.0	0.015	0.021	0.012

SECRET

Locality	Number of stations	Number of samples	Best sample: Thickness feet	Percent uranium: Equivalent U Field	Percent uranium: Equivalent U lab.	Percent uranium: Chemical analysis
Lithonia Granite Gneiss						
B49-G.--Quarry of Consolidated Quarries Corporation, 0.25 mile east of State Highway 124 at a point 3 miles north of Lithonia, DeKalb Co., Georgia	21	2	1.6	0.006	0.011	0.006
Pegmatites						
B10-A.--M and G mica mine in NW. ¼ Sec. 15, T. 19 S., R. 8 E., Clay Co., Alabama						
Dump	27	1	5.0	0.000		
Pegmatite	14	1	1.0	0.001		
B22-A.--Arnott mica mine in NW. ¼ Sec. 2, T. 15 S., R. 10E., Randolph Co., Alabama						
Dump	24	1	grab	0.005		
Pegmatite	22	1	4.0	0.001		
Mica	none	1	grab	0.004	0.004	
B43-G.--Corley mica mine. On south side of Thomaston-Triune Mills road 200 feet east of bridge across east branch of Swift Creek, Upson Co., Georgia						
Dump	27	1	grab	0.001		
Pegmatite	17	1	2.0	0.000		
B44-G.--Battles-Chatfield mica mine, 2.1 miles west of State Highway 74 by a road 0.9 mile north of Culloden, Monroe Co., Georgia						
Dump	12	1	5.0	0.000		
Pegmatite	21	1	3.0	0.001	0.005	
Mica	none	1	grab	0.004		
B45-G.--Stevens or Rock mica mine about 1,000 feet north of State Highway 74, 7.7 miles east of Thomaston, Upson Co., Georgia						
Dumps	28	1	5.0	0.001		
Pegmatite	3	0		* **		

Locality		Number of stations	Number of samples	Best sample: Thickness feet	Percent uranium: Equivalent U Field Lab.	Percent uranium: Chemical analysis
B51-G.--Amphlett mica mine, 6.7 miles by road east of Ball Ground, Cherokee Co., Georgia	Dumps	23	1	2.0	0.002	
	Pegmatite	19	1	1.3	0.000	
B65-G.--Merck mica mine, 1.0 mile from end of pavement on Grape Street, Gainesville, Hall Co., Georgia	Dumps	21	0	0	* **	
	Pegmatite	11	2	1.5	0.002	
B76-NC.--Tin-spodumene. Cuts and adits of Ka-Mi tin mine 800 feet east of U. S. Highway 321, 2 miles south of Lincolnton, Lincoln Co., N. Car.		22	1	4.0	0.000	
B82-NC.--Tin-spodumene. Cuts of Solvay Process Company at south city limits, Kings Mountain, Cleveland Co., N. Car.		33	1	4.0	0.005	0.005
		Thickness tested Feet	**Thickness sampled Feet**			
		Ashland mica schist				
B1-A.--Quenelda graphite pits, NW. ¼, SE ¼ Sec. 19, T. 20 S., R. 7 E., Clay Co., Alabama		120	10.0	5.0	0.006	
B7-A.--Goodwater graphite pit, 0.1 mile east of Central of Georgia Railway bridge on Hatchet Creek about 2 miles west of Goodwater, Coosa Co., Alabama		50	5.0	5.0	0.000	
B8-A.--C. B. Allen graphite pit, SW. ¼ Sec. 20, T. 20 S., R. 7 E., Clay Co., Alabama		50	5.0	5.0	0.003	

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample Thickness Feet	Percent uranium Equivalent U Field	Percent uranium Equivalent U Lab.	Chemical analysis
B54-G.--Road cut on State Highway 53, 1.7 miles west of County Line between Gordon and Pickens Cos., Georgia	20	5.0	5.0	0.000		
		Canton schist				
B55-G.--Road cut on Canton-Hickory Flat road, 1.85 miles east of junction with State Highway 5, Cherokee Co., Georgia	100	5.0	5.0	0.003		
B56-G.--Road cut on Canton-Hickory Flat road, 1.6 miles east of junction with State Highway 5, Cherokee Co., Georgia	105	0	0	* **		
B57-G.--Road cut on Canton-Hickory Flat road, 1.5 miles southeast of junction with State Highway 5, Cherokee Co., Georgia	85	10	5.0	0.003		
B58-G.--Road cut on county road from Oakland School to Ball Ground, 1.75 miles northwest of junction with Orange-Creighton road, Cherokee Co., Georgia	40	0	0	* **		
		Wedowee formation				
B5-A.--Cut on north side of Central of Georgia Railway in vicinity of milepost 374 about 0.5 mile southeast of Goodwater station, Coosa Co., Alabama	70	5.0	5.0	0.000		
B6-A.--Road cut on State Highway 9, Clay Co., 3.2 miles north of bridge over Central of Georgia Railway at Goodwater, Alabama	138	40	5.0	0.000		
B11-A.--Road cut on U. S. Highway 241 about 10 miles east of Alexander City and 0.2 mile south of Jacksons Gap railroad station, Tallapoosa Co., Alabama.	80	0	0	* **		
B12-A.--Cut of abandoned railroad on old location of Central of Georgia Railway at Jacksons Gap, Tallapoosa Co., Alabama	35	0	0	* **		

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample: Thickness Feet	Percent uranium: Equivalent U Field	Equivalent U Lab.	Chemical analysis
B9-A.--Pocahontas mine, Alabama Flake Graphite Company, SE. ¼ Sec. 21, T. 20 S., R. 7 E., Clay Co., Alabama						
Outcrop	60	5.0	5.0	0.000		
Concentrate, graphite		grab		0.000		
Ceylon graphite mine, 8 miles west of Goodwater, Coosa Co., Alabama						
Heads		grab		0.006	0.003	
Concentrate, graphite		grab		0.002		
Talladega slate						
B20-A.--Road cut on county road, 0.55 mile south of bridge across Little Hatchett Creek, Sec. 29, T. 21 S., R. 6 E., Clay Co., Alabama	35	5.0	5.0	0.001		
B21-A.--Road cut on county road, 0.1 mile north of bridge across Little Hatchett Creek, Sec. 29, T. 21 S., R. 6 E., Clay Co., Alabama	105	5.0	5.0	0.000		
B22-A.--Exposures on old road, near line between Sec. 15 and 16, 0.75 mile east of church and road junction in Sec. 16, T. 21 S., R. 6 E. Clay Co., Alabama	15	0	0	* **		
B50-G.--Abandoned quarry N. 30° E. 350 feet from phone pole 31 in mile 42 (No. 41/31) on N. C. & St. L. R.R. east of Emerson, Bartow Co., Georgia	125	5.0	5.0	0.000		
B51-G.--Abandoned quarry on the south side of Pumkinvine Creek about 2 miles south of Emerson, Bartow Co., Georgia	167	5.0	5.0	0.004	0.002	
B53-G.--Road cut on State Highway 53, 1.3 miles east of County Line between Gordon and Pickens Cos., Georgia	7	0	0	* **		

