UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Preliminary mineralogic analyses of vibracore samples from offshore of the north shore of Long Island, New York

by

Andrew E. Grosz[1], George P. Burbanck[2], Michelle P. Aparisi[3], William M. Kelly[3], and James R. Albanese[3]

Open-File Report 89-111

Prepared in cooperation with Hampton University, and the New York State Geological Survey.

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and nomenclature.

[1] USGS, Reston, VA

[2] Hampton University, Hampton, VA

[3] New York State Geological Survey, Albany, NY

1989

Preliminary mineralogic analyses of vibracore samples from offshore of the north shore of Long Island, New York

by

Andrew E. Grosz, George P. Burbanck, Michelle P. Aparisi,

William M. Kelly, and James R. Albanese

INTRODUCTION

As part of a larger effort to assess the mineral resource potential of sediments in the U.S. Exclusive Economic Zone, heavy-mineral components and concentrations were determined for samples taken from 32 vibracores that were collected from offshore of the north shore of Long Island, New York (Fig. 1). These data will be used to determine the heavy-mineral resource potential of the offshore sediments. The vibracores were originally collected by the U.S. Army Corps of Engineers as part of a sand and gravel inventory program of the U.S. Atlantic Continental Shelf (Williams, 1981). The sediments offshore of the north shore of Long Island are potential sources of beach reclamation and nourishment material (Williams, 1981), and possibly for construction aggregate. Based on data presented in this report, these sediments are not a likely source of strategic and critical heavy minerals (including ilmenite, rutile, zircon, and monazite) because of their low levels of concentration in the sediments, however, heavy-mineral species of lesser economic importance such as garnet (and others including staurolite, sillimanite, kyanite, and andalusite) are present as large fractions of heavy-mineral assemblages.

METHODS

The 32 vibracores, 11.4 cm diameter and about 6.5 m average length, were initially split lengthwise, then described, photographed, and sampled

