SOAPSTONE IN NORTH CAROLINA
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ABSTRACT

This is the second report on a continuing soapstone study which was originally recommended by the Laboratory Advisory Committee in the Silvis Report. That part of the project covered in this report involved locating, sampling and processing soapstone from numerous deposits in North Carolina. It also involved the testing of soapstone and talc from several deposits and operating mines in other states. A total of 42 samples are described in this report. Twenty-six of the 34 North Carolina deposits appear to contain significant amounts of good quality talc.

INTRODUCTION

In 1970 a project was undertaken to sample, process, and evaluate samples from soapstone deposits in North Carolina. During the progress of that work, it became evident that a significant number of soapstone deposits existed in Madison County, North Carolina. Since this area was close to the Asheville Laboratory, these deposits were examined first, and standard processing procedures were established for the type of material found in that area. The results of this work were published in the July 1971 Progress Report of the Minerals Research Laboratory, as Report No. 71-13-P, "Soapstone in Madison County, North Carolina."

After the first report was printed, there was a great deal of interest in North Carolina soapstone deposits. In order to compare the soapstone deposits with material from other parts of the United States, samples of talc were obtained from other persons. Three samples from talc mines in North Carolina, two samples from talc mines in Georgia, two samples from potential talc mines in Georgia, and a sample from a talc mine in Texas were obtained and examined for comparison with the soapstone deposits of North Carolina.

During the progress of the work reported herein, it became apparent that the procedure used in processing the samples was not necessarily the best for all types of material. However, the procedure was simple and very consistent when applied to similar types of raw material. Therefore the data in this report are combined into three groups conforming to the three types of rock: foliated, asbestosform, and pyroxenite. (These types will be described in detail later in this report.) The data on any sample in a group is comparable with other samples in that group, but care should be taken when comparing samples from one group with samples from another group. Caution should also be exercised in comparing samples in this report with samples in the previous report, 71-13-P. The previous work, on Madison County soapstone deposits, was performed on foliated material recovered mainly from mine dumps. Material for the present work was collected from outcrops that had been subjected to various degrees of weathering.

A final report, to be written at a later date, will collect various data from the previous report and from this report, and attempts will be made to correlate the data. The final report will also include some test work, now in progress, on methods to increase recovery, and improve colors by different grinding procedures.

OBJECTIVE

The object of this project was to locate soapstone deposits in North Carolina and process samples from these deposits to determine the relative amounts and quality of talc present in each. It had been determined that color would be the primary factor in outlining end product uses.

PROCEUDRE

Sample Descriptions

The samples used in this study were collected from old soapstone mine dumps, outcrops on hills, outcrops along road cuts, and float material in areas where no outcrops were visible. The exact locations of these deposits are given in Table 1, "Locations of Soapstone and Talc Deposits." Those deposits in North Carolina are listed by groups and are located by North Carolina grid. Quadrangles are named according to latest usage. Deposits located outside North Carolina are also shown in Table 1, but no grid or map location is shown. Samples from operating mines are designated by state only.

In Table 2, "Descriptions of Soapstone and Talc Deposits," the deposits are briefly described. Some of the occurrences have been mined before - some for soapstone, some for asbestos, and some for talc. Other occurrences were found from locations given in masters and doctorate theses. Still others were brought to our attention by local property owners.

Equipment

The equipment used to process, test, and analyze the samples includes the following:

Jaw crusher, type H, model 5" x 6", Joy Manufacturing Co., Denver Equipment Division, Denver, Colorado;

Hammer mill, type U.R., model 15 x 9, American Pulverizer Co., St. Louis, Mo.;

Abbe mill, type Trojan, Joy Manufacturing Co., Denver Equipment Division, Denver, Colorado;

Ferrofilter, model 0-31, S. G. Frantz Co., Inc., Trenton, New Jersey;

Batch flotation machine, type D-1, Joy Manufacturing Co., Denver Equipment Division, Denver, Colorado;

Pressure filter, The Galigher Company, Salt Lake City, Utah;

Electric oven, style 680, Despatch Oven Co., Minneapolis, Minn.;

Gas oven, type 981, The G. S. Blodgett Co., Inc., Burlington, Vermont;

Spectroscope, model 6-A, Spectrex Co., Redwood City, California;

Atomic absorption spectrophotometer, model 303, Perkin-Elmer Corp., Norwalk, Connecticut;

Reflectance meter, model 610, Photovolt Corp., New York, New York.

Sample Testing

Each sample was tested using the procedure detailed in Table 3, "Ore Dressing Test Data." If the samples as received were wet, they were first dried in a gas oven overnight at a temperature of 200°F. The dry material was jaw crushed to minus one-half inch, then hammer milled to pass one-sixteenth inch. The mill discharge was mixed well, and a few 250-gram samples were split out. A 250-gram sample was placed in an 8-inch (inside diameter) Abbe mill with 4,470 grams of high-density alumina pebbles. The pebbles are cylinders one and one-fourth inch long, one and one-fourth inch in diameter, weigh 84.5 grams each, and were manufactured by Diamonite Products Manufacturing

Company, Shreve, Ohio 44676. Two hundred and fifty c.c.'s of water were added to make a 50% solids charge. The Abbe mill was then rotated at 54 R.P.M., equal to 82% of the critical speed, for thirty minutes. The ground material was then emptied from the mill and the pebbles separated from the pulp. Care had to be taken not to dilute the sample with too much water. The material was then mixed and passed through a Frantz Ferrofilter. The nonmagnetic product was then poured through the Ferrofilter three more times. The grid on the Ferrofilter was then rinsed. The magnetic material was transferred to a pan and dried. The nonmagnetic material was placed in a Denver, D-1, glass flotation cell. The cell has a capacity of 2500 c.c. Water was added to bring the level of the slurry to the top of the cell, and the machine was turned on. With the air valve turned off, 0.66 lbs. per ton of Aerofroth 73 was added, and the material was allowed to condition for one minute at 1200 R.P.M. After conditioning, the air valve was opened, and the talc froth product was collected for about five minutes, or until the froth no longer supported particles. The froth product was then sprayed with water to break down the froth. The machine discharge was transferred into a separate bucket. The froth product was transferred back into the cell and refloated. The cleaning was repeated once to obtain a final cleaner concentrate, a first cleaner tails, a second cleaner tails, and a rougher tails. All these products were filtered on a pressure filter using No. 4 Whatman filter paper and 80 p.s.i. air pressure. The filtered products were dried in an electric oven at 275° F, and weighed. A fifty-gram sample of the cleaner concentrate was then split out for leaching. Leaching was carried out in a 600-ml. Pyrex glass beaker using 10% sulfuric acid, at $90^{\circ}C$ ($\pm 5^{\circ}$). One hundred and fifty c.c. of acid was heated to $95^{\circ}C$, and then the talc was added.