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample Thickness Feet	Percent uranium Equivalent U Field	Lab.	Chemical analysis
B13-A.--Drainage ditch on Wedowee-Omaha road, 8 miles east of Wedowee, Randolph Co., Alabama	15	0	0	* **		
B14-A.--Road cut on Wedowee-Omaha road, 4.5 miles east of Wedowee, Randolph Co., Alabama	10	0	0	* **		
B15-A.--Road cut on State Highway 48, 0.45 mile west of Wedowee, Randolph Co., Alabama	5	0	0	* **		
B16-A.--Road cut on State Highway 48, 3.02 miles west of Wedowee, Randolph Co., Alabama	4	0	0	* **		
B17-A.--Road cut on State Highway 48, 4.55 miles west of Wedowee, Randolph Co., Alabama	7	2	2.0	0.005		
B18-A.--Road cut on State Highway 48, 5.0 miles west of Wedowee, Randolph Co., Alabama	10	0	0	* **		
B19-A.--Road cut on State Highway 48, 5.25 miles west of Wedowee, Randolph Co., Alabama	7	2	2.0	0.005		
B33-A.--Road cut on U. S. Highway 78A, 5.3 miles west of State Line, Cleburne Co., Alabama	145	5.0	5.0	0.000		
B34-A.--Road cut on U. S. Highway 78A, 4.85 miles west of State Line, Cleburne Co., Alabama	70	0	0	* **		
B35-A.--Road cut on U. S. Highway 78A, 4.65 miles west of State Line, Cleburne Co., Alabama	55	5	5.0	0.000		
B36-A.--Road cut on U. S. Highway 78A, 4.32 miles west of State Line, Cleburne Co, Alabama	90	5	5.0	0.000		
B37-A.--Road cut on U. S. Highway 78A, 3.82 miles west of State Line, Cleburne Co., Alabama	40	5	5.0	0.002		
B38-A.--Road cut on U. S. Highway 78A, 3.22 miles west of State Line, Cleburne Co., Alabama	120	5	5.0	0.005		

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample Thickness Feet	Percent uranium Equivalent U Field	Lab.	Chemical analysis
B39-A.--Road cut on U. S. Highway 78A, 2.87 miles west of State Line, Cleburne Co., Alabama	15	0	0	* **		
B40-A.--Road cut on old road just off U. S. Highway 78A, 2.41 miles west of State Line, Cleburne Co., Alabama	20	0	0	* **		
B41-A.--Road cut on U. S. Highway 78A, 162 miles west of State Line, Cleburne Co., Alabama	25	0	0	* **		
B42-A.--Road cut on U. S. Highway 78A, 0.82 mile west of State Line, Cleburne Co., Alabama	10	0	0	* **		
Hiwassee slate						
B59-G.--Road cut on Jasper-Salem Church road, 3.4 miles southeast of Jasper, Pickens Co., Georgia	120	5	5.0	0.001		
Valleytown formation						
B60-G.--Road cut on Keithsburg-Burroughs road, 3 miles Northwest of Keithsburg, Cherokee Co., Georgia	15	0	0	* **		
Nantahala slate						
B62-G.--Road cut on U. S. Highway 76, 1.4 miles east of railroad station, Blue Ridge, Fannin Co., Georgia	35	5	5.0	0.003		
B63-G.--Road cut on State Highway 5, 0.9 mile northwest of railroad station, Blue Ridge, Fannin Co., Georgia	70	5	5.0	0.001		

SECRET

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample: Thickness Feet	Percent uranium: Equivalent U Field	Percent uranium: Equivalent U Lab.	Percent uranium: Chemical analysis
B54-G.--Road cut on county road, 1.0 mile southeast of bridge at East Ellijay, Gilmer Co., Georgia	90	5	5.0	0.006	0.002	
Carolina gneiss						
B57-G.--Kinsey property formerly operated by Southern Mining and Milling Co., about 1.2 miles north of and 1.65 miles by road from Clarkesville, Habersham Co., Georgia	45	5	5.0	0.004		
B60-G.--Old open cut about 200 feet east of Broad River about 7 miles southwest of Royston, Madison Co., Georgia	71	5	5.0	0.002		
Gold mine						
B66-G.--Abandoned mine on west side of Yahoola Creek, N. 70°E. from square in Dahlonega, Lumpkin Co., Georgia	12 sta.	0	0	* **		
Chattanooga shale						
B24-A.--Road cut on State Highway 38, about 1 mile northwest of traffic light in Oneonta, Blount Co., Alabama	30	11.5	3.5	0.009	0.013	0.006
B25-A.--Road cut on southwest side of county road, 0.9 mile northwest of junction with U. S. Highway 11, Keener, Etowah Co., Alabama	19	6	3.0	0.008		
Erin shale						
B2-A.--Cut on north side of the Atlanta, Birmingham and Coast Railroad in vicinity of milepost 361, 0.8 mile southwest of Erin station, Clay Co., Alabama	290	22	3.5	0.009	[illegible]	0.009

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample Thickness Feet	Percent uranium Equivalent U Field	Lab.	Chemical analysis
B3-A.--Road cuts on Erin-Clairmont Springs road at distances of 0.25 to 0.45 mile west of road junction in Erin, Clay Co., Alabama	155	9	5.0	0.000		
B4-A.--Road cuts on Erin-Pyriton road, 0.15 to 0.2 mile northeast of road junction in Erin, Clay Co., Alabama	55	0	0	* **		
Rockmart slate						
B52-C.--Quarry of O. C. Davis, 300 feet northeast of Seaboard Airline Railway 0.17 mile southeast of Rockmart station, Polk Co., Georgia	220	5	5.0	0.005	0.002	
Asphaltite						
B25-A.--Gasper oolite. Quarry of Alabama Asphaltic Limestone Co., about 2 miles south of Margerum, Colbert Co., Alabama	12	3	3.0	0.000		
B27-A.--Bethel sandstone. Abandoned quarry on the Hargett Tract, about 2.3 miles south of U. S. Highway 72 at Cherokee, Colbert Co., Alabama	9	3	3.0	0.000		
Coal						
B28-A I.--Road cut 0.4 mile west of Oakman, Walker Co., Alabama	2.3	0	0	* **		
B28-A II.--Mine dumps about 1 mile west of State Highway 18 at a point about 2 miles south of Jasper, Walker Co., Alabama		grab sample		0.000		
B28-A III.--Jagger seam. Portal of Debardeleben Coal Corp. mine, about 1.5 miles southwest of Oakman, Walker Co., Alabama	4	0	0	* **		