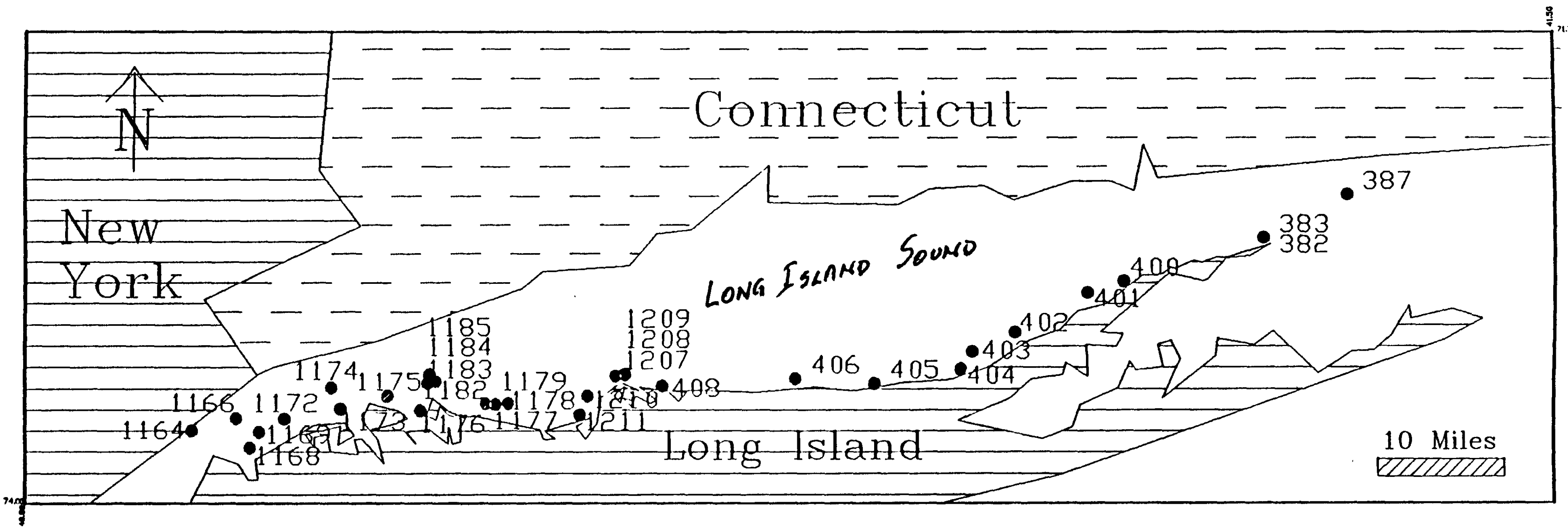

Figure 1. Location Map of Cores from Long Island Sound

for dateable material (e.g., peat, shells), component analyses, and repository samples. A total of 63 samples (Appendix I) were collected from the 32 vibracores on the basis of lithology, or at intervals no greater than 229 cm where the sediment appeared to be uniform throughout the length of the core. The lengths of individual samples varied from 51 to 229 cm (Appendix I). These samples were then split into samples for repository, each of approximately 300-500 g dry weight, and for component analyses, each between 1.5 and 15.5 kg (average about 7 kg) dry weight. The gravel fractions (>2.00 mm size-fraction) from these latter subsamples were removed with a 10-mesh U.S. Standard stainless steel sieve, and were weighed and described. The heavy-mineral components of the <2.00 mm size-fractions were concentrated using a three-turn sampling spiral (Grosz, 1987); 200-350 gram aliquots of sediment rejected by the spiral concentrator were examined to determine the amount of heavy minerals not recovered by this technique. The heavy-mineral concentrates generated by the sampling spiral were further purified using tetrabromoethane (specific gravity of 2.96). The concentrates were split into three representative fractions: 12.5 volume percent for repository, 12.5 volume percent for chemical analyses, and 75 volume percent for mineralogic analyses. The splits retained for mineralogic analyses were further separated into 6 magnetic fractions, with a Frantz Laboratory Magnetic Barrier Separator[1], to facilitate the identification and quantification of the various heavy minerals present. Each of the magnetic fractions was examined using a binocular microscope, comparison charts (e.g., Terry and Chillingar, 1955), and a modified point-counting technique, to visually estimate mineral abundances.

[1] Use of trade names does not constitute endorsement by the U.S. Geological Survey; they are used strictly for descriptive purposes.

Optical examination of nonopaque minerals with a petrographic microscope was used to verify the identification of nonopaque minerals.

RESULTS AND DISCUSSION

The data collected are summarized in Appendix I. Samples are numbered according to location (Fig. 1) and position in the vibracore; .0 refers to the entire core (a short one, commonly less than 1.5 m),.1 refers to the top section of a core (commonly the upper 1.5 m section),.2 refers to the middle (or bottom section) of a core, and .3 refers to the bottom section of a core. The initial dry weight of each subsample is given in grams and the weight percent of sand and gravel (>2.00 mm fraction) was calculated on a dry weight basis. The weight percentage of recovered heavy minerals (RHM) is calculated on the basis of the spiral concentrate and heavy-liquid processes only. THM (total heavy minerals) weight percentage was calculated on the basis of data obtained from heavy minerals in the aliquots (200-350 g) of sediment taken from the materials rejected by the spiral concentrator and from the heavy minerals recovered by the spiral concentrate and heavy-liquid methods. The recovery percentage of heavy minerals (spiral efficiency) was calculated on the basis of THM and RHM values; some of the recovery percentages are as low as 33 percent because of the very fine-grained nature of the sediments. The abundance of magnetite, ilmenite, staurolite, pyroboles (pyroxenes and amphiboles), garnet, epidote, tourmaline, monazite, alumino-silicates (sillimanite, kyanite, and andalusite), sphene, rutile, zircon, and others are expressed as approximate percentages of the RHM; the densities of the different phases were not taken into account in the calculations.

Analyses of the heavy minerals rejected by the spiral concentrator have not yet been completed, therefore a rigorous assessment of the heavy-mineral resource potential for the sediments offshore of the north shore of Long Island is not yet possible. It is expected, however, that this effect is of minor importance to the weight percent economic heavy minerals reported in Appendix I because of the generally high recovery percentages and because the heavy-mineral species not recovered by the spiral tend to have low specific gravities. A preliminary assessment of the potential for heavy-mineral resources is given by the weight % EHM/C (EHM/C is defined as the sum of estimated weight percentages of ilmenite + rutile + zircon + monazite + sphene in the heavy-mineral concentrate, C). These data (Appendix I) indicate that of the heavy-mineral species present an average of 13 percent by weight are of economic value.