The talc was stirred continuously by mechanical means to keep it in suspension. After leaching for thirty minutes, the pulp was filtered on a Buchner filter, using an aspirator for vacuum, and No. 4 Whatman filter paper. The filter cake was washed three times with clear water to remove the acid residue. The filter cake was dried at 275°F and weighed.

A small sample of head feed was ground in a mortar and pestle to pass 100 mesh. This sample, along with samples of the cleaner concentrate and the leached concentrate, was subjected to color evaluation. The reflectance of each sample at different wave lengths of light was measured using a Photovolt color reflectance instrument.

Small samples of head feed, cleaner concentrate, and leached concentrate were submitted for chemical analysis.

The magnetic fraction from the Ferrofilter was examined in a Spectrex visual comparison spectroscope.

RESULTS

The results of the test work of this project have been assembled into a series of tables. It is hoped that, by presenting the data in this form, the interpretation of the results will be simplified. It has been observed that certain industries are primarily interested in specific combinations of factors. These factors should be easier to observe and correlate when the data is in tabulated form.

Table 4, "Processing Results," tabulates the weight yield of each product obtained in the evaluation tests. Cleaner tails #1 and cleaner tails #2 have been combined and reported as one weight fraction called "middlings." The difference between 100 and the sum of the product weight percentages is the amount of losses that occurred during testing.

Tables 5, 6, and 7 - "Chemical Analyses, Head Feed," "Chemical Analyses, Cleaner Flotation Concentrate" and "Chemical Analyses, Leached Concentrate" - tabulate the analyses of the respective products examined. Some changes can be observed by comparing the values in the different products of a single sample. The most obvious of these changes is in the trend of the products, with increasing processing, to approach the chemical values for pure talc. Complete analyses of the leached concentrates were not made, because it was thought unnecessary. The only significant changes caused by leaching would occur in the values of loss on ignition, acid soluble material, and iron.

Table 8, "Reflectance Color," tabulates the reflectance of each sample as determined with different colors of light. Reflectance values were determined on head feed ground to minus 100 mesh, and on cleaner flotation concentrate and leached concentrate each ground to about 90% minus 100 mesh. For this work, a new set of tristimulus filters (green, blue, and amber), and a new enamel reference standard were obtained from the Photovolt Corporation.

Spectroscopic examination of the magnetic fractions from the Ferrofilter disclosed the presence of Fe, Cr, Mn, Mg, and Zn in all but the North Carolina "Green," "Gray," and "White," and the Texas sample. Samples from the North Carolina "Gray" rougher tailing showed the presence of Zr.

Table 9, "Chemical Analyses of Selected 'Talc' Samples," is a collection of chemical analyses obtained from numerous references and reports. This gives an indication of the variety of "talcs" now being used in industry.

DISCUSSION

Talc is an acid metasilicate of magnesium, having a chemical formula of $H_2 Mg_3 (SiO_3)_4$, or H_2O . 3MgO . $4SiO_2$, with approximately 63.37% SiO_2, 31.88% MgO, 4.75% H_2O, and a SiO_2 : MgO ratio of 1.99. One-half of the water is lost below dull red heat, the remainder goes off rapidly at about 900°C. Talc is often called steatite, soapstone or potstone, and by trade names such as talc clay, agalite, asbestine, and verdolite. The whiter, relatively pure talcs are derived from sedimentary magnesium carbonate rocks, while less pure talc is normally derived from ultrabasic igneous rocks. The term "talc" may be used to include all forms of the pure mineral, whereas "steatite" denotes particularly the massive, compact variety, and "soapstone" the impure massive form.

The name "soapstone" is given to dark gray and greenish talcose rocks which are soft enough to be readily cut with a knife, and which have a pronounced soapy or greasy feeling, hence the name. The material is rarely pure and normally contains varying proportions of chlorite, mica, and tremolite; together with perhaps unaltered residuals of pyroxene, granules of iron spinels, pyrites, quartz, and, in seams and veins, calcite and magnesium carbonates.

Foliated talc consists of folia, usually easily separated, having a greasy feel, and usually having a light green, greenish white, or white color. Pseudomorphous talc is a fine to coarse fibrous material, usually altered from enstatite, hypersthene, pyroxene or other amphiboles. Fibrous talc may be composed principally or entirely of anthophyllite. Hence in this work the deposits were classified as "foliated," "pyroxenite" or "pseudomorphic," and "asbestosform" or from anthophyllite deposits.

Talc is one of the most readily floatable nonsulfide minerals and has been classified as a natural floater. It may be collected in a flotation froth with any one of a wide variety of frothers, fatty acids, soaps, or amines; so that the beneficiation will frequently require emphasis on rejecting the contaminants rather than recovering the talc. The frothing agent, Aerofroth 73, was selected because of its low boiling point, 135°C. It was hoped that, by drying the froth product as 275°F, the frother would be driven off leaving a reagent-free surface on the talc.

It was found that some of the talc did not float after several cleaner steps. The stained material tended to be wetted during the cleaner flotation steps and collected in the cleaner tailings. This was a help in obtaining unstained material for color evaluation, since the samples being tested were weathered and stained.

