Prepared for the U. S. Department of Energy
Grand Junction Office, Colorado

GJBX--417-81

DE82 005553

MASTER

EVALUATION OF URANIUM GEOCHEMICAL ANOMALIES IN THE GREENSBORO 1° × 2° NTMS AREA NEAR LOUISBURG, N. C.

**NATIONAL URANIUM RESOURCE
EVALUATION PROGRAM**

ROBERT H. CARPENTER

**E. I. du Pont de Nemours & Co.
Savannah River Laboratory
Aiken, SC 29808**

PREPARED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-76SR00001

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

This report was prepared by E. I. du Pont de Nemours and Company (Du Pont) for the United States Department of Energy under Contract DE-AC09-76SR00001 and is an account of work performed under that Contract. Neither the United States, the United States Department of Energy nor Du Pont, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed herein, or represents that its use will not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, mark, manufacturer, or otherwise does not necessarily constitute or imply endorsement, recommendation, or favoring of same by Du Pont or by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

**EVALUATION OF URANIUM GEOCHEMICAL ANOMALIES
IN THE GREENSBORO 1° × 2° NTMS AREA NEAR
LOUISBURG, N. C.**

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Robert H. Carpenter
Carpenter Minerals Exploration
Elberton, Georgia

Publication Date: September 1981

**E. I. du Pont de Nemours & Co.
Savannah River Plant and Laboratory
Aiken, SC 29808**

PREPARED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-76SR00001

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED *eb*

FOREWORD

The Savannah River Laboratory (SRL) was involved in the National Uranium Resource Evaluation (NURE) program from 1974 through 1981. The SRL role was to design, conduct, and report the data from a geochemical reconnaissance of almost half the continental United States. The purpose of this work was to provide a basis for evaluating the uranium potential of areas and to identify areas meriting conventional geologic followup. In this program, over 275,000 samples of stream sediment, soil, vegetation, and ground or surface water were collected.

As a part of the development program to support interpretation of the geochemical data, SRL conducted a series of "anomaly verification" field studies. Each study area was chosen on the basis of a geochemical anomaly in reconnaissance data. Subcontractors were selected to conduct field scintillometer surveys, compile geologic maps, collect additional samples, or provide other services as deemed appropriate for a given study.

This report, which summarizes the results of a small study in the Greensboro 1° x 2° quadrangle (Jones and Ferguson, 1978), was compiled for SRL by Robert Carpenter and is published as a facsimile of the report to SRL. Normal editing was not done so that the report could be placed in the public domain prior to the termination of the NURE program.

This study is one of a series designed to provide a basis for interpretation of SRL regional geochemical reconnaissance data. It contains a synthesis of published data and results of a four-channel gamma spectrometer survey of an area near Louisburg, N.C.

TABLE OF CONTENTS

Introduction	5
Summary of Published Information Utilized	5
Method of Study	6
Compilation of Published Information	6
Field Evaluation of Project Area	6
Results	7
Synthesis of Published Information	7
Geology	7
Airborne Radiometric Survey	10
Geochemical Surveys	11
Ground Scintillometer Survey	12
Conclusions	15
References	15
Plates	21
Appendix	27

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

INTRODUCTION

This report describes a ground-scintillometer survey in the vicinity of Louisburg, N.C., where uranium geochemical anomalies have been reported by Jones and Ferguson (1978). Published geological, geophysical, and geochemical information is also summarized. Conclusions are made regarding the possible occurrence of uranium concentration.

The study area is in the southeastern corner of the Greensboro 1° x 2° National Topographic Map Series (NTMS) quadrangle and includes an area of approximately 380 mi² in portions of Franklin and Nash Counties.

SUMMARY OF PUBLISHED INFORMATION UTILIZED

Published information used in this study includes the following:

1. Description of a groundwater and stream-sediment geochemical survey of the Greensboro 1° x 2° NTMS area (Jones and Ferguson, 1978).
2. A geologic summary of the Greensboro 1° x 2° NTMS area by J. R. Butler (in Jones and Ferguson, 1978).
3. A geologic and petrographic study of the Castalia pluton (Julian, 1972).
4. A description of portions of the Eastern Monazite Belt (Overstreet, 1967).
5. Aeroradioactivity maps of portions of northeastern North Carolina (Coastal Plains Regional Commission and U.S. Geological Survey, 1975).

County maps of the study area are available at scales of 1 in. = 2 mi and 1 in. = 1 mi from the N.C. Dept. of Transportation in Raleigh. Standard quadrangle maps (1 in. = 2,000 ft) have not been published for the area, but advanced black-line copies are available for Xerox copying at the N.C. Geological Survey office in Raleigh. Geophysical maps and selected student theses are also on file with the N.C. Geological Survey.

METHOD OF STUDY

COMPILATION OF PUBLISHED INFORMATION

All published map information has been plotted at a scale of 1 in. = 2 mi on county road maps. The geologic map is based on the summary by Butler (1978) except for the area east of Louisburg (Castalia pluton area) where more detailed mapping by Julian (1972) is used. A cartographic enlarger was used in transferring geochemical and geophysical data from 1:250,000 scale maps to the county maps.

FIELD EVALUATION OF PROJECT AREA

A GR-410 four-channel gamma-ray spectrometer was utilized in field evaluation. There were 229 measurements made in the accumulate mode (two-minute counts) for total counts, potassium-40, bismuth-214, and thallium-208. Concentrations of potassium (%), uranium (ppm), and thorium (ppm) were calculated using the formulas contained in the operations manual. In addition, uranium/thorium (U/Th) ratios were calculated. Corrections for background were not made.

From the field data, contour maps of uranium (in ppm) and U/Th ratios were prepared. Sample numbers are related to individual 7¹/₂-minute quadrangles by an alphabetic code which identifies each quadrangle and a numerical code which identifies samples within each quadrangle. The alphabetic code is indicated on Plate 1 and is also summarized in Table 1.