CONCLUSIONS

Preliminary results indicate a difference in gravel composition from west to east in the Sound. The gravel found in the western cores is dominated by quartz pebbles with lesser amounts of rock fragments, while the eastern cores contain gravel consisting of quartz pebbles and significant amounts of shell fragments.

The heavy-mineral assemblage is qualitatively and quantitatively different from those found offshore of Virginia (Grosz and Escowitz, 1983; Berquist and Hobbs, 1988), New Jersey and South Carolina (Grosz and others, 1988), and Maine (Luepke and Grosz, 1986). Pyroboles, garnet, and aluminosilicates (sillimanite, kyanite, andalusite) dominate the heavy-mineral assemblage found in sediments offshore of the north shore of Long Island; the EHM/C (economically valuable minerals ilmenite + rutile + sphene + zircon + monazite expressed as a percentage of the heavy-mineral concentrate) values average 13.3 in a range of 3.2 to 30.9 percent. THM values average 1.27 in a range of 0.19 to 3.76 percent. RHM values average 1.06 in a range of 0.14 to 3.40 percent. These are low values in comparison to those derived from samples elsewhere on the Atlantic Continental Shelf and are consistent with the observation that immature heavy-mineral suites prevail offshore of glaciated terranes (Grosz and others, 1988).

ACKNOWLEDGMENTS

The preparation of samples for analyses was done by Larry Cheung and George P. Burbanck of Hampton University, Virginia under USGS Contract Number 14-08-0001-A0202. We acknowledge Ed Escowitz for making arrangements for that contract. Funding for mineralogic analyses and preparation of this report was provided by a grant from the Minerals Management Service through the Texas Bureau of Economic Geology under Cooperative Agreement Number 14-12-001-30387 to the New York Geological Survey. We are indebted to these individuals and agencies for their support.

REFERENCES

Berquist, C.R., and Hobbs, C.H., III, 1988, Reconnaissance of economic heavy minerals of the Virginia inner continental shelf: Virginia Institute of Marine Sciences, College of William and Mary, Contribution No. 1425, 69 p.

Grosz, A.E., 1987, Nature and distribution of potential heavy-mineral resources offshore of the Atlantic coast of the United States: Marine Mining, v. 6, pp. 339-367.

Grosz, A.E., Lopez, Ricardo, Aparisi, Michelle, Albanese, J.R., Kelly, W.M., Berquist, Rick, Nelson, D.D., Nocita, B.W., Scott, T.M., and Burbanck, G.P., 1988, Recent developments: U.S. Atlantic shelf marine mineral surveys: Abstracts with Program, 19th Annual Underwater Mining Institute, October 2-5, 1988, Woods Hole, MA, 4 p.

Grosz, A.E., and Escowitz, E.C., 1983, Economic heavy minerals of the U.S. Atlantic continental shelf, in: Tanner, W.F., (ed.), Proceedings of the sixth symposium on coastal sedimentology, Florida State University, Tallahassee, FL, pp. 231-242.

Luepke, Gretchen, And Grosz, A.E., 1986, Distribution of economic heavy minerals in sediments of Saco Bay, Maine: U.S. Geological Survey Bulletin 1681, 12 p.

Terry, R.D., and Chillingar, G.V., 1955, Comparison charts for visual estimation of percentage composition: Journal of Sedimentary Petrology, V. 25, pp. 229-234.

Williams, S.J., 1981, Sand resources and the geological character of Long Island Sound: U.S. Army Corps of Engineers, Coastal Engineering Research Center, Technical Paper 81-3, 65 p.

APPENDIX I

Table showing locations of samples and heavy-mineral content and composition for sediments offshore of the north shore of Long Island, New York

Explanation of superscripts for Appendix I

1 Sample numbers correspond to sample locations in Figure 1
Sample number modifiers: .0 indicates entire core
.1 indicates upper (top) section of a core
.2 indicates lower (or middle) section of a core
.3 indicates lower (bottom) section of a core

2 CERC NO.: U.S. Army Corps of Engineers (Williams, 1981) core number

3 Heavy-mineral (HM) recovery %: Recovered heavy minerals (RHM) as a percentage of the total heavy minerals (THM). HM recovery is a measure of the efficiency of the spiral concentrator