As can be seen in Tables 5, 6 and 7, the composition of head feed samples varies considerably. But the analyses of the flotation concentrates and the leached concentrates vary by only small amounts. This indicates that the products are approaching the theoretical values because the contaminating minerals are being removed.

The color values do not indicate that any of the material would be suitable for cosmetic uses. However, work to be reported later has indicated that, by grinding the product to a finer size, these color values can be improved considerably. The color values shown here were obtained using a new set of tristimulus filters and a new reference standard. The colors reported in the first report were obtained with an old set of filters and an old standard. In the final report, new color values for the previous work will be determined, thereby allowing data in this and the previous report to be compared.

The significance of Cr, Mn, and Zn in the magnetic fractions is uncertain. The Zr in one sample probably indicates that the talc was derived from a sedimentary magnesium carbonate.

Pure talc is an extreme rarity and the term "true talc" is a more practical phrase to use. Actually, only a very unusual application would require talc that is mineralogically pure. Each industry requires specific characteristics in the talc it uses, and within each industry certain products require distinct types. The wide range of analyses of talcs currently being used (see Table 9) shows that most industries will accept rather impure talcs.

CONCLUSIONS

Of the 34 North Carolina soapstone deposits sampled and processed, 26 appear to contain talc of such quality and quantity as to be regarded as potential sources of filler grade talc.

In order to determine which talcs would be suitable for any particular industry, testing oriented toward that industry would have to be undertaken. That type of work was outside the scope of this project. If a specific industry becomes interested in a specific deposit, or group of deposits, testing could be undertaken to determine if the talc is compatible with their requirements.

Table 1

LOCATIONS OF SOAPSTONE AND TALC DEPOSITS

Location Name	Lab No.	Quadrangle Map Name	N.C. Grid Location North	N.C. Grid Location East
Foliated				
Leicester #1	3689	Leicester	712,700	919,700
Leicester #2	3693	Leicester	737,350	902,600
Iredell #3	3705	Charlotte (2°sheet)	803,000*	1,458,500*
Danbury	3998	Winston-Salem	968,900	1,661,500
Leicester #3	4027	Leicester	713,600	916,750
Gosnell	4028	Marshall	792,850	923,900
Foster Creek	4059	Sams Gap	812,950	935,450
Wilkes #3	4065	Boomer	863,300	1,299,300
Reed Mountain	4070	Sams Gap	810,000	944,650
Roaring Fork	4071	Sams Gap	811,800	940,350
Teasdale	4072	Leicester	740,250	918,250
Asbestosform				
Newdale	4015	Micaville	804,000	1,052,850
Blue Rock Road	4016	Micaville	792,150	1,057,450
Blue Rock	4017	Micaville	794,800	1,056,100
Oakland	4051	Reid	520,300	809,900
Asbestos	4052	Cashiers	522,100	801,000
Miller	4053	Cashiers	514,350	802,350
Brockton	4054	Big Ridge	525,400	804,000
Rattlesnake	4055	Big Ridge	525,250	802,800
Simpson	4062	Collettsville	787,700	1,199,700

(continued)

*Estimated from 2°sheet.

Table 1 (continued)

Location Name	Lab No.	Quadrangle Map Name	N.C. Grid Location North	East
Pyroxenite				
Iredell #1	3703	Charlotte (2°sheet)	774,500*	1,472,500*
Iredell #2	3704	Charlotte (2°sheet)	782,000*	1,474,500*
Peppers Creek	3833	Little Switzerland	774,900	1,109,400
Fontana	3994	Tuskeegee	642,950	594,200
Mt. Grant	3995	Marion (15'sheet)	699,950	1,107,100
Crabtree Creek	3996	Celo	784,200	1,068,100
Grassy Branch	3997	Spruce Pine	794,650	1,091,900
Soapstone Gap	4012	Skyland	631,400	923,650
Baldwin	4030	Todd	957,100	1,250,000
Wilkes #1	4063	Purlear	872,400	1,315,200
Wilkes #2	4064	Purlear	883,100	1,326,500
Wilkes #4	4066	Wilkesboro	886,600	1,361,300
Sparta #1	4067	Sparta East	1,016,750	1,402,000
Sparta #2	4068	Sparta East	1,015,650	1,400,850
Out-of-State				
Holly Springs	3934	(Georgia)	N/A	N/A
Nix	3988	(Georgia)	N/A	N/A
Mines				
N. C. (Green)	None	N/A	N/A	N/A
N. C. (Gray)	3691	N/A	N/A	N/A
Georgia	3730	N/A	N/A	N/A
Georgia	3731	N/A	N/A	N/A
Texas	3732	N/A	N/A	N/A
N. C. (White)	3808-C	N/A	N/A	N/A

*Estimated from 2° sheet.

Table 2

DESCRIPTIONS OF SOAPSTONE AND TALC DEPOSITS

Location Name	Description
Foliated	
Leicester #1	Outcrop of an altered dunite.
Leicester #2	Outcrop of a body 25' thick and about 600' long.
Iredell #3	Bulldozed prospect trench and float. Only discontinuous elongated blocks up to 3' by 1' present in walls of the trench. A nearby shallow pit, about 30' in diameter, reportedly produced soapstone blocks that were cut into marking pencils in about 1900.
Danburry	Outcrop in a road cut. Outcrop 2' to 3' thick and traced about 50' along strike.
Leicester #3	Outcrop in a driveway, 2' to 3' thick.
Gosnell	Outcrop exposed on a hillside, thickness unknown.
Foster Creek	Outcrop, 2-3' thick, exposed on a hillside by a landslide.
Wilkes #3	Outcrop along a road cut. About 40' thick.
Reed Mountain	Dump material from several old prospect pits and abundant float material.
Roaring Fork	Dump material from an old open cut. Exposure is about 25' true thickness.
Teasdale	Exposed material, 2-3' thick, in a new prospect pit.
Asbestosform	
Newdale (1)	Asbestos mine, random sample from ore stockpile.
Blue Rock Road(1)	Outcrop in a road bank.
Blue Rock(1)	Asbestos mine, random samples from a fresh mine face.
Oakland(1)	Asbestos mine, random samples from a weathered mine face.
Asbestos(1)	Asbestos mine, random samples from a weathered mine face.
Miller(1)	Asbestos mine, random samples from a weathered mine face.