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample Thickness Feet	percent uranium Equivalent U Field	Lab.	Chemical analysis
B29-A.--Road cut on county road 1.15 miles west of Dora, Walker Co., Alabama	4	0	0	* **		
B30-A.--Road cut on U. S. Highway 78, 4.1 miles east of bridge across Locust Fork of Warrior River, Jefferson Co., Alabama	3	0	0	* **		
B31-A.--Abandoned mine on southeast side of county road 2.9 miles southwest of junction with State Highwau 91 at a point 1.15 miles west of Cahaba River bridge, Shelby Co., Alabama	3	0	0	* **		
B32-A.--Wadsworth seam. Portal of abandoned mine near Pen Coal Company and adjacent to State Highway 91, 0.5 mile southeast of Cahaba River bridge, Shelby Co., Alabama	8	0	0	* **		
Monazite deposits						
B69-NC.--Sandy Run Creek, 6.5 miles on Hollis road from Ellenboro, Rutherford Co., N. Car.						
Gneiss	48	6	6.0	0.005		0.003
Placer	9 sta.	2.2	2.2	0.005		0.006
Concentrate		3 cu. ft.				not available
Magnetic rejects (?)				0.027		0.017
B70-NC.--Stream sand and gravel on small tributary to Southeast Muddy Creek 1.0 mile west of Kirksey McDowell Co., N. Car.	2 sta.	0	0	* **		
B71-NC.--Northeast of bridge on South Muddy Creek 0.5 mile northwest of Dysortville, McDowell Co., N. Car.	2 sta.	0	0	* **		
B72-NC.--North Muddy Creek near crossing of State Highway 26 northeast of Nealswood P. O., McDowell Co., N. Car.	2 sta.	0	0	* **		

SECRET

Locality	Thickness tested Feet	Thickness sampled Feet	Best sample: Thickness Feet	Percent uranium: Equivalent U Field	Equivalent U Lab.	Chemical analysis
B73-NC.--North side tributary of North Muddy Creek, 0.8 mile west of U. S. Highway 221, McDowell Co., N. Car.	2 sts.	0	0	* **		
B74-NC.--Mica mine on north side of Hollis road 3.85 miles north of U. S. Highway 74 at Ellenboro, Rutherford Co., N. Car.	13 sts.	0	0	* **		
B76-NC.--Open cut and stream deposits, location of former British Monazite Co. on land of C. C. Champion about 3 miles northeast of Shelby courthouse, Cleveland Co., N. Car.						
Gneiss	64	28	3.0	0.011	0.021	0.003
Stream gravel	6 sts.	grab		0.006		
Pan concentrate	0.25 cu. ft.					not available
B77-NC.--Little Knob Creek near bridge on county road 2.4 miles ~~west~~ east of State Highway 10, Cleveland Co., N. Car.						
Stream gravel	4 sts.	grab		0.009	0.009	
Pan concentrate	0.25 cu.ft.					not available
B78-NC.--Small stream on west side of Carpenter Knob and tributary to Knob Creek, 0.29 mile upstream from county road 1.3 miles east of Carpenters Grove, Cleveland Co., N. Car.						
Stream gravel	3 sts.	0	0	* **		
Pan concentrate	0.25 cu. ft.					not available
B79-NC.--Small stream of east side of Carpenters Knob, tributary to Knob Creek, crosses county road 1.7 miles east of Carpenters Grove, Cleveland Co., N. Car.	2 sts.	0	0	* **		
B80-NC.--Poundingmill Creek upstream from bridge on county road 2.5 miles northeast of Carpenter Grove, Cleveland Co., N. Car.						
Gravel	4 sts.	1.4	1.4	0.015	0.016	0.004
Pan concentrate	0.25 cu. ft.					not available

Locality	Thickness tested	Thickness sampled	Best sample Thickness Feet	Percent uranium Equivalent U Field	Lab.	Chemical analysis
B81-NC.--Jacob Fork River at bridge on State Highway 18, Burke Co., N. Car.	1 sta.	0	0	* **		
B82-NC.--Camp Creek about 200 feet upstream from bridge on State Highway 18, Burke Co., N. Car.	1 sta.	0	0	* **		

The symbol * ** in the column for field determination of equivalent uranium indicates that no sample was taken because outcrop counts indicated little or no radioactivity. On many monazite deposits, samples were not taken where the outcrop counts indicated less than 0.01 percent of equivalent uranium.