Table 1. Quadrangle Code for Radiometric Measurements
in the Louisburg area, North Carolina

7 ¹ / ₂ -Minute Quadrangle	Alphabetic Code
Louisburg NE	A
Louisburg SE	B
Castalia NW	C
Castalia SW	D
Castalia SE	E
Castalia NE	F

At some sites, multiple measurements were taken. These are indicated by subscripts (a, b, c, etc.) after the site number. On the contour maps, only the first measurement (without the subscript) is plotted.

Also at each site, a brief notation of the rock type and weathering status (outcrop, saprolite, soil) is noted. This information, together with analytical data, is summarized in Appendix A.

RESULTS

SYNTHESIS OF PUBLISHED INFORMATION

Geology

The principal geologic units are shown on Plate 1. These include the Rolesville pluton, undivided gneisses and schists of the Raleigh Belt, undivided metasediments and metavolcanic rocks of the eastern Slate Belt, and the Coastal Plain. A steep metamorphic gradient exists between the Slate Belt (4u) and the Raleigh Belt (4n). The Castalia pluton was emplaced along this boundary.

According to Butler and Ragland (1969), the porphyritic Rolesville pluton is syntectonic and is probably early to middle Paleozoic in age. The medium-crystalline Castalia pluton, however, is posttectonic, as the Rb-Sr whole-rock isochron age is 313 ± 13 m.y.

Two features of the Castalia pluton appear to be of interest. During field evaluation of a quarry exposure of the Castalia pluton (north of site D-15), quartz and quartz-feldspar veins were found to show anomalously high uranium values and U/Th ratios. The veins are very straight, are commonly less than 1 ft in thickness, and trend in various directions. Fine-grained pyrite is locally present. The form of the veins indicates that the pluton had crystallized prior to vein emplacement. The veins are probably of hydrothermal origin, as some consist almost entirely of quartz.

Another feature is a northeast-southwest trending zone of "mixed" gneisses, pegmatites, and granites described by Julian (1972) which bisect the Castalia pluton (Plate 1). At site D-40, located within this zone, high uranium and U/Th values were obtained. The origin of the "mixed" zone is problematical. Except for excellent exposures at site D-40 on a tributary of Red Bud Creek, the distribution of the "mixed" zone could not be independently verified in our examination. In addition to the lithologies described by Julian (1972), a mafic unit was observed in this zone near site D-40.

A geologic feature of the area which is not indicated on the geologic map is the veneer of alluvial material on hilltops at a number of localities. These areas typically show fine, white sandy soils that are in contrast with the brownish-red residual soils. In many areas, white rounded quartz pebbles, commonly less than 2 in. in diameter, are contained within the sands. The

thickness of the sand veneer is probably less than 2 m in most areas. The alluvial sands are abundant on hilltops in the southern portion of the Castalia NW Quadrangle, northern portion of the Castalia SW Quadrangle, and central portion of the Castalia NE Quadrangle. Based on geophysical evidence, the sands probably have a distribution wider than that just indicated. Whether the unconsolidated sands are inliers of the Coastal Plain sands (Cretaceous), or represent younger terrace deposits, is not known.

The alluvial sand veneer is important because in some localities it is very rich in radioactive accessory minerals, probably monazite and zircon. In ditches along roads where heavy minerals are concentrated, calculated thorium concentrations locally exceed 500 ppm, and the U/Th is less than 0.04. It appears likely that the alluvial sand veneer contributes substantially to aerially detected radioactivity (gross-gamma) patterns as well as to stream-sediment geochemical values. These possibilities will be discussed in greater detail in this report.

In Appendix A, the rock type descriptions do not always include mention of the sand veneer. Measurements were typically made in roadcuts on saprolite or outcrop.

Another feature of the geology is the Eastern Monazite Belt. According to Mertie (1953), the belt can be traced from near Rolesville (just south of the Louisburg SE Quadrangle) to the vicinity of Fredericksburg, Virginia, a distance of approximately 200 mi. Monazite has been identified in alluvium throughout this belt, but analyses of monazite concentrates have not been reported. Principal rock units included in the Eastern Monazite Belt in the study area are the Rolesville pluton and the gneisses and schists of the Raleigh Belt. The Eastern Monazite Belt is considered to be a likely source

for the monazite-rich alluvial sand veneer discussed herein. The distance of transport would be less than 10 mi.

Very few mineral occurrences are reported in the study area. In the north-central portion of the Castalia NE Quadrangle, beryllium and lithium are reported to occur in granite pegmatites of the Inez pegmatite district (Butler, 1978). Granite has also been quarried in small quantities from the Castalia pluton.

Airborne Radiometric Survey

Only the southern tier of quadrangles has been included in published airborne scintillometer surveys by the U.S. Geological Survey (1975). The results are summarized on Plate 2. The most pronounced anomaly trends northeast-southwest through the Castalia SW Quadrangle. Values in excess of 2,400 cps occur over an 8-mi distance. The anomalous zone is within the outcrop of the Castalia pluton; however, there is little or no correlation between the outline of the Castalia pluton and the radiometric high. Based on observations that alluvial sand veneer is coincident with the radiometric anomaly in the north, and also that scintillometer measurements indicate the sand veneer is quite radioactive here, it is likely that the radiometric anomaly is a function mainly of the sand veneer rather than bedrock geology.

A weaker radiometric high trending approximately north-south is present in the Louisburg SE Quadrangle. This anomaly is partially coincident with the outcrop of the Rolesville pluton. Some of the highs in this area are probably related to the alluvial sand veneer.