4 Defined on the basis of magnetic susceptibility, luster, and streak.

5 Undifferentiated pyroxene and amphibole

6 Aluminosilicates: sillimanite, kyanite, and andalusite

7 Economic heavy minerals (EHM = the sum of weight percentages of ilmenite + rutile + zircon + monazite + sphene) expressed as a percentage of the heavy-mineral concentrate, C)

SAMPLE NUMBER [1]	CERC NO. [2]	LATITUDE NORTH (degrees)	LONGITUDE WEST (degrees)	LENGTH (cm)	BULK SAMPLE WT (g)	WEIGHT % GRAVEL	WEIGHT % THM	WEIGHT % RHM	HM RECOVERY % [3]
382.0	1	41.19248	72.1924	196	12882	7.44	3.28	3.21	97.8
383.0	9-2	41.19105	72.1922	122	6403	4.94	3.41	3.07	90.0
387.1	3	41.25786	72.0555	127	6555	0.35	1.44	0.97	67.2
387.2	3	41.25786	72.0555	127	5326	0.68	3.30	2.98	90.2
400.1	70	41.12730	72.3828	135	9484	16.17	0.49	0.42	86.3
400.2	70	41.12730	72.3828	150	11917	12.93	0.38	0.33	87.9
401.1	71	41.10985	72.4348	180	11721	1.31	2.36	1.78	75.4
401.2	71	41.10985	72.4348	206	13017	0.18	0.89	0.67	75.4
402.1	72	41.05096	72.5406	117	6395	4.44	0.72	0.71	98.6
402.2	72	41.05096	72.5406	117	7582	0.80	1.04	1.03	98.7
403.1	73	41.02230	72.6038	152	9181	0.95	1.57	1.05	67.2
403.2	73	41.02230	72.6038	61	3191	0.69	0.76	0.74	97.3
404.1	74	40.99681	72.6206	132	9618	0.91	0.70	0.66	94.8
404.2	74	40.99681	72.6206	173	14070	12.59	0.59	0.52	88.2
404.3	74	40.99681	72.6206	104	7067	3.74	0.75	0.66	88.5
405.1	75	40.97544	72.7472	198	13457	0.50	1.02	0.99	97.4
405.2	75	40.97544	72.7472	193	13598	0.43	0.82	0.78	95.2
406.1	77	40.98247	72.8625	132	5872	0.56	0.94	0.91	96.7
406.2	77	40.98247	72.8625	137	10530	1.11	0.70	0.67	96.2
408.1	78	40.97208	73.0582	135	8687	12.92	0.39	0.29	73.5
408.2	78	40.97208	73.0582	132	10673	18.49	1.33	1.11	83.7
1164.0	33	40.90621	73.7470	191	5466	0.48	0.30	0.18	61.6
1165.0	9-33	40.90621	73.7470	218	6985	0.47	0.19	0.14	73.8
1168.1	32	40.88033	73.6610	114	3336	6.74	0.77	0.47	60.7
1168.2	32	40.88033	73.6610	104	7687	4.89	2.20	2.00	90.7
1169.1	31	40.90302	73.6471	122	8503	0.52	1.77	1.66	94.0
1169.2	31	40.90302	73.6471	122	8386	0.62	1.72	1.61	93.3
1172.1	30	40.92373	73.6107	117	4823	0.95	0.97	0.83	85.5
1172.2	30	40.92373	73.6107	183	12783	9.29	1.93	1.15	59.4
1173.1	29	40.93821	73.5289	51	1528	10.47	0.49	0.47	96.2
1174.1	9-36	40.96930	73.5420	152	10584	40.45	0.50	0.32	64.6
1174.2	9-36	40.96930	73.5420	145	11873	41.09	0.30	0.18	60.4
1174.3	9-36	40.96930	73.5420	130	11310	31.54	0.46	0.30	64.6
1175.1	9-37	40.95755	73.4604	152	7054	0.52	0.80	0.76	95.5
1175.2	9-37	40.95755	73.4604	206	14386	4.32	3.10	2.14	69.2
1176.1	39	40.93579	73.4124	173	5725	1.54	0.54	0.53	97.4
1176.2	39	40.93579	73.4124	145	10841	2.91	0.91	0.81	88.9