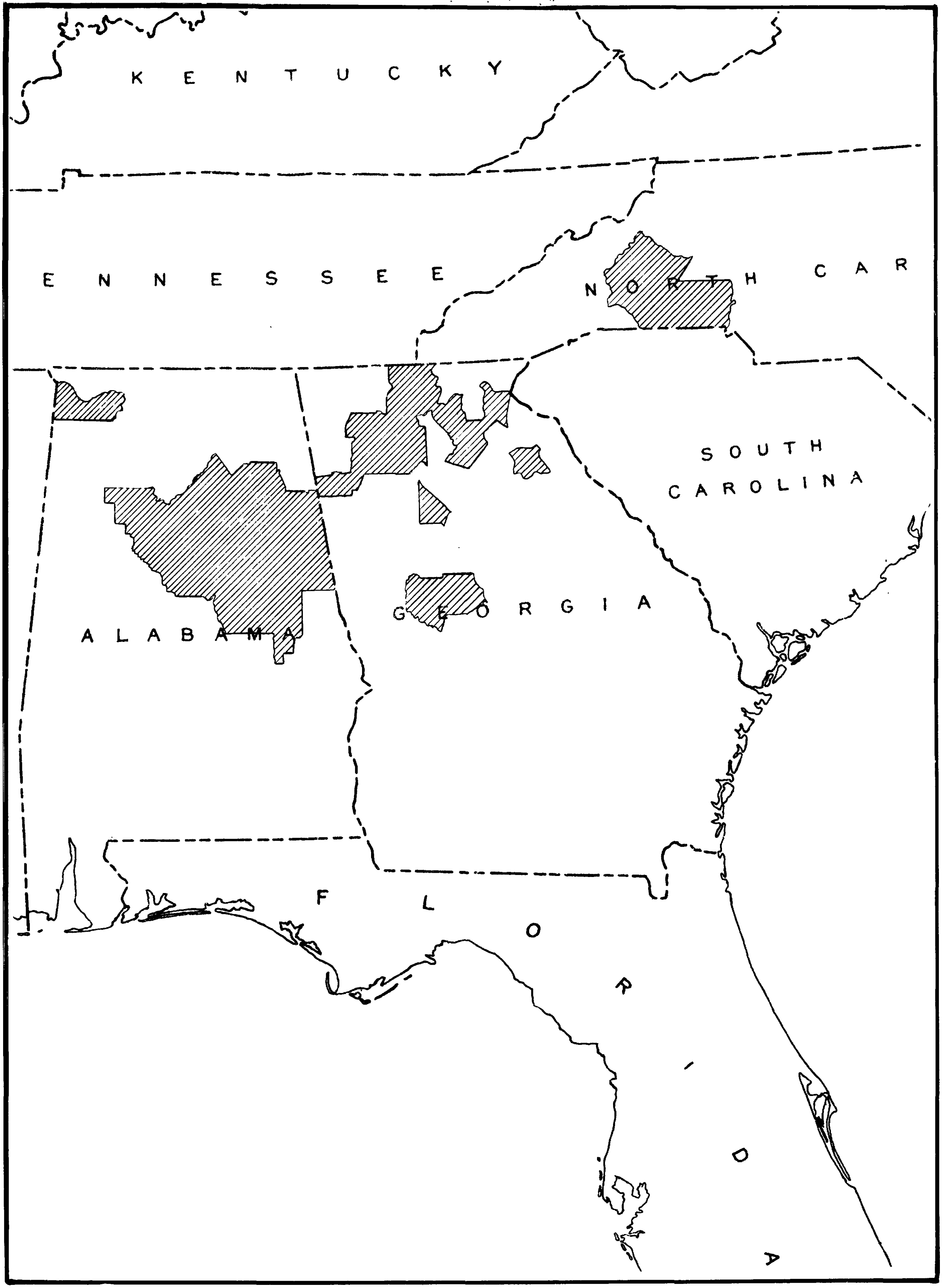
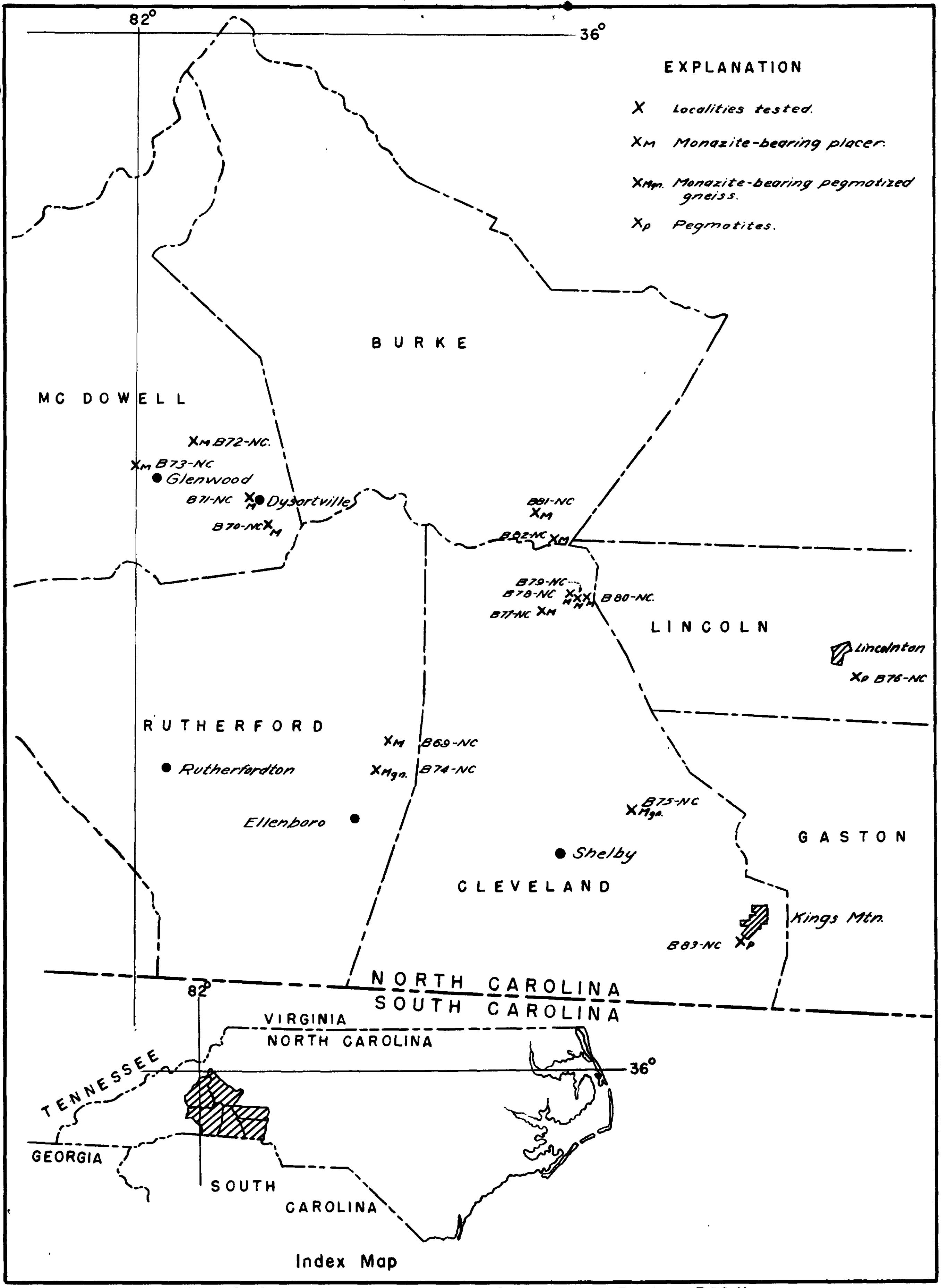