(1)See mine descriptions in "Anthophyllite Asbestos in N. C.," by Conrad, S.G.; Wilson, W.F., Allen, E.P.; and Wright, T.J. - N. C. Dept. of Conserv. and Develop., Bull #77, 1963, 61 p.

(continued)

Table 2 (continued)

Location Name	Description
Asbestosform (cont.)	
Brockton[1]	Asbestos mine, random samples from a weathered mine face.
Rattlesnake[1]	Asbestos mine, random samples from a weathered mine face.
Simpson[1,2]	Asbestos mine, random samples of old dump material.
Pyroxenite	
Iredell #1	Outcrop in a road cut, sampled along a 100' exposure.
Iredell #2	Outcrop on tree farm, exposure about 50' wide, and at least 200' long. Location near old Plyler chromite mine.
Peppers Creek	Dump material from around an old mine shaft and open cut. Reportedly mined by Bryson Talc Co. in early 1940's. Reportedly about 20 carloads of ore were ground into powder at a mill in Marion, N. C.
Fontana[3]	Dump material and exposed material from a fresh bulldozer cut at an old open face mine.
Mt. Grant	Outcrop in a road cut along side of a curve.
Crabtree Creek[4]	Outcrop in a road cut.
Grassy Branch[4]	Outcrop in a road cut.
Soapstone Gap[5]	Outcrop in a road cut.
Baldwin	Dump material from an old open-cut mine. Ore zone is about 25' wide. The mine was operated for dimension material in the 1920's.

(1)See mine descriptions in "Anthophyllite Asbestos in N. C.," by Conrad, S. G.; Eilson, W. F., Allen, E. P.; and Wright, T. J. - N. C. Dept. of Conserv. and Develop., Bull #77, 1963, 61 p.

(2)See mine description in "Geology of the Spruce Pine District, Avery, Mitchell, and Yancey Counties, N. C.," byBrobst, D. A., U. S. Geological Survey, Bull. 1122-A, 1962, p. 9.

(3)See description in "Geologic Atlas of the U. S., Nantahala Folio," by Keith, A., U. S. Geological Survey, 1907, p. 8.

(4)See description in "Geology of the Grandfather Mountain Window, N. C. and Tennessee," by Bryant, B., and Reed J. C., Jr., U. S. Geological Survey Paper 615, 1970, p. 48.

(5)See description in "Geologic Atlas of the U. S., Asheville Folio," by Keith, A., U. S. Geological Survey, 1904, p. 8.

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Table 2 (continued)

Location Name	Description
Pyroxenite (cont.)	
Wilkes #1	Outcrop in a road cut. Exposure is about 20' wide. The area seemed to have been mined by adit and hill-side pits.
Wilkes #2	Float material, about 75' across, in a forested field.
Wilkes #4	Outcrop in a road cut.
Sparta #1	Outcrop in a road cut.
Sparta #2	Four-foot outcrop in a road bank.
Out-of-State	
Holly Springs	Chip sample from a potential talc mine location.
Nix	Chip sample from a potential talc mine location.
Mines	
N. C. (Green)	Selected sample of talc rock, light green in color.
N. C. (Gray)	Selected sample of talc rock, light gray in color.
Georgia	Selected samples of ore from an operating talc mine.
Georgia	Selected samples of ore from an operating talc mine.
Texas	Selected samples of ore from an operating talc mine.
N. C. (White)	Selected sample of talc rock, snow white in color.

Table 3

ORE DRESSING TEST DATA

Lab. No. ______________________ Test No. ______________________

Operator ______________________ Date ______________________

Object of Test Flotation of Talc

					Color						
		Wt %			Green	Blue	Amber				
Magnetics		xx									
Ro. Tails		xx									
Cl. Tails #1		xx									
Cl. Tails #2		xx									
Cl. Conc.		xx			xx	xx	xx				
Losses		xx									
Total		100.0									
Head Fd. to Leach		100.0									
Leached Conc.		xx			xx	xx	xx				
Head Feed		100.0			xx	xx	xx				

Conditions — Reagents (lbs per ton)

Process	(Min) Time	% Solids	pH			AF-73		H_2SO_4			
Jaw Crush -1/2"											
Hammer Mill -1/16"											
Pebble Mill	30	50									
Ferrofilter											
Condition	1					0.66					
Float	5										
Clean F.P. #1	3										
Clean F.P. #2	3										
Leach	30	25						600			

Remarks:

Pebble mill with high density alumina pebbles.
Pass through Ferrofilter 4 times.
Condition in cell at 1200 r.p.m. with Aerofroth 73.
Float for 5 min., or until froth no longer supports particles.
Clean for 3 min., or until froth no longer supports particles.
Repear cleaner step.
Filter and dry all products at 275°F.
Leach 50 gr. for 30 min. at 25% solids at 85 to 95°C with H_2SO_4.

Record colors on head, cleaner concentrate, and leached concentrate using a Photovolt reflectance testing machine.

