EVALUATION OF NORTH CAROLINA FELDSPAR ORES

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(Lab. Nos. - See Table 1) - Book 224
by

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Purpose of Tests

Beginning in the spring of 1967, a project was initiated to find and evaluate new sources of feldspar in North Carolina. This project was launched in an effort to assist feldspar producers in the State and to increase the use of a North Carolina mineral.. To this end, it is hoped to uncover new feldspar ore deposits with commercial potential.

More specifically, an important goal is to find sources of high-potash feldspar, a commodity which is in short supply and which brings a premium price. It is needed for the manufacture of color television tubes, foam latex filler, and a wide range of ceramic applications. Potash feldspar weathers more slowly than other varieties, and deposits of high-potash feldspar resulting from this differential decomposition are being exploited by Kings Mountain Mica Company. A major effort is being made to find additional similar deposits which have resulted from the weathering of feldspathic rocks such as granite, porphyritic granite and porphyritic gneiss.

In addition, where a given ore may yield a high percentage of feldspar having a "glass grade" chemical analysis (i.e. less potash and more soda), this fact may be of special interest if a potential site for a glass plant is near at hand.

The feldspar program is being conducted in cooperation with the North Carolina Division of Mineral Resources, the samples for testing being gathered and brought in principally by geologists Jerry Bundy and Al Carpenter. To date, 46 samples have been evaluated, with more on hand still to be processed.

Procedure

Grinding Techniques - At the onset, two comparative preparation techniques were followed in order to ascertain which would be easier and also give a true picture of quantity and quality of feldspar present. One technique involved reduction of the head sample to minus one-quarter inch, then wet-milling of the entire sample, usually in several stages, to minus 35 mesh, followed by de-watering, scrubbing, desliming, and floation. The second technique was to size-reduce to minus one-quarter inch, then carefully rod-mill dry, only the plus 35 mesh fraction to minus 35 mesh, followed by the other steps mentioned. The second technique described permitted more precise control of scrubbing pulp density, and easier product measurement. After a number of comparative assays of feldspar products, it was found that the second technique produced equal or better results in terms of spar quality and recovery, and so it was installed as standard procedure.

After milling, the sample was scrubbed at 80 percent solids for ten minutes with two pounds per ton of NaOH. In some cases, pulp was diluted to 75 percent solids to assure proper circulation. Next the sample was diluted to about ten percent solids and deslimed three times on 325 mesh, readying it for conditioning. Effectiveness of the scrub cycle can be ascertained by the high terminal temperature of the scrub pulp, which approached or equalled 212°F.

Flotation - A series of three floats was performed on each sample to remove micaceous minerals, iron-bearing minerals, and feldspar, leaving a final machine discharge consisting of quartz. A brief description of these follows:

Micaceous Mineral Flotation - A typical reagent schedule for micaceous minerals was as follows, calculated against 1000 grams in all cases:

NaOH	- 0.4#/T
Rosin amine acet.	- 0.25#/T
TE-42	- 0.15#/T (Sodium N-methyl N-Oleyl taurate)
"65" Frother	- 0.10#/T

The sample was conditioned with the above reagents for one minute at about 50% solids, then floated. Where the removal of micaceous minerals was obviously deficient, it was possible to add increments of amine acetate to the cell and selectively float additional concentrate.

Iron Mineral Flotation - The machine discharge from the previous flotation was dewatered and conditioned for 3 minutes at about 65% solids with the following reagents:

H_2SO_4	- 1.5#/T
Petroleum sulfonate, 70%	- 0.5#/T (quantity varied)
Pine oil	- 0.1#/T

Flotation followed conditioning.

<u>Feldspar Flotation</u> - The machine discharge from the previous float was dewatered and conditioned at about 55% solids for three minutes with the following reagents:

HF	- 1.5#/T
Tallow amine acetate	- 0.3#/T
Fuel oil	- 0.75#/T
Pine oil	- 0.1#/T

Reagent levels were sometimes varied from the above quantities on the basis of observed ore variations. Also, since some ores did not float selectively with the standard procedure, re-scrubbing, re-conditioning, and cleaner floats were sometimes resorted to. These are mentioned in the individual test data in the Laboratory Notebook.