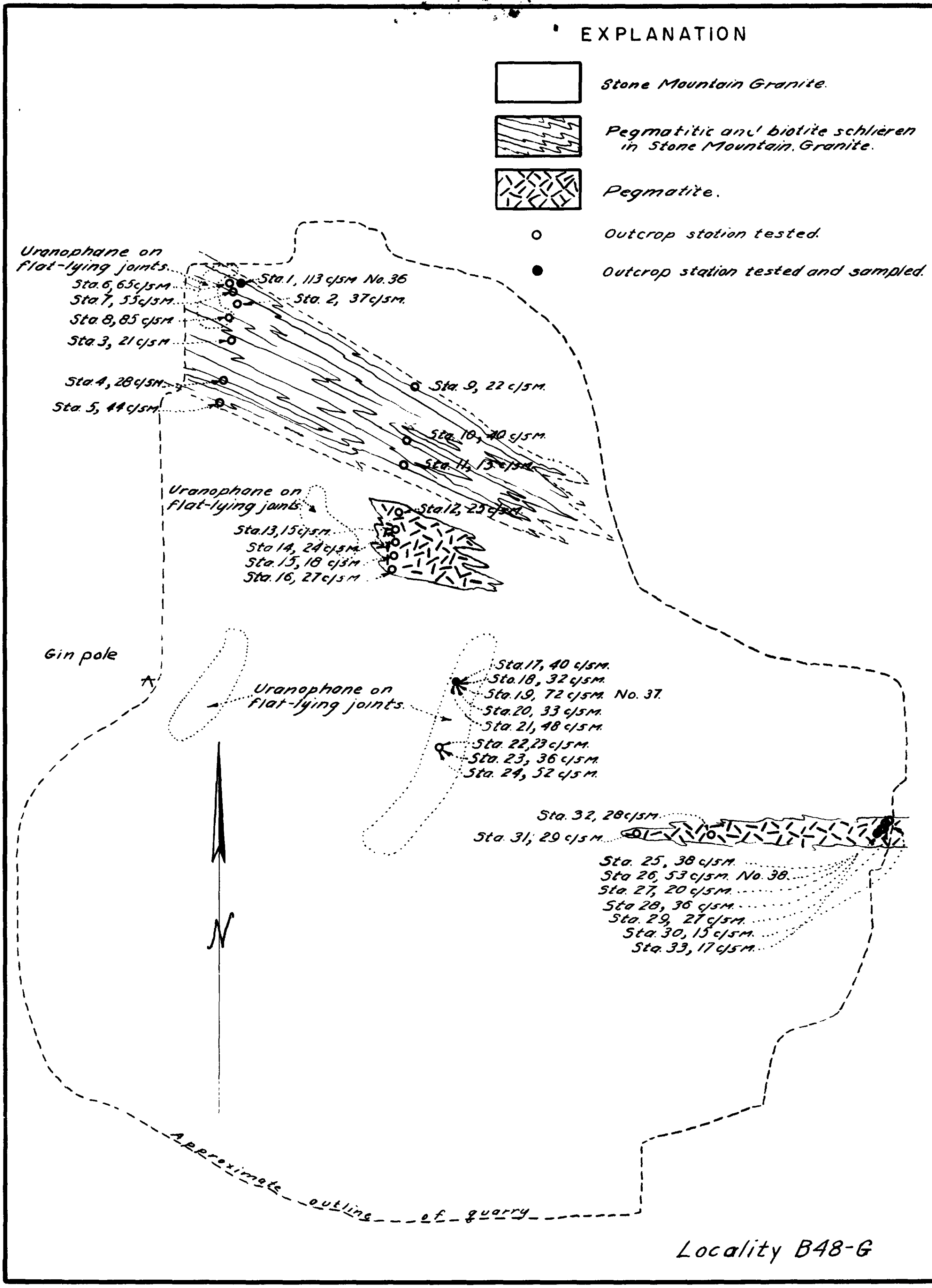
FIGURE I.- INDEX MAP SHOWING AREAS IN WHICH ROCKS WERE INVESTIGATED



MAP SHOWING LOCALITIES TESTED IN NORTH CAROLINA

Scale

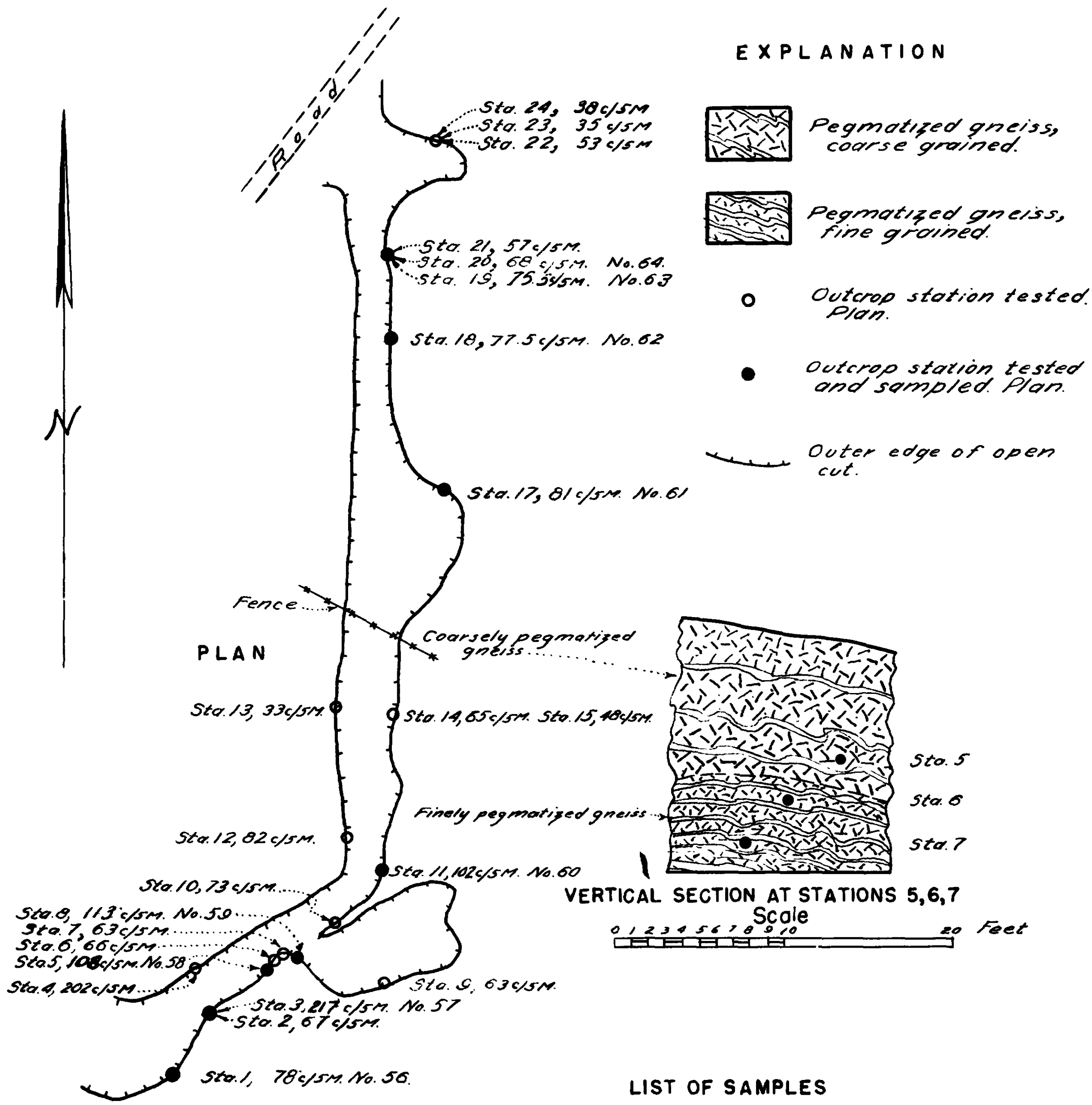
0 1 2 3 4 5 6 7 8 9 10 20 Miles

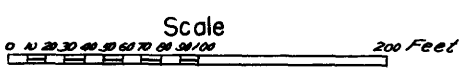


STONE MOUNTAIN GRANITE CORPORATION QUARRY, DE KALB CO., GEORGIA

Scale

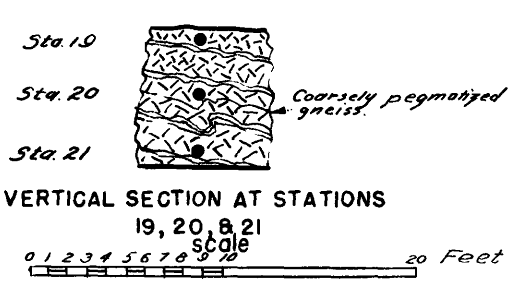
0 10 20 30 40 50 100 Feet





LIST OF SAMPLES

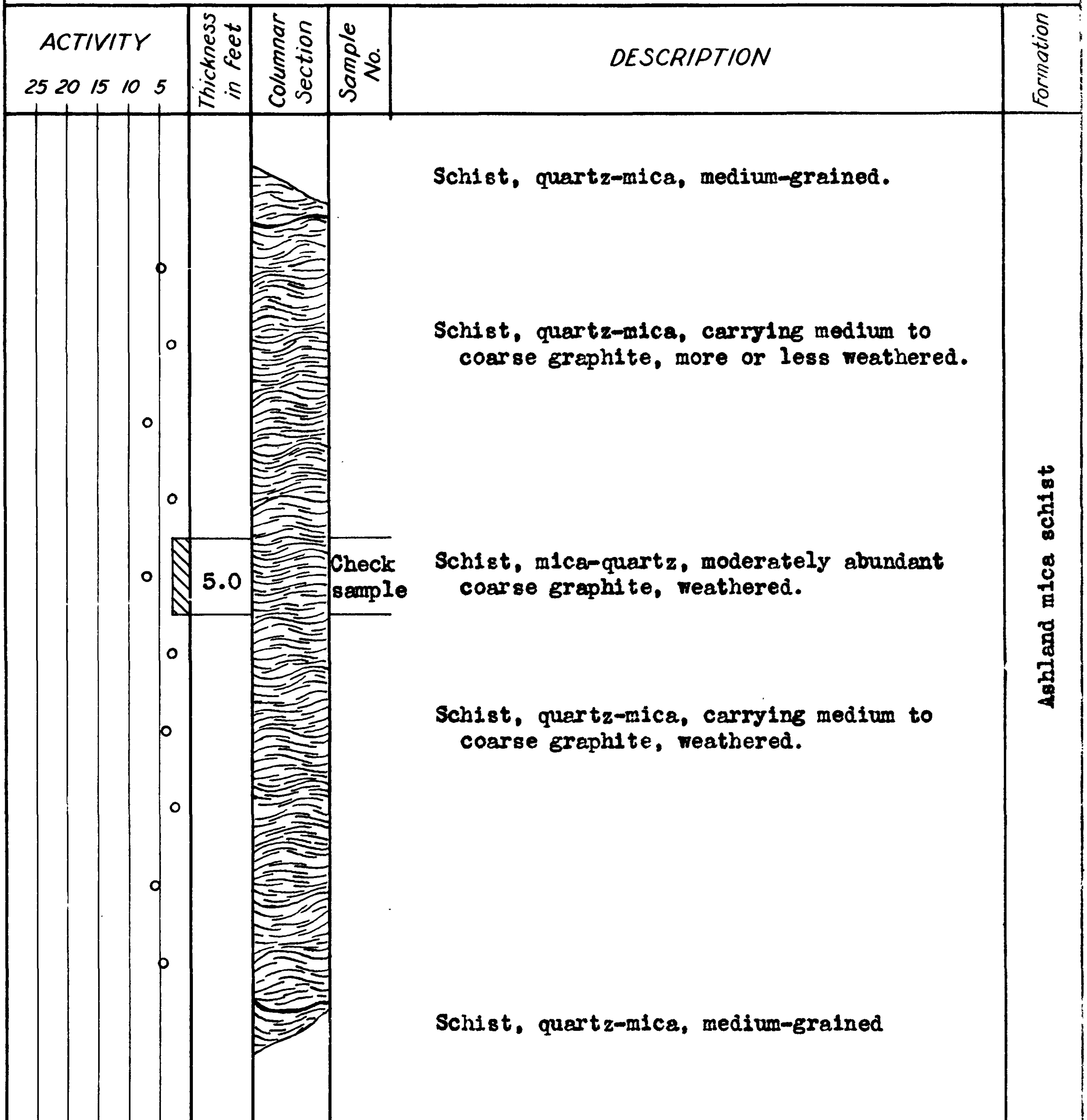
Sample No.	Width Ft.	% equivalent uranium (lab)	% uranium (chem.)
B75-NC No. 56	3.0	.021	
57	3.0	.019	
58	3.0	.013	
59	3.0	.014	
60	2.0	.013	
61	3.0	.014	
62	3.0	.008	
63	3.0	.009	
64	3.0	.011	



MONAZITE MINE AT LOCALITY B 75-NC, CLEVELAND CO., NORTH CAROLINA

B8-A