Table 4

PROCESSING RESULTS

Location Name	Lab No.	Flotation Yield - % of Head Feed* Magnetics	Ro. Tails	Middlings	Clean Conc.	% Yield Leach	Overall
Leicester #1	3689	3.5	41.7	21.2	29.2	98.6	28.8
Leicester #2	3693	4.2	16.1	15.9	58.9	98.6	58.1
Iredell #3	3705	4.4	64.2	22.9	7.2	96.0	6.9
Danbury	3998	4.6	14.5	17.0	61.4	98.6	60.5
Leicester #3	4027	3.2	21.6	19.4	54.9	99.2	54.5
Gosnell	4028	4.0	22.5	27.6	44.4	99.6	44.2
Foster Creek	4059	-	-	-	-	-	-
Wilkes #3	4065	2.0	46.3	36.9	13.8	98.0	13.5
Reed Mountain	4070	2.8	28.0	31.7	35.6	98.4	35.0
Roaring Fork	4071	12.9	32.4	35.9	17.0	97.4	16.6
Teasdale	4072	9.0	26.5	32.0	30.0	98.0	29.4
Newdale	4015	4.0	32.0	22.6	38.4	94.2	36.2
Blue Rock Road	4016	11.6	31.6	15.6	39.4	94.6	37.2
Blue Rock	4017	16.6	34.0	13.5	33.2	99.0	32.9
Oakland	4051	11.2	36.7	20.6	25.3	99.2	25.1
Asbestos	4052	14.2	25.7	21.2	34.7	99.4	34.5
Miller	4053	21.8	32.5	21.4	19.3	98.6	19.0
Brockton	4054	17.3	35.4	25.8	18.4	98.6	18.1
Rattlesnake	4055	13.6	24.8	21.8	36.4	99.4	36.2
Simpson	4062	6.4	41.7	33.8	15.2	98.6	15.0

*Difference from 100 is losses.

(continued)

Table 4 (continued)

Location Name	Lab No.	Flotation Yield - % of Head Feed* Magnetics	Ro. Tails	Middlings	Clean. Conc.	% Yield Leach	Overall
Iredell #1	3703	8.7	23.9	19.8	43.7	98.8	43.2
Iredell #2	3704	5.2	21.9	19.3	51.3	98.8	50.7
Peppers Creek	3833	0.7	39.9	36.2	20.5	97.4	20.0
Fontana	3994	1.4	22.8	21.9	51.0	99.2	50.6
Mt. Grant	3995	20.4	67.2	-	8.2	-	-
Crabtree Creek	3996	7.8	45.6	14.1	29.4	99.2	29.2
Grassy Branch	3997	9.5	37.4	17.9	32.4	99.6	32.3
Soapstone Gap	4012	25.6	35.5	13.3	22.6	98.2	22.2
Baldwin	4030	10.0	40.0	13.9	34.2	98.6	33.7
Wilkes #1	4063	2.9	32.1	34.2	29.6	98.0	29.0
Wilkes #2	4064	8.4	20.8	18.5	50.8	98.0	49.8
Wilkes #4	4066	5.6	28.4	35.6	29.6	98.0	29.0
Sparta #1	4067	11.8	47.0	22.1	17.4	98.0	17.1
Sparta #2	4068	5.6	20.0	22.1	50.4	98.6	49.7
Holly Springs	3934	9.6	34.7	10.2	43.7	96.4	42.1
Nix	3988	3.1	17.2	27.5	49.0	99.6	48.8
N. C. (Green)	(None)	-	-	-	-	-	-
N. C. (Gray)	3691	0.0	24.5	25.6	47.6	-	-
Georgia	3730	4.4	64.2	22.9	7.2	96.0	6.9
Georgia	3731	5.5	63.0	19.9	10.4	96.6	10.0
Texas	3732	0.7	39.9	36.2	20.5	97.4	20.0
N. C. (White)	3808-C	-	-	-	-	-	-

*Difference from 100 is losses.

Table 5

CHEMICAL ANALYSES, HEAD FEED

Location Name	Lab No.	Chemical Analyses %									
		SiO_2	MgO	Ratio SiO_2/MgO	CaO	Na_2O	K_2O	Al_2O_3	LOI	FeO*	Acid** Sol.
Leicester #1	3689	53.0	31.4	1.69	0.20	0.04	0.05	1.9	7.6	4.7	7.2
Leicester #2	3693	59.3	27.2	2.18	0.70	0.06	0.05	2.3	5.3	4.8	4.6
Iredell #3	3705	61.7	27.5	2.24	0.70	0.04	0.04	0.3	4.9	3.2	1.2
Danbury	3998	59.1	29.6	2.00	0.03	0.18	0.04	2.4	5.2	3.8	4.0
Leicester #3	4027	58.5	30.5	1.92	0.19	0.07	0.05	1.1	5.5	3.8	5.0
Gosnell	4028	58.5	29.8	1.96	0.17	0.05	0.05	0.7	5.4	4.9	4.7
Foster Creek	4059	29.3	30.6	0.96	0.37	0.04	0.05	21.8	11.9	5.5	11.0
Wilkes #3	4065	52.9	26.7	1.98	0.08	0.02	0.04	5.7	7.1	7.3	8.6
Reed Mountain	4070	59.2	28.4	2.08	0.13	0.12	0.04	0.8	4.8	5.7	1.8
Roaring Fork	4071	54.9	27.7	1.98	1.09	0.08	0.02	1.2	5.7	8.4	7.7
Teasdale	4072	59.4	29.5	2.01	0.05	0.06	0.03	0.6	5.0	4.4	3.4
Newdale	4015	49.5	38.1	1.30	0.08	0.05	0.08	1.7	5.0	5.3	21.2
Blue Rock Road	4016	51.4	31.9	1.61	0.33	0.03	0.03	3.9	6.8	5.5	9.3
Blue Rock	4017	50.4	33.6	1.50	0.20	0.03	0.03	1.3	9.8	4.8	16.5
Oakland	4051	53.5	29.1	1.84	0.90	0.07	0.04	3.3	5.7	6.4	7.5
Asbestos	4052	56.4	26.9	2.10	0.19	0.06	0.04	1.7	5.3	6.7	7.6
Miller	4053	54.4	30.7	1.77	0.44	0.03	0.02	2.0	5.4	6.5	8.5
Brockton	4054	56.2	29.1	1.93	0.38	0.05	0.12	2.0	5.1	5.2	8.2
Rattlesnake	4055	58.4	26.2	2.23	0.13	0.05	0.04	1.6	5.0	6.1	8.5
Simpson	4062	55.8	30.1	1.85	0.91	0.11	0.03	1.1	5.1	7.5	5.5

*Total iron as FeO

**Acid soluble run on separate sample in hot 1:1 HCl.

(continued)

Table 5 (continued)