<u>Magnetic Separation and Screening</u> - Following drying and weighing of products, plus calculation of wet losses, the spar and quartz products were run across a laboratory roll-type, high-intensity magnetic separator. Products were weighed.

Potash feldspar is often coarser grained than other feldspars, especially in weathered rocks. Because of this fact, it was felt that the coarser portion of some of the feldspar concentrates might contain considerably more potash than finer fractions. Each non-magnetic concentrate was therefore screened into a coarse fraction and a fine fraction, of about equal weights, and each fraction was analyzed for K_2O, Na_2O and Fe_2O_3 (see Table 2). Quartz products were also analyzed for these constituents, principally for the purpose of determining feldspar recovery.

<u>Test Data</u>

The following tables set forth what is considered pertinent data. Table 1 gives general description of the locality and the ore. Table 2 gives quantitative data on the products obtained from each ore sample. In those cases where the composite feldspar concentrate, coarse and fine combined, contains as much as nine percent potash, the calculated analysis of the composite is shown.

Table 1

Location and Description of Samples

Field Sample No.	Lab Sample No.	General Location or Source	Description of Ore
-	3104	Quarry, N. C. Granite Corp., outside Mt. Airy	Granite fines
FG-1	3132A	Rowan County, Salisbury Quad.	Soft biotite granite
FG-2	3132B	" " " "	Hard " "
FG-3	3133A	Rowan County, Salisbury Quad., S.E., Comolli Granite Quarry, Road #2128	Fine granitic material
FG-4	3133B	(as FG-3)	Coarse granitic material
FG-5	3134A	Rowan County, 1/10 mi. north of Faith	Fresh granitic material
FG-6	3134B	(as FG-5)	Weathered granitic material
FG-7	3135A	Rowan County, Rockwell Quad., near Faith & Klutz Roads	W. granitic material
FG-8	3135B	(as FG-7)	Hard " "
FG-9	3136	Rowan County, Rockwell Quad. Abandoned quarry, near Faith and Artz Roads	Weathered grano-diorite
FG-10	3137	Rowan County, Rockwell Quad., near intersection of Shives and Shupings Mill Roads	White biotite-granite, weathered, from Starr Quarry.
FG-11	3138	Rowan County, Statesville Quad., intersection of Road 1535 and Sloans Creek	Grano-Diorite, relatively weathered.
FG-12	3139	Rowan County, Statesville Quad., near intersection of Road 1211 and 1533	Weathered granite, large pieces of potash spar
FG-13	3140	Rowan County, Statesville Quad. intersection of Roads 1350 and 1533	Coarse, weathered porphyritic granite plus aplite
FG-14	3141	Close to 3140, near intersection of 1350 and 1554	Coarse grained porph. gran.
FG-15	3142	Rowan. Statesville Quad., Road 1763 near Back Creek	Mixture, loose material and spar
FG-16	3143	Rowan. Statesville Quad., intersection of Rd. 1754-55.	Mix. of fine & coarse material from road cut
FG-17	3144	Rowan. Statesville Quad., near Withrow Creek on 1754	Similar to 3142-43
FG-18	3145	Rowan. Statesville Quad., near intersection of 1954-1953	Fine material, porphyritic
FG-19	3146	Rowan. Statesville Quad., near intersection of 1954-1702	Mixture, loose material and spar

(continued on page 5)

Table 1

(continued from page 4)

Field Sample No.	Lab Sample No.	General Location or Source	Description of Ore
FG-20	3147	Rowan. Statesville Quad., intersect. of Second Creek and U.S. 601	Porphyritic biotite granite with phenocrysts
FG-21	3148	Rowan. Statesville Quad., near intersection of Deals Creek and Road 1910	Porphyritic biotite granite
FG-22	3149	Rowan. Statesville Quad., intersection of Third Creek and Road 1702	Crushed, weathered granite, Woodleaf quarry
FG-23	3150	Rowan. Statesville Quad., near intersection of N.C. 801 and Road 1984	Med. to fine grained weathered granite. Road cut
FG-27	3156A	Guilford County, 2 mi. south of Jamestown, east of High Pt.	Minus 1/2 in. product granite quarry, weathered
FG-28	3156B	(as FG-27)	(as 3156A - hard)
-	3179	(as FG-22)	Granite screenings
FG-29	3186	Buncombe County, Weaverville Quad., near fork of U.S. 25 and N.C. 191	Hard, fresh material from quarry
FG-30	3187	Henderson County, Horse Shoe Quad., 1 mi. n. of Crab Creek Church on Road 1133	Soft, weathered Henderson granite gneiss
FG-31	3189	Avery or Watauga County, Grandmother Gap	Soft, weathered quartzite
FG-32	3193	Buncombe County, Black Mtn. Quad., 1.3 mi. northeast of Lakey Gap	Weathered mortar gneiss
FG-33	3199	Cabarrus County, on Road 2400 at Dutch Buffalo Creek	Coarse, crystalline pink granite
FG-34	3200A	Mecklenburg County, old quarry n.w. of Road 2422	Grano-diorite to diorite
FG-35	3200B	(as FG-35)	(as 3200A)
FG-36	3201	Cabarrus County, Road 1158 near Rocky River	Augite syenite. Nearby quarry has similar material.