Pit of the C. B. Allen graphite mine, SW. ¼ Sec. 20, T. 20 S., R. 7 E., Clay County, Alabama



ACTIVITY:

o *Count per minute at outcrop.*

Approximate radioactivity determined by testing (in field) crushed rock, expressed in thousandths of percent equivalent uranium. Not determined for all samples.

Uranium content determined by chemical analysis, expressed in thousandths of percent.

SCALE (in feet)

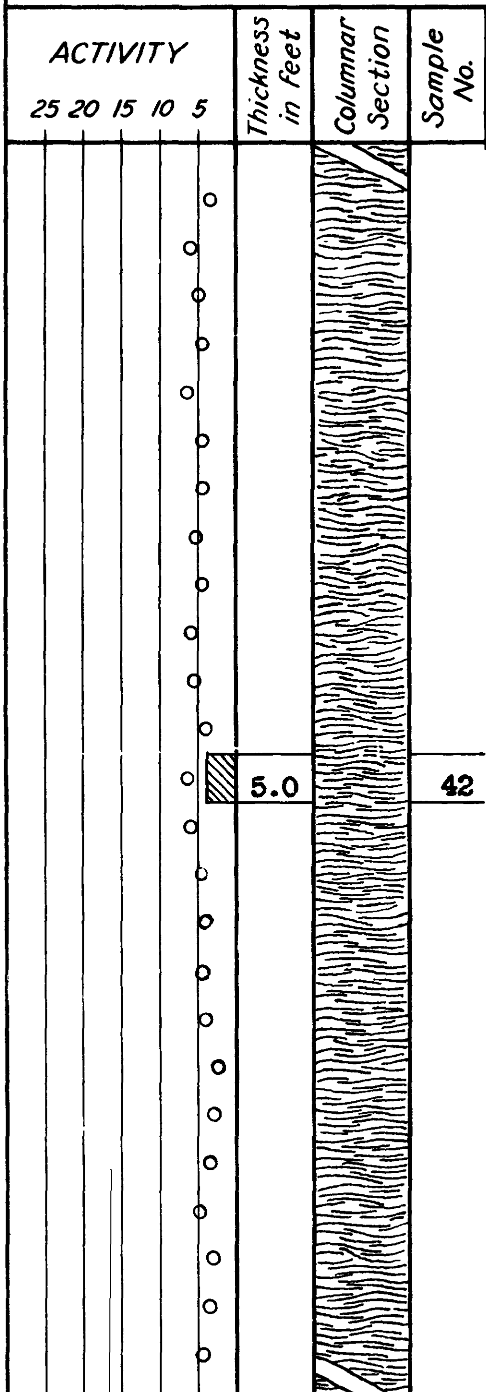
0 10 20 30

Measured and sampled by

A. P. Butler, Jr.
C. W. Chesterman
March 1, 1945

B51-G

Abandoned quarry on the south side of Pumpkinvine Creek about 2 miles south of Emerson, Bartow County, Georgia



DESCRIPTION

Phyllite, graphitic, black. Top not exposed. Outcrop counts at 3 stations not shown on column ranged from 4 to 6 per minute.