Radiometric lows in the study area are associated with gneisses and schists of the Raleigh Belt, metasediments and metavolcanic rocks of the

eastern Slate Belt, Coastal Plain sediments, and the southeastern lobe of the Castalia pluton.

Geochemical Surveys

Figures 1 through 5 are stream-sediment geochemical maps, for uranium, thorium, hafnium, cerium, and dysprosium, taken from Jones and Ferguson (1978). They show significant anomalies for each of these elements within the study area.

Plates 3 and 4 are a summary of stream-sediment and groundwater geochemical data for uranium replotted at a scale of 1 in. = 2 mi for the study area. In both cases, higher values correspond to the outcrop of the Castalia pluton and, to a lesser extent, the Rolesville pluton. For stream sediments, this relationship is probably fortuitous, as the alluvial sand veneer in this area is probably responsible for most of the anomalous relationships.

On Plate 3, stream-sediment sites having the highest concentrations of uranium are summarized in a table. Except for sample NCFR 048, anomalous samples contain either high thorium plus cerium plus-or-minus dysprosium (probably monazite and xenotime) or high hafnium (probably zircon). In these samples, the overall uranium concentration is within the range of average uranium content of monazite and zircon. Most of the samples are within areas where the alluvial soil veneer has been identified in the field or indicated by geophysical relationships. Sample NCFR 048 is of considerable interest, as the drainage basin lies immediately north of the "mixed" zone of the Castalia pluton where the highest uranium concentrations were identified in the ground radiometric survey (site D-40, Plates 5 and 6).

In general, groundwater anomalies are less abundant in the area (Plate 4). The two highest values at sites NCFR 542 and 536 are within the outcrop of the Castalia pluton. Site 536 occurs very close to ground scintillometer site D-2, which is a weak uranium anomaly (9.2 ppm, Plate 5). The origin of the anomalies is not known. They may be related to uranium-enriched quartz veins in the Castalia pluton mentioned herein.

GROUND SCINTILLOMETER SURVEY

The results of the ground scintillometer survey are summarized in Appendix A. The site-number locations are indicated on Plate 1. Contour maps of calculated uranium concentrations (in ppm) and U/Th ratios are presented on Plates 5 and 6, respectively. Sites at which uranium content exceeds 10 ppm, thorium content exceeds 100 ppm, and U/Th exceeds 0.6 are summarized in Table 2. These serve to identify the principal anomalies on Plates 5 and 6.

The patterns defined are not clearly related to the distribution of geologic units shown on Plate 1. Low U/Th (~ 0.1) commonly is a reflection of the alluvial sand veneer throughout the area. All the major radiometric highs indicated on Plate 2 correspond to areas of low U/Th on Plate 6. Measurements taken on outcrops or saprolite in the Rolesville and Castalia plutons typically indicate 2 to 6 ppm uranium and U/Th ratios of 0.2 to 0.5.

The principal anomalies are in the Castalia quarry north of site D-15 and in a creek exposure at site D-40. In the Castalia quarry, calculated uranium values locally exceed 25 ppm, and U/Th ratios of 1.28 were determined. At site D-40, uranium values of 35.7 ppm and a U/Th ratio of 2.45 were determined.

Table 2. Selected Ground Scintillometer Sites in the
Louisburg, N.C., Study Area

Site #	U(ppm)	Th(ppm)	U/Th	Rock Type	Comment
A-22	11.0	19.8	0.56	Rolesville granite	--
A-26	4.8	7.1	0.68	granite	Shown on geologic map as gneiss and schist. Possibly at contact of Rolesville pluton
B-30	1.4	116.7	0.01	granite	Alluvial sand veneer suspected. Area high in aeroradioactivity
C-8c	20.4	505.6	0.04	Castalia granite	Alluvial sand veneer. Measurement taken on heavy min. conc. in ditch
D-15b	25.4	19.8	1.28	Castalia granite	In quartz veins in quarry
D-27	10.7	14.4	0.74	Rolesville granite	Granite saprolite near margin of Rolesville pluton
D-40c	35.7	14.6	2.45	Castalia granite	Pegmatitic rocks in "mixed" zone
D-43	11.0	25.3	0.43	Castalia granite	In granitic rocks just south of "mixed" zone
E-25	3.3	4.4	0.75	Coastal Pl.	Site identified as granitic soil
E-30	4.2	5.6	0.75	Castalia granite	Homogenous granite saprolite,
E-34	11.8	20.6	0.57	Castalia granite	Homogenous granite saprolite

CONCLUSIONS

Principal conclusions derived from this study are as follows.

1. Most uranium stream-sediment anomalies, probably all the major airborne radiometric highs, and areas of very low U/Th ratios calculated from ground scintillometer measurements appear to reflect an alluvial sand veneer rich in heavy minerals (principally monazite and zircon). Calculated thorium values commonly exceed 50 ppm and locally exceed 500 ppm.

2. In the most extensive exposure of the Castalia pluton at a quarry north of site D-15, quartz and quartz-feldspar veins are anomalous in both uranium (+25 ppm) and U/Th (+1.0). Similar veins probably occur elsewhere in the area.

3. The area having most potential as identified in this study occurs in the northeasternmost portion of the Castalia SW Quadrangle. In the pegmatite-rich "mixed" zone of the Castalia pluton, ground scintillometer measurements indicate uranium concentrations of up to 35.7 ppm uranium and a U/Th ratio of 2.45. Less than 0.5 mi north of this occurrence, stream-sediment sample site NCFR 048 contains 26.6 ppm uranium and only 11 ppm thorium, 13 ppm hafnium, 50 ppm cerium, and 25.3 ppm dysprosium. Having made an extensive study of Savannah River Laboratory stream-sediment geochemical data for places elsewhere in the southeastern United States, this writer believes this is one of the higher uranium concentrations in which so little thorium, hafnium, cerium, or dysprosium is present.