SAMPLE NUMBER [1]	CERC NO. [2]	LATITUDE NORTH (degrees)	LONGITUDE WEST (degrees)	LENGTH (cm)	BULK SAMPLE WT (g)	WEIGHT % GRAVEL	WEIGHT % THM	WEIGHT % RHM	HM RECOVERY % [3]
1177.1	24	40.94646	73.2987	152	9702	3.71	1.16	1.13	97.1
1177.2	24	40.94646	73.2987	221	15490	4.42	1.17	0.85	73.1
1178.1	25	40.94541	73.3169	160	9984	0.44	0.71	0.70	98.6
1178.2	25	40.94541	73.3169	132	8761	0.33	0.39	0.38	97.2
1179.1	9-25	40.94627	73.3154	193	13771	0.28	0.56	0.56	99.3
1179.2	9-25	40.94627	73.3154	229	12769	0.43	0.32	0.32	98.6
1182.1	26	40.97878	73.3898	163	9334	1.76	3.04	2.38	78.4
1182.2	26	40.97878	73.3898	152	10170	0.98	3.76	3.40	90.5
1183.0	28	40.97616	73.4007	157	9256	8.15	0.65	0.53	82.3
1184.1	38	40.97572	73.4020	178	11027	31.29	0.84	0.75	89.4
1184.2	38	40.97572	73.4020	168	10124	29.66	0.43	0.36	84.3
1185.1	27	40.98897	73.3985	183	12324	3.26	1.62	1.49	92.0
1185.2	27	40.98897	73.3985	130	9919	11.17	2.04	1.81	88.7
1185.3	27	40.98897	73.3985	89	5837	2.11	1.81	1.12	61.9
1207.1	9-20	40.98901	73.1122	168	11539	2.11	1.39	1.28	92.1
1207.2	9-20	40.98901	73.1122	76	4365	0.39	0.73	0.72	98.5
1208.1	20	40.98958	73.1125	165	10827	2.06	1.41	1.24	88.2
1208.2	20	40.98958	73.1125	56	3461	0.32	0.45	0.44	97.0
1209.1	21	40.98696	73.1258	102	6107	19.68	1.10	0.66	60.4
1209.2	21	40.98696	73.1258	213	12501	11.82	2.49	1.11	44.6
1209.3	21	40.98696	73.1258	69	5241	61.78	1.46	0.48	33.2
1210.1	22	40.95718	73.1670	117	5534	2.24	1.14	0.96	84.5
1210.2	22	40.95718	73.1670	117	8322	71.16	1.14	0.86	75.3
1211.1	23	40.92978	73.1788	173	10604	0.61	1.85	1.80	97.5
1211.2	23	40.92978	73.1788	193	12116	0.39	2.22	2.16	97.4
1211.3	23	40.92978	73.1788	140	7811	0.28	2.21	2.13	96.3