Phyllite, graphitic, black, at some places veined with quartz.

Phyllite, graphitic, pyritic, black, veined with quartz.

Phyllite, graphitic, black, in part pyritic, some veins of quartz.

Phyllite, graphitic, black, in part pyritic. Base not exposed. At 5 stations not shown on column counts ranged from 3 to 5 per min.

Formation: **Talladega slate**

ACTIVITY:

o *Count per minute at outcrop.*

Approximate radioactivity determined by testing (in field) crushed rock, expressed in thousandths of percent equivalent uranium. Not determined for all samples.

Uranium content determined by chemical analysis, expressed in thousandths of percent.

SCALE **(in feet)**

0 20 40 60

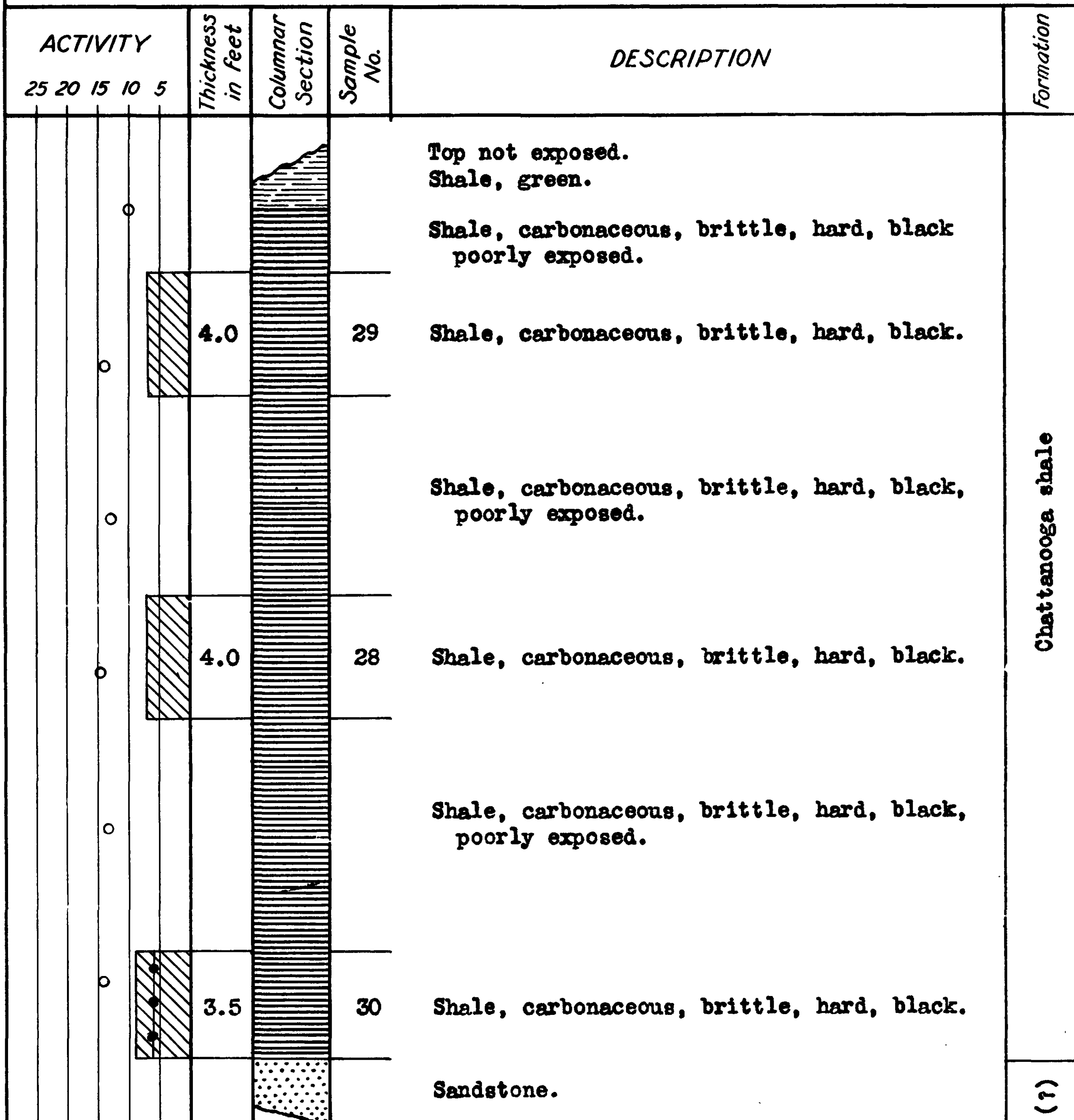
Measured and sampled by
A. P. Butler, Jr.
C. W. Chesterman
March 31, 1945

100471

United States Department of the Interior
Geological Survey

Figure 9

B24-A
Road cut on State Highway 38 about 1 mile northwest of traffic light in Oneonta, Blount County, Alabama



ACTIVITY:

o Count per minute at outcrop.

Approximate radioactivity determined by testing (infield) crushed rock, expressed in thousandths of percent equivalent uranium. Not determined for all samples.

Uranium content determined by chemical analysis, expressed in thousandths of percent.