4. Further evaluation of the "mixed" zone to the southwest is complicated by the presence of the alluvial sand veneer. Stream-sediment anomalies in this area are related mainly to monazite derived from the sands. Similarly, ground and airborne radiometric anomalies in this area reflect the alluvial sand veneer.

REFERENCES

Butler, J. R., 1978, Appendix A: Detailed Description of the Greensboro Study Area, in Preliminary Basic Data Release, Greensboro 1° x 2° NTMS Area, North Carolina and Virginia, by P. L. Jones and R. B. Ferguson: Savannah River Laboratory, Aiken, S.C.

Butler, J. R., and Ragland, P. E., 1969, A petrochemical survey of plutonic intrusions in the Piedmont, southeastern Appalachians, U.S.A.: Contrib. Mineral. and Petrol., v. 24, p. 164-190.

Coastal Plains Regional Commission and the U.S. Geological Survey, 1975, Aeroradioactivity Maps of Parts of Georgia, South Carolina, and North Carolina: Area 1, Northeastern North Carolina.

Jones, P. L., and Ferguson, R. B., 1978, Preliminary Basic Data Release, Greensboro 1° x 2° NTMS Area, North Carolina and Virginia: Savannah River Laboratory, Aiken, S.C.

Julian, E. L., 1972, The Castalia adamellite in Franklin and Nash Counties, North Carolina, and the petrogenesis of some associated aplites and pegmatites: M.S. thesis, North Carolina State University, 61 p.

Mertie, J. B., Jr., 1953, Monazite deposits of the southeastern Atlantic states: U.S. Geol. Survey, Circ. 237, 31 p.

Overstreet, W. C., 1967, The geologic occurrence of monazite: U.S. Geol. Survey, Prof. Paper 530, 327 p.

GREENSBORO 1°x2' Sheet
Uranium In Sediments
1234 Values Above D.L.

Uranium concentration - p.p.m.				
• < 0.7	• 1.1- 1.3	○ 2.1- 3.1	⊙ 8.5- 9.1	● 15.7- 23.8
• 0.7- 0.9	• 1.3- 1.6	○ 3.1- 4.9	⊙ 9.1- 12.2	◆ 23.8- 42.8
• 0.9- 1.1	○ 1.6- 2.1	○ 4.9- 8.5	● 12.2- 15.7	★ > 42.8

FIGURE 1. Areal Distribution of Uranium Concentrations in Stream Sediment

GREENSBORO 1'x2' Sheet
Thorium In Sediments
872 Values Above D.L.

Thorium concentration - p.p.m.

FIGURE 2. Areal Distribution of Thorium Concentrations in Stream Sediment

GREENSBORO 1'x2' Sheet
Hafnium In Sediments
1223 Values Above D. L.

Hafnium concentration - p.p.m.

+ < 2.7	• 5.6- 6.9	○ 13.4- 20.1	⊙ 62.2- 106.3	● 207.6- 314.0
x 2.7- 4.1	○ 6.9- 9.3	⊙ 20.1- 34.8	⊙ 106.3- 165.4	◆ 314.0- 693.0
• 4.1- 5.6	○ 9.3- 13.4	⊙ 34.8- 62.2	● 165.4- 207.6	★ > 693.0

FIGURE 3.. Areal Distribution of Hafnium Concentrations in Stream Sediment

GREENSBORO 1x2' Sheet
Cerium In Sediments
855 Values Above D.L.

Cerium concentration - p.p.m.				
+ < 11.0	• 22.0- 26.0	○ 42.0- 60.0	⊙ 120.0- 180.0	● 300.0- 620.0
x 11.0- 16.0	◦ 26.0- 33.0	⊙ 60.0- 80.0	⊙ 180.0- 280.0	◆ 620.0- 940.0
• 16.0- 22.0	○ 33.0- 42.0	⊙ 80.0- 120.0	● 280.0- 380.0	★ > 940.0

FIGURE 4. Areal Distribution of Cerium Concentrations in Stream Sediment

GREENSBORO 1x2° Sheet
Dysprosium In Sediments
1029 Values Above D.L.

Dysprosium concentration - p.p.m.

FIGURE 5.. Areal Distribution of Dysprosium Concentrations in Stream Sediment

CASTALIA PLUTON

LOCATION MAP

GEOLOGIC UNITS

- ☐ CP Coastal Plain sediments
- ☐ 4PG Castalia Pluton
- ☐ 4GGP gneisses, granites and pegmatites
- ☐ 4G Rousesville Pluton
- ☐ 4N gneiss and schist
- ☐ 4U Undivided metasedimentary and metavolcanic rocks
- ☐ Eastern monazite belt

○ Survey site

PLATE I

CASTALIA PLUTON

GEOLOGIC UNITS

- ☐ CP Cousal Plum sediments
- ☐ 4PG Castalia Pluton
- ☐ 4GGP gneisses, granites and pegmatites
- ☐ 4G Rolesville Pluton
- ☐ 4N gneiss and schist
- ☐ 4U Undivided metasedimentary and metavolcanic rocks
- ☐ Eastern monazite belt

AIRBORNE TOTAL COUNT GAMMA RAY INTENSITY

- ☐ Survey site

PLATE 2

Uranium In Sediments
Values Above D.L.

Uranium concentration - p.p.m.

• < 0.7	• 1.1- 1.3	○ 2.1- 3.1	● 6.5- 8.1	● 15.7- 23.8
• 0.7- 0.9	• 1.3- 1.6	○ 3.1- 4.8	● 9.1- 12.2	◆ 23.8- 42.8
• 0.9- 1.1	• 1.6- 2.1	○ 4.8- 6.5	● 12.2- 15.7	★ > 42.8

URANIUM in SEDIMENTS
Castalia Pluton Area
Franklin and Nash Cos.