Location Name	Lab No.	SiO_2	MgO	Ratio SiO_2/MgO	CaO	Na_2O	K_2O	Al_2O_3	LOI	FeO*	Acid Sol.**
		Chemical Analyses %									
Iredell #1	3703	57.5	25.9	2.22	0.60	0.05	0.04	4.1	4.9	5.9	4.0
Iredell #2	3704	59.0	26.5	2.23	1.90	0.07	0.04	2.4	5.0	5.8	3.5
Peppers Creek	3833	55.3	31.0	1.78	0.30	0.06	0.05	2.5	6.3	3.7	3.7
Fontana	3994	61.1	31.3	1.95	0.66	0.08	0.02	1.5	5.1	1.4	1.5
Mt. Grant	3995	43.6	20.8	2.10	5.40	0.85	0.06	14.2	6.2	8.5	N.D.
Crabtree Creek	3996	51.5	30.0	1.72	0.11	0.05	0.04	6.6	5.5	6.1	6.0
Grassy Branch	3997	55.7	28.5	1.95	0.02	0.05	0.03	4.5	5.0	5.5	6.5
Soapstone Gap	4012	42.6	23.7	1.80	2.00	0.16	0.05	10.1	5.9	10.6	16.3
Baldwin	4030	42.2	30.0	1.41	1.66	0.08	0.02	4.8	12.3	6.6	21.1
Wilkes #1	4063	54.6	28.0	1.95	0.51	0.06	0.03	4.1	6.3	6.1	10.2
Wilkes #2	4064	55.2	27.9	1.98	0.27	0.02	0.01	2.5	5.9	5.6	7.4
Wilkes #4	4066	55.2	27.7	1.99	0.17	0.02	0.03	3.3	6.1	6.9	7.5
Sparta #1	4067	44.7	31.0	1.44	1.36	0.03	0.01	6.5	8.4	7.5	10.3
Sparta #2	4068	61.6	27.4	2.25	0.22	0.03	0.01	1.0	5.0	5.2	1.8
Holly Springs	3934	31.0	34.5	0.90	1.06	0.05	0.04	1.7	25.1	5.2	49.2
Nix	3988	58.0	29.1	1.99	0.07	0.05	0.04	2.9	5.8	4.8	6.4
N. C. (Green)	(none)	62.1	31.5	1.97	0.20	0.03	0.01	0.2	5.1	0.6	0.7
N. C. (Gray)	3691	50.7	29.1	1.74	5.40	0.03	0.02	1.5	11.9	1.2	16.6
Georgia	3730	46.5	8.5	5.47	4.90	0.71	1.11	21.4	8.5	7.2	26.6
Georgia	3731	46.4	12.4	3.74	5.50	0.71	0.48	17.5	9.6	6.4	29.0
Texas	3732	58.6	32.0	1.83	1.70	0.09	0.05	0.2	6.5	0.4	8.3
N. C. (White)	3808-C	62.2	31.2	1.99	0.50	0.02	0.06	0.8	4.9	0.5	1.2

*Total iron as FeO. N.D. = Not determined.
**Acid soluble run on separate sample in hot 1:1 HCl.

Table 6

CHEMICAL ANALYSES, CLEANER FLOTATION CONCENTRATE

Location Name	Lab No.	Chemical Analyses %									
		SiO_2	MgO	Ratio SiO_2/MgO	CaO	Na_2O	K_2O	Al_2O_3	LOI	FeO*	Acid** Sol.
Leicester #1	3689	61.5	30.0	2.05	0.10	0.03	0.02	0.3	4.9	2.3	1.7
Leicester #2	3693	61.2	28.0	2.19	0.20	0.03	0.02	1.3	5.0	4.2	1.1
Iredell #3	3705	62.7	28.9	2.17	0.20	0.03	0.01	0.3	4.9	2.7	0.5
Danbury	3998	60.5	30.5	1.98	0.00	0.06	0.02	0.6	5.3	3.4	4.1
Leicester #3	4027	60.8	31.4	1.94	0.02	0.03	0.02	0.2	4.8	2.6	1.3
Gosnell	4028	60.7	30.6	1.98	0.04	0.06	0.03	0.4	4.7	3.5	2.0
Foster Creek	4059	-	-	-	-	-	-	-	-	-	-
Wilkes #3	4065	60.2	30.2	1.99	0.01	0.02	0.01	0.9	5.1	4.3	2.1
Reed Mountain	4070	60.8	29.5	2.06	0.02	0.07	0.02	0.5	4.5	4.8	0.9
Roaring Fork	4071	60.0	30.0	2.00	0.16	0.04	0.01	0.5	5.0	4.6	1.4
Teasdale	4072	61.5	31.0	1.98	0.04	0.07	0.02	0.2	4.9	2.4	1.0
Newdale	4015	57.7	33.9	1.70	0.03	0.03	0.02	0.5	5.4	2.5	6.8
Blue Rock Road	4016	60.6	31.3	1.94	0.05	0.02	0.02	0.4	4.5	2.4	1.0
Blue Rock	4017	61.0	33.7	1.81	0.02	0.04	0.02	0.2	5.2	1.6	2.0
Oakland	4051	61.1	29.2	2.09	0.16	0.07	0.03	0.8	5.0	2.4	2.0
Asbestos	4052	61.6	29.2	2.11	0.04	0.07	0.01	0.5	4.8	2.2	1.8
Miller	4053	61.5	30.3	2.03	0.09	0.03	0.01	0.4	4.8	2.3	2.2
Brockton	4054	61.4	29.2	2.10	0.05	0.07	0.01	0.5	4.8	2.2	1.8
Rattlesnake	4055	61.3	28.8	2.13	0.03	0.08	0.01	0.7	4.8	2.4	2.0
Simpson	4062	59.7	31.2	1.91	0.20	0.04	0.01	0.4	4.7	5.1	2.0

*Total iron as FeO

**Acid soluble run on separate sample in hot 1:1 HCl.

(continued)

Table 6 (continued)