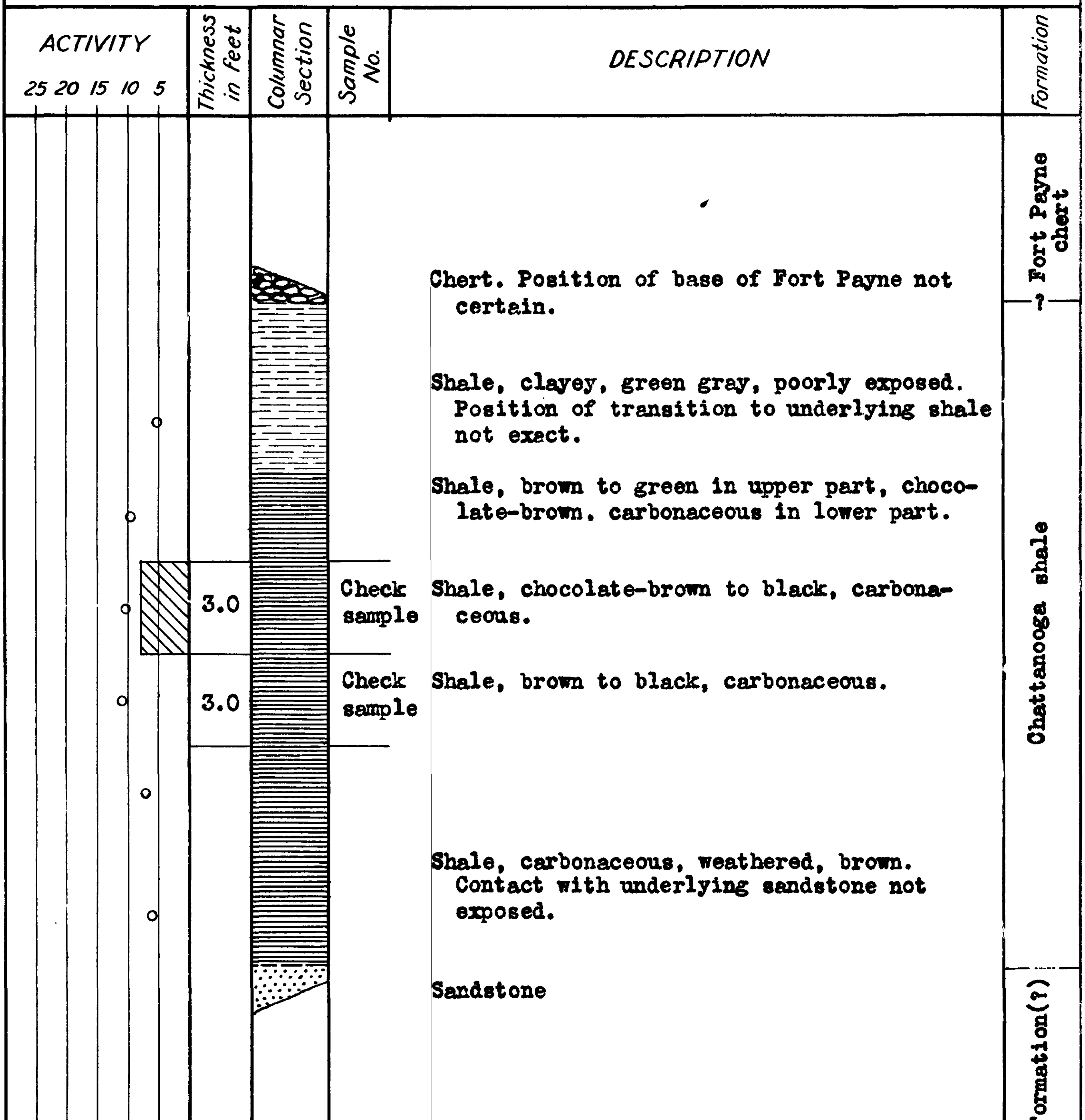
SCALE (in feet)
0 5 10 15

Measured and sampled by
A. P. Butler, Jr.
C. W. Chesterman
March 10, 1945

100471

B25-A

Road cut on southwest side of county road, 0.9 mile northwest of junction with U. S. Highway 11, Keener, Etowah County, Alabama



ACTIVITY:

o Count per minute at outcrop.

Approximate radioactivity determined by testing (in field) crushed rock, expressed in thousandths of percent equivalent uranium. Not determined for all samples.

Uranium content determined by chemical analysis, expressed in thousandths of percent.

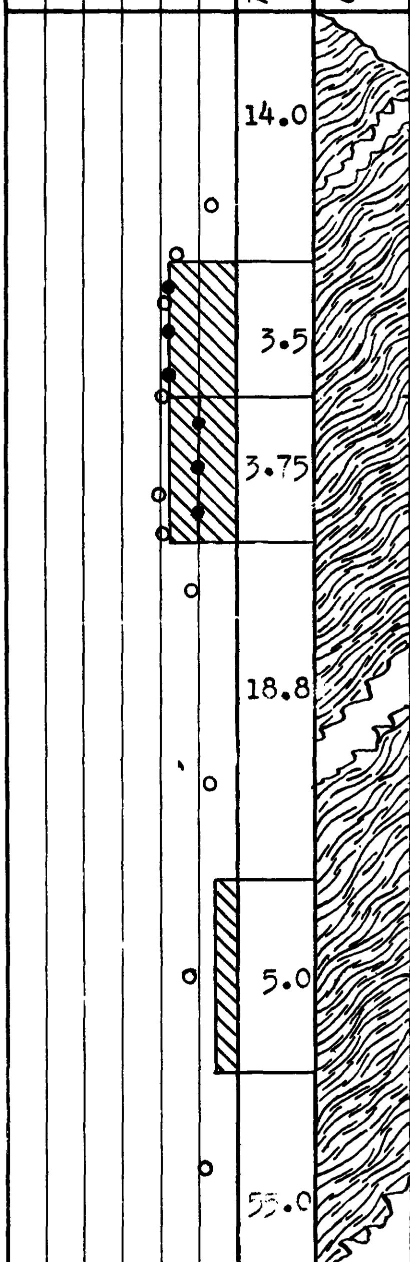
SCALE (in feet)
0 5 10 15

Measured and sampled by
A. P. Butler, Jr.
C. W. Chesterman
March 11, 1945

100471

B2-A

North side of cut on the Atlanta, Birmingham and Coast Railroad in vicinity of milepost 361 about 0.8 mile southwest of Erin Station, Clay County, Alabama



Thickness in feet	Sample No.	DESCRIPTION	Formation
		Top of formation not exposed.	Erin shale
14.0		Slate, graphitic, phyllitic. Checked by outcrop counts at 2 stations. Counts ranged from 3.6 to 5 per minute	
3.5	3	Slate, graphitic, phyllitic, shaly in thin layers, black	
3.75	4	Slate, graphitic, phyllitic, shaly partings, black.	
18.8		Slate, graphitic, phyllitic, black. Outcrop counts at 2 stations not indicated on column ranged from 3.2 to 4.8 per minute.	
5.0	5	Slate, graphitic, phyllitic, black.	
55.0		Slate, graphitic, phyllitic, black. Outcrop counts at 9 stations not shown on column ranged from 2.6 to 5.8 per minute.	

Continued on next page

ACTIVITY:

o Count per minute at outcrop.

Approximate radioactivity determined by testing (in field) crushed rock, expressed in thousandths of percent equivalent uranium. Not determined for all samples.

Uranium content determined by chemical analysis, expressed in thousandths of percent.

SCALE (in feet)
0 5 10 15

Measured and sampled by
A. P. Butler, Jr.
C. W. Chesterman
Februarary 24-25, 1945

B2-A, Continued

ACTIVITY 25 20 15 10 5	Thickness in feet	Columnar Section	Sample No.	DESCRIPTION	Formation
o				Interval is the same as that described on preceding page.	
o	[illegible].0		6	Slate, graphitic, phyllitic, weathered, brown-gray.	
o o	60.0			Slate, graphitic, phyllitic, graphitic, black, decreasingly graphitic in lower 10 feet. Outcrop counts at 10 stations not shown on column ranged from 2 to 6 per minute.	Erin shale
o	5.0		7	Slate, graphitic, phyllitic, black.	
o	120.0			Slate, phyllitic, in part graphitic or carbonaceous, some weathered. Outcrop counts at 23 stations not shown on column ranged from 3 to 6 per minute. Base of formation not exposed.	

ACTIVITY:

o Count per minute at outcrop.

Approximate radioactivity determined by testing (in field) crushed rock, expressed in thousandths of percent equivalent uranium. Not determined for all samples.

Uranium content determined by chemical analysis, expressed in thousandths of percent.

SCALE (in feet)

0 5 10 15

Measured and sampled by
A. P. Butler, Jr.
C. W. Chesterman
February 24-25, 1945

100471