SRL I.D.	U	Th	Hf	Ce	Dy
NCFR-034	29.3	242	10	700	59.7
NCFR-042	31.4	287	12	810	73.1
NCFR-048	26.6	11	13	50	25.3
NCFR-067	25.2	330	54	900	26.3
NCNA-042	52.1	50	3010	100	23.9
NCNA-044	18.0	95	82	280	10.1

PLATE 3

Uranium In Ground Water
Values Above D. L.

Uranium concentration - p.p.b.

• < 0.001	• 0.011- 0.016	○ 0.033- 0.047	⊙ 0.163- 0.415	● 1.442- 3.233
• 0.001- 0.004	• 0.016- 0.023	○ 0.047- 0.080	⊙ 0.415- 0.749	◆ 3.233- 14.230
• 0.004- 0.011	○ 0.023- 0.033	○ 0.080- 0.163	● 0.749- 1.442	★ > 14.230

URANIUM in GROUND WATER
Castalia Pluton Area
Franklin and Nash Cos.

PLATE 4

PLATE 5

CASTALIA PLUTON

U/Th

GEOLOGIC UNITS

- CP Coastal Plain sediments
- 4PG Castalia Pluton
- 4GGP gneisses, granites and pegmatites
- 4G Rolesville Pluton
- 4N gneiss and schist
- 4U Undivided metasedimentary and metavolcanic rocks
- Eastern monazite belt

○ Survey site

PLATE 6

APPENDIX A

Sample #	Cumulate Counts (2 minutes)				Calculated Concentration			Rock	Occurrence
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th	Type
A-1	929	893	376	258	1.4	5.5	16.1	.34	gneiss
A-2	1398	1722	452	362	3.3	5.7	22.6	.25	granite
A-3	1789	2240	425	673	4.5	-0.3	42.1	-.007	granite
A-4	1272	1534	379	437	2.9	2.5	27.3	.09	granite
A-5	841	1293	227	184	2.7	2.8	11.5	.25	granite
A-6	1210	1860	246	318	4.1	1.0	19.9	.05	granite
A-7	1709	2186	436	540	4.4	2.3	33.8	.07	granite
A-8	1096	1301	366	297	2.5	4.6	18.6	.25	granite
A-9	1676	2122	538	484	4.1	5.9	30.3	.19	granite
A-10	987	1367	288	209	2.8	4.0	13.1	.31	granite
A-11	877	880	335	318	1.4	3.4	19.9	.17	granite
A-12	542	588	199	153	1.0	2.6	9.6	.27	granite
A-13	762	932	249	169	1.8	3.7	10.6	.35	granite
A-14	1637	2054	518	516	4.0	4.8	32.3	.15	granite
A-15	1482	1822	456	453	3.5	4.3	28.3	.15	granite
A-16	1604	2285	377	475	4.8	1.8	29.7	.06	granite
A-17	1159	1671	292	240	3.5	3.8	15.0	.25	granite
A-18	1256	964	514	479	1.3	5.4	29.9	.18	granite
A-19	815	702	380	241	1.0	5.9	15.1	.39	granite
A-20	687	650	277	201	1.0	3.9	12.6	.31	granite
A-21	792	1032	262	198	2.0	3.5	12.4	.28	granite
A-22	1293	952	619	316	1.1	11.0	19.8	.56	granite
A-23	454	288	199	140	.3	2.7	8.8	.31	granite
A-24	602	807	173	81	1.7	3.2	5.1	.61	granite
A-25	826	525	424	240	.4	7.1	15.0	.47	granite
A-26	1003	1719	253	113	3.8	4.8	7.1	.68	granite
A-27	814	893	314	164	1.6	5.5	10.3	.53	gneiss
A-28	1201	1668	323	284	3.5	3.7	17.8	.20	gneiss ?
A-29	1078	1140	351	375	2.0	2.8	23.4	.11	granite
A-30	1753	2124	514	547	4.1	4.2	34.2	.12	granite
A-31	1456	1945	413	416	3.9	3.8	26.0	.15	granite
A-32	801	718	317	255	1.1	4.0	15.9	.25	granite
A-33	1350	2048	336	253	4.4	4.5	15.8	.28	granite
A-34	1124	1513	322	331	3.1	2.8	20.7	.13	granite