Table 2

Quantitative Results

Field Sample No.	Lab Sample No.	FP #1 Mica % Wt	FP #2 Fe-Minerals % Wt	FP #3 Feldspar % Wt	MD Qtz % Wt	Slime Loss % Wt	Nonmag Spar % of Hd.Fd
-	3104	8.0	-	51.8	27.6	12.6	48.4
FG-1	3132A	2.9	1.2	28.7	33.4	33.8	23.0
FG-2	3132B	0.2	2.2	57.3	23.8	16.5	48.2
FG-3	3133A	1.1	3.3	56.8	24.2	14.6	49.3
FG-4	3133B	1.3	3.3	56.8	24.4	14.2	52.9
FG-5	3134A	2.9	2.8	54.4	23.8	16.1	49.4
FG-6	3134B	1.3	2.8	31.0	28.2	36.7	26.8
FG-7	3135A	9.2	9.2	20.8	30.2	30.6	18.2
FG-8	3135B	(not run)	4.0	54.5	25.8	15.7	49.1
FG-9	3136	0.5	1.2	38.1	31.8	28.4	33.2
FG-10	3137	1.4	0.8	39.3	29.5	29.0	35.3
FG-11	3138	11.0	26.5	20.6	21.9	20.0	16.8
FG-12	3139	6.0	1.5	53.3	16.5	22.7	47.3
FG-13	3140	7.8	0.6	24.6	41.8	25.2	19.4
FG-14	3141	6.6	6.1	34.3	28.5	24.5	30.2
FG-15	3142	8.7	1.7	44.7	19.0	25.9	37.8
FG-16	3143	15.6	5.0	17.3	15.5	46.6	16.7
FG-17	3144	5.5	10.3	43.2	12.3	28.7	39.3
FG-18	3145	1.2	4.7	35.9	21.0	37.2	33.2
FG-19	3146	6.2	15.6	25.5	28.3	24.4	22.9
FG-20	3147	9.4	6.6	24.4	41.2	18.4	21.2
FG-21	3148	7.6	3.6	44.3	17.9	26.6	38.2
FG-22	3149	5.4	1.2	37.3	32.8	23.3	34.0
FG-23	3150	10.8	0.7	36.6	29.6	22.3	29.3
FG-27	3156A	4.1	4.3	49.0	24.2	18.4	42.3
FG-28	3156B	3.2	6.5	52.5	20.5	17.3	42.1
FG-29	3186	6.4	4.9	56.4	12.7	19.6	51.2
FG-30	3187	6.4	1.3	35.2	29.7	27.4	32.3
FG-31	3189	11.6	4.2	15.8	40.2	28.2	14.2
FG-32	3193	24.5	3.9	16.5	5.2	49.9	15.2
FG-33	3199	3.6	10.4	67.2	0.5	18.3	54.2
FG-34	3200A	5.1	6.8	34.3	25.5	28.3	26.9
FG-35	3200B	7.2	12.4	40.0	22.3	28.1	28.5
FG-36	3201	2.9	1.3	36.3	9.3	50.2	28.8
-	3179	6.7	24.8	34.9	16.0	17.6	27.6