Location Name	Lab No.	Chemical Analyses % SiO_2	MgO	Ratio SiO_2/MgO	CaO	Na_2O	K_2O	Al_2O_3	LOI	FeO*	Acid Sol.**
Iredell #1	3703	61.9	28.2	2.20	0.20	0.04	0.02	1.6	5.0	2.9	1.1
Iredell #2	3704	60.9	27.8	2.19	0.20	0.03	0.01	1.0	5.8	3.8	1.1
Peppers Creek	3833	61.8	30.6	2.02	0.20	0.02	0.02	0.3	5.0	1.8	1.3
Fontana	3994	61.5	31.8	1.93	0.02	0.09	0.03	0.6	4.9	1.4	1.2
Mt. Grant	3995	53.1	29.0	1.83	2.41	0.24	0.05	5.2	5.5	6.2	N.D.
Crabtree Creek	3996	61.0	31.6	1.93	0.02	0.04	0.02	0.1	4.7	2.5	1.2
Grassy Branch	3997	61.3	31.2	1.96	0.00	0.09	0.02	0.5	5.0	2.0	1.4
Soapstone Gap	4012	58.1	30.2	1.92	0.33	0.04	0.02	1.6	5.7	3.8	2.8
Baldwin	4030	59.9	32.4	1.85	0.13	0.03	0.02	0.5	5.4	2.8	2.5
Wilkes #1	4063	60.2	30.3	1.99	0.03	0.05	0.03	0.7	4.9	3.9	1.4
Wilkes #2	4064	60.8	31.8	1.91	0.04	0.03	0.01	0.4	4.9	3.0	1.3
Wilkes #4	4066	59.8	29.6	2.02	0.02	0.02	0.01	0.9	5.0	5.4	2.0
Sparta #1	4067	60.4	32.0	1.89	0.14	0.02	0.01	0.7	5.1	2.3	1.4
Sparta #2	4068	61.2	30.6	2.00	0.03	0.06	0.01	0.3	4.5	3.9	1.0
Holly Springs	3934	59.1	31.9	1.85	0.09	0.02	0.02	0.3	6.6	1.9	4.9
Nix	3988	60.4	30.3	1.99	0.02	0.04	0.02	0.6	4.9	3.4	1.9
N. C. (Green)	(None)	-	-	-	-	-	-	-	-	-	-
N. C. (Gray)	3691	60.3	30.9	1.95	0.80	0.03	0.02	1.0	5.6	1.1	2.3
Georgia	3730	57.2	26.2	2.18	1.60	0.13	0.14	2.9	6.0	5.0	6.8
Georgia	3731	58.6	27.2	2.15	1.00	0.07	0.05	3.3	6.2	3.7	6.3
Texas	3732	62.3	31.4	1.98	0.10	0.05	0.02	0.2	5.4	0.2	3.5
N. C. (White)	3808-C	-	-	-	-	-	-	-	-	-	-

*Total iron as FeO. N.D. = Not determined.

**Acid soluble run on separate samples in hot 1:1 HCl.

Table 7

CHEMICAL ANALYSES, LEACHED CONCENTRATE

Location Name	Lab Number	Chemical Analyses % LOI	FeO*	Acid Soluble**
Leicester #1	3689	4.8	3.25	1.1
Leicester #2	3693	4.7	3.79	1.2
Iredell #3	3705	4.8	2.80	0.4
Danbury	3998	4.3	3.43	0.9
Leicester #3	4027	4.8	2.44	0.7
Gosnell	4028	4.9	3.43	1.5
Foster Creek	4059	-	-	-
Wilkes #3	4065	5.0	4.06	1.5
Reed Mountain	4070	4.7	4.70	0.6
Roaring Fork	4071	4.7	4.52	0.5
Teasdale	4072	4.7	2.53	0.5
Newdale	4015	5.4	2.35	2.9
Blue Rock Road	4016	5.0	2.35	0.7
Blue Rock	4017	4.8	1.63	1.0
Oakland	4051	5.0	2.26	2.0
Asbestos	4052	4.9	2.17	1.4
Miller	4053	4.9	2.17	1.4
Brockton	4054	4.7	2.17	1.4
Rattlesnake	4055	4.8	2.35	1.6
Simpson	4062	4.7	4.52	1.0

*Total iron as FeO

**Acid soluble run on separate samples in hot HCl.

(continued)

Table 7 (continued)

Location Name	Lab Number	Chemical Analyses % LOI	FeO	Acid Soluble**
Iredell #1	3703	4.9	2.89	0.8
Iredell #2	3704	4.7	3.61	0.7
Peppers Creek	3833	5.0	1.72	1.1
Fontana	3994	5.0	1.26	1.0
Mt. Grant	3995	-	-	-
Crabtree Creek	3996	4.8	2.44	0.9
Grassy Branch	3997	4.8	3.43	0.9
Soapstone Gap	4012	5.0	4.89	1.6
Baldwin	4030	5.2	2.80	1.4
Wilkes #1	4063	4.8	3.97	1.0
Wilkes #2	4064	4.9	2.80	1.0
Wilkes #4	4066	4.6	5.33	1.1
Sparta #1	4067	4.8	2.26	1.0
Sparta #2	4068	4.7	3.88	0.8
Holly Springs	3934	5.3	1.72	1.5
Nix	3988	4.8	3.43	1.5
N. C. (Green)	(None)	-	-	-
N. C. (Gray)	3691	5.0	1.08	0.6
Georgia	3730	4.9	4.97	4.3
Georgia	3731	4.8	3.70	3.0
Texas	3732	5.0	0.18	1.0
N. C. (White)	3808-C	-	-	-