Sample #	Cumulate Counts (2 minutes)					Calculated Concentration			Rock	Occurrence
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th	Type	
B-1	1181	1759	288	239	3.8	3.5	14.9	.23	granite	outcrop
B-2	1149	1623	274	322	3.4	1.7	20.1	.08	granite	outcrop
B-3	807	926	292	182	1.7	4.6	11.3	.40	granite ?	saprolite
B-4	1184	1176	423	437	-0.5	3.7	27.3	.14	granite ?	soil
B-5	1118	1642	296	237	3.5	3.8	14.8	.26	granite	saprolite
B-6	1054	1576	268	201	3.5	3.6	12.6	.29	granite	saprolite
B-7	1463	1934	524	292	3.8	8.8	18.2	.48	gneiss ?	soil
B-8	1163	1202	419	378	2.1	4.6	23.6	.19	gneiss ?	saprolite
B-9	834	907	273	254	1.7	2.9	15.9	.18	?	soil
B-10	1880	2002	670	583	3.5	7.7	36.4	.21	granite	saprolite
B-11	1253	1690	403	240	3.4	6.5	15.0	.43	granite	saprolite
B-12	981	744	470	237	0.9	8.4	14.8	.57	granite	soil
B-13	1362	1645	453	363	3.1	5.8	22.7	.25	granite	saprolite
B-14	1277	1561	439	369	2.9	5.3	23.1	.23	granite	saprolite
B-15	1775	2260	530	589	4.6	3.9	36.8	.11	granite	outcrop
B-16	1126	1614	320	283	3.3	3.6	17.7	.20	granite	saprolite
B-17	1175	1120	470	293	1.8	7.4	18.3	.40	granite	saprolite
B-18	788	1278	175	117	3.0	2.6	7.3	.36	granite	saprolite
B-19	1075	1100	339	432	1.9	1.5	27.0	.06	granite	saprolite
B-20	1505	1598	506	554	2.8	3.9	34.6	.11	granite	saprolite
B-21	1096	1538	298	299	3.2	2.7	18.7	.14	granite	soil
B-22	1626	1392	578	786	2.1	1.8	49.1	.02	granite	saprolite
B-23	1439	1926	365	544	3.9	3.0	34.0	.01	granite	outcrop
B-24	1098	1410	340	373	2.7	2.6	23.3	.11	granite	saprolite
B-25	1347	1435	413	583	2.6	9.0	36.4	.24	granite	saprolite
B-26	1334	1112	500	624	1.6	2.5	39.0	.06	granite	saprolite
B-27	998	1699	199	214	3.8	1.6	13.4	.12	granite	outcrop
B-28	1239	1808	291	372	3.8	1.3	23.3	.06	granite	outcrop
B-29	1234	1339	394	462	2.4	2.5	28.8	.09	granite	saprolite
B-30	3593	2236	1267	1867	2.4	1.4	116.7	.01	granite	saprolite
B-30a	1853	1575	699	840	2.3	4.1	52.5	.08	granite	soil
B-30b	1599	1719	468	620	3.2	1.7	38.8	.04	granite	saprolite
B-30c	2584	1928	844	1210	2.7	1.5	75.6	.02	granite	saprolite
B-30d	1904	1686	638	862	2.7	2.1	53.9	.04	granite	saprolite
B-30e	3136	2098	1114	1671	2.4	.73	104.4	.007	sediment	culvert
B-31	1786	1427	688	752	2.0	5.3	47.0	.11	granite	soil
B-32	899	901	272	319	1.6	1.7	19.9	.09	granite	saprolite
B-33	1350	1740	401	372	3.5	4.2	23.3	.18	granite	saprolite
B-34	1433	1344	478	603	2.2	2.3	37.7	.06	granite	saprolite
B-35	1314	1845	385	333	3.8	4.5	20.8	.21	granite	outcrop

Sample #	Cumulate Counts (2 minutes)				Calculated Concentration			Rock	Occurrence	
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th	Type	
C-1	389	400	143	98	.7	2.1	6.1	.34	?	soil
C-2	622	711	213	177	1.3	2.6	11.1	.23	gneiss ?	soil
C-3	568	483	282	152	.6	4.9	9.5	.51	schist	saprolite
C-4	1135	655	466	548	.5	2.9	34.3	.08	schist ?	soil
C-5	1758	2235	580	406	4.4	8.4	25.4	.33	granite	outcrop
C-6	1234	1136	440	483	1.8	3.3	30.2	.11	granite	saprolite
C-7	1352	1662	402	422	3.2	3.4	26.4	.13	granite	outcrop
C-8	2381	1552	964	1176	1.6	5.3	73.5	.07	granite	soil
C-8a	3585	2067	1615	1867	1.4	10.6	116.7	.09	granite	saprolite
C-8b	3107	1718	1242	1710	1.2	3.4	106.9	.03	granite	saprolite
C-8c	4039	6590	6029	8090	1.7	20.4	505.6	.04	coastal plain sand	culvert
C-9	2031	2446	652	709	4.6	5.1	44.3	.12	granite	outcrop
C-10	1600	2127	486	459	4.2	5.0	28.7	.17	granite	outcrop
C-11	1467	1997	463	394	4.0	5.5	24.6	.22	granite	outcrop
C-12	1607	1542	618	555	2.5	6.8	34.7	.20	?	saprolite
C-13	957	1537	197	148	3.4	2.7	9.3	.29	granite	outcrop
C-14	1311	1469	414	442	2.7	3.4	27.6	.12	granite	saprolite
C-15	1213	1751	293	294	3.7	2.7	18.4	.15	granite	outcrop
C-16	707	666	260	220	1.1	3.1	13.8	.23	?	saprolite
C-17	1365	1709	428	323	3.4	5.8	14.5	.40	granite	outcrop
C-18	238	316	49	46	.7	.5	2.9	.18	schist	outcrop
C-19	445	324	209	168	.4	2.6	10.5	.25	gneiss ?	saprolite
C-20	601	600	228	183	1.0	2.9	11.4	.25	?	saprolite
C-21	1091	1102	429	289	1.8	6.4	18.1	.35	schist	saprolite
C-22	925	1093	309	220	2.1	4.4	13.8	.32	granite	saprolite
C-23	1042	1475	301	165	3.1	5.1	10.3	.50	granite	outcrop
C-24	1248	1241	428	460	2.1	3.4	28.8	.12	granite	soil
C-25	687	547	296	201	.7	4.4	12.6	.35	granite	saprolite
C-26	369	470	127	109	.9	1.5	6.8	.22	?	soil
C-27	1078	1043	384	353	1.7	4.1	22.1	.19	?	saprolite
C-28	491	389	187	160	.6	2.2	10.0	.22	schist	saprolite
C-29	398	256	183	133	.2	2.6	8.3	.31	schist	saprolite
C-30	1164	1129	465	276	1.9	7.6	17.3	.44	schist	saprolite
C-31	562	592	206	156	1.0	2.8	9.8	.28	schist ?	saprolite
C-32	580	630	193	170	1.1	2.2	10.6	.21	schist	saprolite
C-33	1058	1874	198	185	4.2	2.1	11.6	.18	granite	saprolite
C-34	403	525	99	137	1.1	2.6	8.6	.30	schist	saprolite