*Listed only when K_2O is at least 8.5 percent

Coarse Spar					Fine Spar				
Screen Class.	% of Hd.Feed	Chemical Analysis K_2O	Na_2O_3	Fe_2O_3	Screen Class.	% of Hd.Feed	Chemical Analysis K_2O	Na_2O	Fe_2O_3
+60	22.0	3.44	6.70	0.30	-60	26.4	3.44	6.76	0.11
+100	12.2	11.84	2.07	0.13	-100	10.8	9.78	3.45	0.11
+60	21.2	5.24	6.30	0.14	-60	27.0	5.64	6.29	0.08
+60	19.6	4.93	6.76	0.18	-60	29.7	5.41	6.60	0.12
+60	24.0	4.75	6.88	0.20	-60	29.0	5.24	6.90	0.12
+60	21.0	5.49	6.15	0.13	-60	28.4	5.70	6.26	0.09
+100	10.2	11.38	2.84	0.09	-100	16.6	9.05	4.02	0.08
+100	10.3	13.10	1.36	0.15	-100	7.9	11.10	1.76	0.11
+100	30.6	5.40	6.25	0.11	-100	18.5	5.92	6.04	0.09
+100	16.3	10.69	3.32	0.14	-100	16.9	6.19	5.15	0.10
+100	18.0	10.14	3.52	0.10	-100	17.3	6.95	5.59	0.06
+100	8.4	7.60	0.28	0.33	-100	8.4	7.94	0.14	0.13
+100	27.9	7.39	2.09	0.10	-100	19.4	4.93	2.57	0.07
+100	8.2	11.0	2.88	0.16	-100	11.2	7.01	4.34	0.12
+100	18.4	11.30	2.35	0.09	-100	11.8	9.10	3.30	0.09
+100	24.6	2.87	7.16	0.11	-100	13.2	4.05	7.35	0.16
+60	7.2	12.30	1.62	0.07	-60	9.5	12.36	1.59	0.07
+60	19.4	6.05	4.35	0.22	-60	19.9	5.52	4.66	0.18
+100	21.0	10.91	2.65	0.16	-100	12.2	7.31	4.23	0.09
+100	14.5	6.45	3.82	0.09	-100	8.4	5.39	5.16	0.09
+100	11.7	6.58	4.94	0.15	-100	9.5	6.01	5.45	0.11
+100	23.0	8.35	3.58	0.13	-100	15.2	7.05	5.34	0.13
+100	19.0	12.21	1.80	0.13	-100	15.0	8.90	3.20	0.06
+100	14.5	11.20	2.58	0.11	-100	14.8	7.60	3.88	0.10
+60	17.0	0.39	8.44	0.15	-60	25.3	0.39	8.70	0.13
+60	18.8	0.41	7.92	0.40	-60	23.3	0.41	8.27	0.18
+100	32.6	0.95	8.26	0.40	-100	18.6	1.03	8.30	0.09
+100	17.7	11.59	2.33	0.09	-100	14.6	9,85	3.37	0.08
+100	9.5	11.48	0.30	0.15	-100	4.7	8.30	0.57	0.15
+100	6.4	5.22	4.50	0.60	-100	8.8	3.38	6.15	0.22
+60	21.0	5.39	6.80	0.33	-60	33.2	4.88	6.80	0.28
+100	17.7	0.41	8.05	0.31	-100	9.2	0.27	7.75	0.24
+100	18.2	0.38	7.60	0.57	-100	21.8	0.16	7.61	0.31
+100	13.5	7.85	4.27	0.29	-100	15.3	7.57	4.24	0.26
+100	17.8	4.66	4.86	0.37	-100	9.8	4.86	5.14	0.10