*Total iron as FeO

**Acid soluble run on separate samples in hot 1:1 HCl.

Table 8

REFLECTANCE COLOR

Location Name	Lab Number	Head Feed Green	Head Feed Blue	Head Feed Amber	Cl. Float. Conc. Green	Cl. Float. Conc. Blue	Cl. Float. Conc. Amber	Leached Conc. Green	Leached Conc. Blue	Leached Conc. Amber
Leicester #1	3689	58	44	61	76	66	78	81	76	80
Leicester #2	3693	64	45	61	74	64	76	76	68	78
Iredell #3	3705	70	66	71	77	72	77	79	74	78
Danbury	3998	74	63	72	72	66	73	74	69	75
Leicester #3	4027	72	58	75	76	66	80	80	76	82
Gosnell	4028	65	46	70	70	54	74	73	60	78
Foster Creek	4059	60	53	61	-	-	-	-	-	-
Wilkes #3	4065	54	37	58	62	47	65	71	55	74
Reed Mountain	4070	68	60	70	72	65	72	74	68	75
Roaring Fork	4071	65	57	66	72	60	73	76	71	78
Teasdale	4072	68	53	71	76	67	79	80	74	82
Newdale	4015	70	69	70	76	72	76	83	80	84
Blue Rock Road	4016	59	47	61	74	64	76	78	70	80
Blue Rock	4017	75	69	75	84	78	84	84	82	85
Oakland	4051	64	50	68	70	60	74	72	62	76
Asbestos	4052	68	51	74	75	64	79	75	61	79
Miller	4053	71	67	73	80	73	81	79	75	80
Brockton	4054	76	65	79	77	69	80	79	76	83
Rattlesnake	4055	66	50	71	70	57	73	73	60	77
Simpson	4062	63	57	65	65	61	65	67	64	67

(continued)

Table 8 (continued)

Location Name	Lab Number	Head Feed			Cl. Float. Conc.			Leached Conc.		
		Green	Blue	Amber	Green	Blue	Amber	Green	Blue	Amber
Iredell #1	3703	58	46	62	70	59	72	72	64	73
Iredell #2	3704	63	52	60	76	66	73	79	70	76
Peppers Creek	3833	65	58	61	79	74	77	80	77	80
Fontana	3994	75	58	78	83	75	86	87	80	89
Mt. Grant	3995	43	29	42	51	36	51	-	-	-
Crabtree Creek	3996	56	39	56	68	56	71	76	67	78
Grassy Branch	3997	66	45	68	76	55	78	80	64	84
Soapstone Gap	4012	41	28	38	65	50	63	68	57	67
Baldwin	4030	53	40	54	68	56	70	76	60	75
Wilkes #1	4063	58	45	62	70	60	71	69	59	72
Wilkes #2	4064	55	37	60	69	55	72	70	58	75
Wilkes #4	4066	57	43	61	65	54	69	70	57	73
Sparta #1	4067	52	39	53	68	58	70	75	68	79
Sparta #2	4068	62	42	67	70	58	72	76	66	78
Holly Springs	3934	70	70	69	78	79	68	79	80	79
Nix	3988	62	43	66	65	52	70	68	53	72
N. C. (Green)	(None)	84	80	89	-	-	-	-	-	-
N. C. (Gray)	3691	83	80	85	86	85	89	85	84	89
Georgia	3730	54	49	49	70	72	65	69	72	64
Georgia	3731	57	51	54	71	66	71	72	67	71
Texas	3732	78	75	81	80	74	83	80	74	83
N. C. (White)	3808-C	90	93	96	-	-	-	-	-	-

Table 9

CHEMICAL ANALYSES OF SELECTED "TALC" SAMPLES

		Chemical Analyses %										
Location	Ref. No.	SiO_2	MgO	Ratio SiO_2/MgO	CaO	Na_2O	Al_2O_3	FeO	Fe_2O_3	MnO	LOI	CO_2
N. C.	7	61.35	26.03	2.36	0.82	-	4.42	(1.68)		-	5.10	-
N. C.	8	58.70	31.92	1.84	-	-	5.67	-	0.64	-	3.30	-
Georgia	7	41.02	28.60	1.43	4.76	-	4.23	(5.85)		-	15.51	-
Georgia	8	55.18	29.02	1.90	-	-	3.16	-	6.06	-	5.80	-
Virginia	7	39.54	24.84	1.59	5.93	0.08	3.72	7.12	3.62	1.60	5.04	9.50
Virginia	9	36.11	26.48	1.36	3.99	0.23	6.78	-	9.96	-	14.87	-
Alabama	8	62.17	32.34	1.92	-	-	0.51	-	1.43	-	2.98	-
Alabama	9	52.57	24.62	2.14	0.51	4.75	1.88	-	5.62	0.05	7.70	-
Maryland	9	57.12	18.31	3.12	Tr.	-	17.09	-	4.71	-	2.77	-
New York	6	62.16	32.40	1.92	-	-	-	1.30	-	2.15	2.05	-
New York	7	59.80	27.45	2.18	6.80	-	0.57	0.15	0.05	0.39	4.75	1.18
New York	7	66.23	25.71	2.58	2.26	-	1.05	0.22	0.13	0.16	3.86	0.56
New York	8	60.59	34.72	1.75	-	-	0.13	0.21	-	1.16	3.77	-
Vermont	6	61.06	28.60	2.13	-	-	3.63	2.89	-	-	3.92	-
Vermont	6	60.21	27.90	2.16	-	-	4.23	4.12	-	0.28	4.90	-
Vermont	7	60.48	28.52	2.12	0.02	0.03	0.82	4.59	0.10	0.09	4.94	-
California	6	60.20	27.98	2.15	2.60	-	1.25	-	2.50	-	5.70	-
California	7	59.61	30.01	1.99	0.84	0.26	1.65	0.92	-	-	5.94	-
California	7	57.40	23.91	2.40	13.55	0.44	1.29	(0.86)		-	2.20	-
Montana	7	62.65	30.23	2.07	-	0.20	0.31	(1.51)		-	4.95	0.27
India	9	59.02	32.30	1.83	0.30	-		(→ 3.60 ←)		-	5.50	-
Canada	9	47.55	32.21	1.48	6.65	-	2.37	-	0.80	-	5.87	-
France	9	55.16	33.40	1.65	0.19	-	5.42	-	0.85	-	4.63	-
Switzerland	8	61.51	30.93	1.99	3.70	-	0.83	0.12	-	-	2.84	-
Italy	9	54.46	30.60	1.78	0.72	-	5.68	-	0.94	-	7.05	-

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