Sample #	Cumulate Counts (2 minutes)				Calculated Concentration				Rock	Occurrence
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th	Type	
D-1	1058	1096	435	260	1.8	7.0	16.3	.43	?	saprolite
D-2	1277	909	625	420	1.0	9.3	26.3	.35	gneiss ?	saprolite
D-3	1063	646	442	454	.6	3.9	28.4	.14	?	soil
D-4	1022	1305	308	275	2.6	3.4	17.2	.20	granite	outcrop
D-5	2014	2379	615	681	4.5	4.6	42.6	.11	granite	outcrop
D-6	1265	909	474	571	1.1	2.7	35.7	.08	granite	saprolite
D-7	1180	833	465	504	1.0	3.6	31.5	.12	granite	saprolite
D-8	626	618	287	238	.9	3.5	14.9	.23	?	saprolite
D-9	321	237	125	133	.3	1.0	8.3	.12	gneiss	saprolite
D-10	1814	955	795	874	.5	6.0	54.6	.11	granite	saprolite
D-11	1191	1105	489	410	1.7	5.9	25.6	.23	granite	soil
D-11a	2135	2245	709	829	3.9	4.5	51.8	.08	granite	outcrop
									rock	
D-12	1400	836	663	488	.7	9.2	30.5	.30	granite	saprolite
D-13	1801	2281	548	529	4.5	5.4	33.1	.16	granite	outcrop
D-14	1492	1944	527	311	3.8	8.6	19.4	.44	granite	outcrop
D-15	1929	2333	627	495	4.5	8.1	30.9	.26	granite	outcrop
D-15a	2102	2384	888	392	4.2	16.8	24.5	.69	qtz py	granite quarry
									vein	
D-15b	2459	2380	1166	317	3.7	25.4	19.8	1.28	granite	quarry
D-16	1523	1836	448	510	3.5	3.1	31.9	.10	granite	saprolite
D-17	1536	2035	490	388	4.0	6.3	24.3	.26	granite	saprolite
D-18	1326	1103	431	557	1.7	1.8	34.8	.05	granite	saprolite
D-19	1724	2123	517	493	4.1	5.2	30.8	.17	granite	outcrop
D-20	1099	1253	375	292	2.3	4.9	18.6	.26	granite	outcrop
D-21	881	1594	161	143	3.6	1.8	8.9	.20	granite	outcrop
D-22	909	532	472	259	.4	8.0	16.2	.50	granite	saprolite
D-23	1421	1746	385	404	3.5	3.2	25.3	.13	granite	outcrop
D-24	2157	2224	724	703	3.9	7.1	43.9	.16	granite	saprolite
D-25	1345	2021	409	226	4.2	6.9	14.1	.49	gneiss	outcrop
D-26	1550	1960	500	409	3.8	6.2	25.6	.24	granite	saprolite
D-27	1042	763	554	230	.8	10.7	14.4	.74	granite	soil
D-28	889	761	357	364	1.1	3.2	22.8	.14	granite	saprolite
D-29	1547	1911	516	349	3.7	7.7	21.8	.35	granite	outcrop
D-30	1823	2070	522	668	3.9	2.3	41.75	.06	granite	saprolite

Sample #	Cumulate Counts (2 minutes)				Calculated Concentration				Rock	Occurrence
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th	Type	
D-31	1142	962	418	504	1.4	2.4	31.5	.08	granite	saprolite
D-32	531	350	256	151	.3	4.2	9.4	.45	granite	soil
D-33	1060	1247	397	269	2.3	5.9	16.8	.35	granite	saprolite
D-34	648	479	237	270	.6	3.0	16.9	.17	granite	soil
D-35	828	853	315	268	1.4	3.7	16.8	.22	granite	saprolite
D-36	1066	1192	361	258	2.2	5.1	16.1	.32	granite	saprolite
D-37	611	445	275	205	.5	3.8	12.8	.29	granite	soil
D-38	1073	576	427	516	.4	2.4	32.3	.08	granite	saprolite
D-39	515	372	225	196	.4	2.6	12.3	.21	granite	soil
D-40	1694	2057	705	250	3.8	14.3	15.6	.92	granite	outcrop
D-40a	1887	1875	871	224	3.0	19.2	14.0	1.37	granite	outcrop
D-40b	2326	2319	1172	220	3.6	27.3	13.8	1.98	granite	outcrop
D-40c	2727	2474	1497	233	3.4	35.7	14.6	2.45	pegmatite	outcrop
D-41	1690	1473	698	642	2.1	7.4	40.1	.18	pegmatite?	trenched area
D-42	1218	1866	323	251	4.0	4.2	15.7	.27	magnetite	outcrop
									bearing gneiss	
D-43	1825	2127	676	404	3.9	11.0	25.3	.43	granite	outcrop
									rock	
D-44	2659	2028	1038	1232	2.6	7.3	77.0	.09	dirt road	soil
D-45	1905	2066	588	660	3.8	4.2	41.3	.10	granite	soil
									rock	