SAMPLE NUMBER	MAGNETITE %	ILMENITE %	STAUROLITE %	PYROBOLES %	GARNET %	EPIDOTE %	TOURMALINE %	MONAZITE %
382.0	3.8	4.6	4.8	38.1	21.5	11.7	1.6	0.18
383.0	4.0	4.7	5.2	33.6	23.1	15.5	1.7	0.08
387.1	0.9	12.0	1.3	28.5	10.3	23.0	0.8	0.05
387.2	1.5	17.3	0.8	27.1	8.0	23.8	1.0	.00
400.1	7.5	6.2	16.6	20.9	30.9	4.0	2.1	0.06
400.2	8.5	5.0	20.9	18.6	22.7	6.8	2.7	0.08
401.1	0.7	8.8	5.5	33.5	9.9	27.0	0.5	0.02
401.2	0.2	19.0	1.9	25.6	14.4	18.1	1.0	0.02
402.1	0.4	5.0	14.8	27.6	16.4	5.6	8.6	0.14
402.2	0.3	4.6	10.8	39.0	17.8	3.8	4.8	0.31
403.1	1.2	16.0	2.1	18.5	18.2	21.0	0.3	0.02
403.2	50.7	1.6	4.2	6.4	5.5	4.7	4.4	0.44
404.1	0.8	4.6	18.6	28.5	17.0	2.2	7.8	0.61
404.2	2.8	5.0	19.1	42.1	8.3	1.7	2.9	0.11
404.3	4.1	4.4	11.4	33.8	17.2	7.4	1.3	.00
405.1	0.3	2.9	16.9	27.4	17.7	1.6	13.9	0.50
405.2	0.2	2.8	21.2	21.2	17.3	6.5	7.2	0.30
406.1	0.6	8.5	20.1	24.0	20.5	4.3	1.9	0.19
406.2	0.1	5.3	21.3	32.0	10.5	3.6	6.0	0.10
408.1	51.5	4.8	3.7	3.9	8.8	1.5	5.9	0.10
408.2	3.8	11.4	21.5	28.8	13.9	6.6	2.1	0.04
1164.0	22.9	1.2	0.8	4.8	2.8	13.3	1.2	0.99
1165.0	33.3	1.3	0.6	5.8	3.9	13.5	1.1	0.73
1168.1	39.4	2.1	3.0	5.2	3.4	0.6	1.7	.00
1168.2	3.1	19.5	3.3	39.7	13.1	1.9	0.6	0.13
1169.1	0.4	10.9	4.3	57.4	11.2	2.4	1.3	0.03
1169.2	0.4	22.9	2.9	49.5	11.0	1.3	1.3	0.04
1172.1	1.0	16.4	7.7	40.9	15.5	2.6	0.5	.00
1172.2	3.9	13.3	15.0	40.8	13.4	1.8	0.4	.00
1173.1	28.2	1.6	3.6	9.4	2.4	0.3	2.0	0.41
1174.1	1.4	5.8	23.4	45.2	6.2	0.2	3.1	0.00
1174.2	55.3	2.2	4.8	6.3	5.5	2.3	4.8	.00
1174.3	3.0	5.0	15.2	46.3	7.5	1.9	2.5	.00
1175.1	1.0	19.5	4.5	32.7	12.7	0.5	0.8	.00
1175.2	4.0	19.6	8.6	30.8	20.1	4.3	0.5	0.04
1176.1	0.9	19.5	7.1	29.0	20.7	2.0	1.3	0.08
1176.2	2.0	27.8	3.7	30.4	7.3	3.1	1.0	0.16

SAMPLE [1] NUMBER	MAGNETITE [4] %	ILMENITE [4] %	STAUROLITE %	PYROBOLES [5] %	GARNET %	EPIDOTE %	TOURMALINE %	MONAZITE %
1177.1	0.3	19.3	12.3	20.2	18.9	9.2	1.6	0.10
1177.2	0.2	14.0	14.6	29.6	15.5	5.6	1.2	0.01
1178.1	.0	1.6	16.6	32.9	13.4	7.9	5.9	0.00
1178.2	.0	1.0	18.7	39.4	2.9	8.1	6.3	0.00
1179.1	.0	1.7	16.8	40.3	10.3	2.5	6.9	.00
1179.2	0.1	2.2	12.5	48.6	4.5	5.0	4.1	0.09
1182.1	4.7	23.3	10.4	25.1	19.8	5.7	0.2	0.04
1182.2	5.5	18.3	10.7	30.0	17.4	3.0	0.3	0.04
1183.0	0.5	2.9	20.8	26.7	9.6	3.0	16.0	.00
1184.1	0.4	5.4	18.4	31.6	23.3	0.3	6.1	0.04
1184.2	0.4	3.3	20.6	29.4	17.1	1.9	10.5	0.00
1185.1	0.6	9.8	7.9	46.0	10.1	7.9	2.5	0.08
1185.2	1.2	14.6	5.4	39.3	16.9	6.7	1.0	0.07
1185.3	5.5	14.4	4.1	27.7	28.5	0.4	0.2	0.24
1207.1	0.5	19.0	13.5	16.4	18.2	13.3	1.5	.00
1207.2	0.4	1.5	24.4	31.7	1.0	1.4	7.3	0.01
1208.1	2.0	20.8	7.4	23.9	18.3	6.0	0.8	0.01
1208.2	47.7	1.7	5.9	5.4	1.3	2.0	5.7	0.00
1209.1	0.8	13.0	14.6	29.9	20.9	1.2	1.8	0.01
1209.2	2.7	6.7	14.6	36.2	16.0	2.8	5.7	0.05
1209.3	7.4	10.9	18.0	30.9	12.7	1.6	3.5	0.01
1210.1	0.8	20.6	8.6	18.5	20.0	10.6	0.6	0.00
1210.2	51.4	2.2	2.7	8.1	3.4	2.4	2.7	0.01
1211.1	0.2	22.8	9.5	19.7	25.9	6.6	0.9	.00
1211.2	0.2	9.6	13.1	19.7	30.2	10.4	1.9	0.00
1211.3	0.5	12.8	10.7	18.3	33.8	8.4	1.1	0.07