Quartz Chemical Analysis			Nonmag Quartz	Composite Spar Analysis*		
K_2O	Na_2O	Fe_2O_3	% of Hd.Fd	K_2O	Na_2O	Fe_2O_3
0.11	0.21	0.04	26.4			
0.05	0.03	0.01	31.8	10.68	2.72	0.12
0.07	0.07	0.02	22.5			
0.05	0.06	0.02	22.7			
0.10	0.08	0.02	23.0			
0.07	0.06	0.02	22.8			
0.09	0.03	0.01	26.4	9.95	3.56	0.09
0.30	0.15	0.06	28.2	12.20	1.53	0.13
0.06	0.07	0.02	24.5			
0.12	0.12	0.03	29.9			
0.11	0.07	0.02	27.8	8.59	4.53	0.10
1.48	0.08	1.12	19.7			
1.00	0.55	0.06	15.7			
1.96	0.82	0.07	38.2			
0.06	0.08	0.04	26.6	10.45	2.72	0.09
0.65	0.24	0.19	15.3			
0.11	0.03	0.11	14.9	12.33	1.61	0.07
0.15	0.41	0.11	11.2			
0.22	1.09	0.05	20.2	9.57	3.23	0.13
1.83	1.02	0.04	26.9			
2.15	1.71	0.08	38.4			
0.14	0.12	0.04	16.6			
0.44	0.27	0.05	31.5	10.80	2.40	0.10
1.10	0.37	0.06	28.0	9.38	3.24	0.11
0.04	0.13	0.04	22.6			
0.03	0.11	0.07	18.5			
0.09	0.17	0.15	11.6			
0.08	0.04	0.07	28.0	10.80	2.80	0.09
0.08	0.02	0.09	35.4	10.43	2.20	0.15
0.24	0.13	0.37	4.4			
-	-	-	-			
0.06	0.14	0.05	24.3			
0.04	0.12	0.07	-			
2.52	2.05	0.27	7.2			
0.09	0.09	0.06	15.1			

Comments

The feldspar evaluation project was designed in its early stages to outline promising areas for more intensive investigations of new sources of feldspar.

The area of investigation has, thus far, been concentrated in two geologic belts, the Charlotte Belt and the Henderson gneiss-Whiteside granite complex of the Inner Piedmont Belt.

Due to their high iron content and general metamorphic history, the gneiss of the Blue Ridge and Inner Piedmont Belts would not normally be of significance in this investigation. However, the gross mineralogy and textural relationships of orthoclase and microcline within these units suggest a potential source of feldspar.

Of the eleven ore samples yielding feldspar concentrates analyzing 8.5 percent K_2O or higher, four might well be appraised as a group. These come from the Charlotte Belt, which contains large masses of Paleozoic granitic intrusive rocks. These granitic rocks are normally high in orthoclase and microcline and low in iron and mafic mineral content. Laboratory samples Nos. 3135A, 3134B, 3132A, and 3137 were collected in Rowan County which is located in the central section of the Charlotte Belt. The feldspar concentrates from these samples have an average chemical analysis of 10.35 percent K_2O, 3.09 percent Na_2O and 0.11 percent Fe_2O_3. The samples were obtained from a slightly foliated quartz monzonite (adamellite) intrusive pluton approximately eighteen square miles in area located in the southeast central part of the county. The quartz monzonite varies in color from grey to pink to blue. The pink variety is extensively quarried in this area. These four samples are the first four on Table 2 which report high-potash spar.

The above listed samples were all taken from weathered zones of pink quartz monzonite. As much as possible, an attempt was made to collect a fresh sample and a weathered sample from the same quartz monzonite outcrop. It was possible to collect sample pairs from three outcrops. Chemical analyses of the three sample pairs indicate the following apparent relationship between the paired samples: the K_2O content of the weathered sample is approximately twice the K_2O content of the fresh sample; and the Na_2O content of the weathered sample is approximately one-half the Na_2O content of the fresh sample. This would tend to indicate an upgrading of the K_2O content and a lowering of the Na_2O content as the degree of weathering increases.

The remaining seven samples containing high potash spar (Nos. 3141, 3143, 3145, 3149, 3150, 3187, and 3189) are all weathered, and are so located that they do not appear to comprise, as a group, any definite geologic pattern. Since, however, each one represents the possibility of an economic deposit of feldspar ore, further proximal sampling is indicated in all cases - following which more definite conclusions will be sought.

The foregoing relates to potential sources of high-potash feldspar. If sources of feldspar for lower grade ceramic applications, or for glass, are desired, attention might be directed to the data on Table 2 relating to the following Lab Samples: Nos. 3132B, 3133A, 3133B, 3134A, 3135B, 3139, 3144, 3148, and 3199. All of the above nine samples were obtained from Rowan County. Six of these Nos., 3132B, 3133A, 3133B, 3134A, 3135B, and 3199, were obtained from the quartz monzonite pluton described above. The remaining three samples, Nos. 3139, 3144, and 3148, came from scattered points; around which further sampling is warranted.

Future Plans

It is intended to continue this investigation, both with respect to areas around promising samples and also new areas.