Sample #	Cumulate Counts (2 minutes)					Calculated Concentration			Rock	Occurrence
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th	Type	
E-1	353	206	160	154	.2	1.6	9.6	.17	?	saprolite
E-2	673	941	185	174	1.9	1.9	10.9	.17	?	soil
E-3	929	958	337	331	1.6	3.2	20.7	.15	?	saprolite
E-4	656	781	210	200	1.5	2.1	12.5	.17	granite	saprolite
E-5	432	276	193	191	.3	1.8	11.9	.15	?	saprolite
E-6	1021	939	323	383	1.6	2.0	23.9	.08	?	saprolite
E-7	473	379	178	145	.6	2.2	9.1	.24	meta sediment?	saprolite
E-8	497	484	182	143	.8	2.4	8.9	.27	?	saprolite
E-9	1224	1811	312	306	3.8	3.0	19.1	.16	meta sediment	saprolite
E-10	1343	1226	648	317	1.8	11.5	19.8	.58	granite	saprolite
E-11	1250	1365	421	372	2.5	4.7	23.2	.20	granite	saprolite
E-12	1329	1772	390	306	3.6	5.1	19.1	.27	granite	outcrop
E-13	1215	1104	431	500	1.7	2.8	31.2	.09	granite	saprolite
E-14	907	769	354	268	1.2	4.8	16.8	.29	granite	saprolite
E-15	621	525	240	179	.8	3.3	11.2	.29	granite	soil
E-16	614	378	269	264	.3	2.6	16.5	.16	?	soil
E-17	708	518	218	203	1.6	2.3	12.7	.18	?	saprolite
E-18	309	204	147	99	.2	2.2	6.2	.35	sediment	saprolite
E-19	554	342	280	214	.3	3.7	13.3	.28	?	saprolite
E-20	356	282	127	108	.4	1.5	6.8	.22	?	saprolite
E-21	406	280	205	105	.3	3.6	6.6	.55	?	saprolite
E-22	288	220	138	105	.3	1.8	6.6	.27	?	saprolite
E-23	928	1306	277	161	2.7	4.6	10.1	.45	granite	soil
E-24	965	995	328	286	1.8	3.8	17.9	.21	granite	saprolite
E-25	413	351	169	71	.3	3.3	4.4	.75	granite	soil
E-26	1018	816	431	266	1.1	6.8	16.6	.41	granite	saprolite
E-27	691	666	244	199	1.1	3.0	12.4	.24	granite	saprolite
E-28	710	668	208	196	1.2	2.1	12.2	.17	granite	soil
E-29	1165	1132	453	284	1.9	7.1	17.8	.40	granite	saprolite
E-30	680	999	215	89	2.1	4.2	5.6	.75	granite	saprolite
E-31	1169	1358	406	265	2.5	6.2	16.6	.37	granite	saprolite
E-32	739	1037	243	140	2.1	4.0	8.8	.46	granite	saprolite
E-33	956	1442	274	213	3.0	3.6	13.3	.27	granite	outcrop
E-34	1391	1275	661	329	1.9	11.8	20.6	.57	granite	saprolite
E-34a	1101	1005	484	301	1.5	7.6	18.8	.40	granite	saprolite
E-35	730	591	271	286	1.1	2.3	17.9	.13	granite	saprolite
E-36	696	437	301	280	.4	3.6	17.5	.21	coastal plain	
E-37	1155	1594	316	280	3.3	3.6	17.5	.21	granite	water well
E-38	1013	932	373	343	1.5	4.0	21.4	.19	granite	saprolite

Sample #	Cumulative Counts (2 minutes)					Calculated Concentration			Rock Type	Occurrence
	Total	Potassium	Uranium	Thorium	K%	U(ppm)	Th(ppm)	U/Th		
F-1	900	841	333	354	1.3	2.7	22.1	.12	granite	saprolite
F-2	456	364	211	147	.5	3.1	9.2	.33	?	soil
F-3	1104	961	475	257	1.4	8.2	16.1	.51	?	saprolite
F-4	608	503	291	159	.7	5.0	9.9	.50	gneiss	saprolite
F-5	671	624	273	219	1.0	3.5	13.7	.26	gneiss ?	saprolite
F-6	599	474	268	154	.6	4.4	9.6	.46	gneiss	saprolite
F-7	588	372	293	183	.3	4.6	11.4	.40	gneiss ?	saprolite
F-8	266	220	107	100	.3	1.1	6.3	.18	?	saprolite
F-9	1743	2085	558	444	4.0	7.1	27.8	.26	granite	outcrop
F-10	2056	1828	769	905	2.8	4.8	56.5	.085	granite	saprolite
F-11	1101	694	465	508	.7	3.6	31.8	.11	granite	saprolite
F-12	1810	1937	443	471	3.8	3.6	29.4	.12	granite	outcrop
F-13	588	451	236	189	.6	3.0	11.8	.25	granite?	saprolite
F-14	1691	2142	513	467	4.2	5.6	29.2	.19	granite	outcrop
F-15	670	493	297	251	.6	3.5	15.7	.23	?	saprolite
F-16	816	872	295	309	1.4	2.5	19.3	.13	?	saprolite
F-17	517	401	222	178	.5	2.8	11.1	.25	?	saprolite
F-18	568	396	222	225	.5	2.0	14.1	.14	schist ?	saprolite
F-19	547	369	241	218	.4	2.6	13.6	.19	schist ?	saprolite
F-20	444	488	157	160	.9	1.4	10.	.14	schist ?	saprolite
F-21	429	419	151	130	.7	1.8	8.1	.22	?	soil
F-22	466	320	224	147	.3	3.4	9.2	.37	?	saprolite
F-23	703	725	222	233	1.3	1.9	14.6	.13	meta siltstone ?	saprolite
F-24	559	453	217	220	.6	2.0	13.8	.14	?	soil
F-25	533	375	194	208	.5	1.6	13.0	.12	?	saprolite
F-26	375	244	187	139	.2	2.6	8.7	.29	schist ?	saprolite
F-27	472	260	200	189	.2	2.0	11.8	.17	schist ?	saprolite
F-28	672	607	268	233	.9	3.1	14.6	.21	schist ?	saprolite
F-29	578	361	245	208	.4	2.9	13.0	.22	?	saprolite
F-30	563	408	238	206	.5	2.6	12.9	.21	gneiss ?	saprolite
F-31	584	428	249	203	.5	3.1	12.6	.25	?	soil