SAMPLE NUMBER [1]	ALSIL % [6]	SPHENE %	RUTILE %	ZIRCON %	OTHERS %	WEIGHT % EHM/C [7]
382.0	5.3	0.76	0.5	1.2	6.1	7.18
383.0	5.4	0.90	0.7	1.3	3.8	7.74
387.1	9.7	1.40	1.2	2.2	8.6	16.88
387.2	7.3	1.16	1.1	0.8	10.1	20.25
400.1	6.0	0.36	1.4	1.7	2.2	9.73
400.2	4.9	0.12	1.3	2.1	6.4	8.58
401.1	6.8	1.05	0.8	1.7	3.8	12.33
401.2	10.1	1.35	0.7	3.2	4.3	24.30
402.1	12.3	0.48	2.3	3.1	3.3	10.98
402.2	11.4	0.26	2.8	2.2	2.0	10.10
403.1	11.0	1.45	1.7	2.5	6.0	21.68
403.2	10.1	0.99	1.8	1.1	8.2	5.91
404.1	11.7	0.22	3.2	3.1	1.7	11.63
404.2	11.4	0.17	1.5	1.7	3.3	8.49
404.3	12.0	0.11	1.7	1.2	5.3	7.40
405.1	14.1	0.82	2.1	1.7	0.3	7.90
405.2	14.3	0.45	2.1	2.5	4.0	8.09
406.1	11.9	0.07	2.0	2.2	3.7	13.00
406.2	13.6	0.16	1.8	3.0	2.5	10.34
408.1	14.5	0.22	0.9	1.4	2.7	7.46
408.2	5.1	1.21	1.0	2.2	2.5	15.74
1164.0	20.3	0.35	0.8	3.0	27.6	6.33
1165.0	18.7	0.50	0.6	3.0	17.0	6.14
1168.1	10.3	0.37	0.5	1.5	32.0	4.46
1168.2	6.4	1.48	1.2	1.4	8.2	23.73
1169.1	6.7	1.16	0.7	0.2	3.3	13.03
1169.2	6.0	1.95	0.5	0.6	1.8	26.02
1172.1	8.6	0.12	0.6	1.3	4.9	18.41
1172.2	5.7	0.04	0.2	0.6	5.0	14.15
1173.1	5.2	0.13	4.3	4.8	37.6	11.26
1174.1	9.5	1.81	0.3	1.7	1.5	9.56
1174.2	8.9	3.51	0.5	1.2	4.6	7.47
1174.3	8.6	3.60	0.3	1.6	4.4	10.53
1175.1	13.1	0.18	1.4	2.9	10.8	23.96
1175.2	6.0	0.08	0.3	0.7	4.9	20.76
1176.1	9.7	0.71	0.4	2.4	6.3	23.05
1176.2	13.0	0.28	0.2	2.5	8.6	30.94

SAMPLE 1/ NUMBER	ALSIL 6/ %	SPHENE %	RUTILE %	ZIRCON %	OTHERS %	WEIGHT % 7/ EHM/C
1177.1	13.3	0.24	0.3	2.5	1.8	22.44
1177.2	14.4	1.24	0.5	1.5	1.6	17.25
1178.1	17.4	1.31	0.3	1.1	1.6	4.29
1178.2	19.0	1.09	0.3	0.8	2.2	3.24
1179.1	17.6	1.33	0.5	0.8	1.2	4.32
1179.2	19.3	0.57	0.9	0.8	1.4	4.50
1182.1	5.8	0.94	0.4	1.0	2.5	25.68
1182.2	6.2	0.45	0.3	1.0	6.8	20.10
1183.0	14.6	0.79	0.3	0.7	4.2	4.62
1184.1	9.8	0.65	0.2	1.5	2.5	7.76
1184.2	13.3	0.79	0.3	0.6	1.8	5.01
1185.1	11.2	0.61	0.2	0.8	2.2	11.41
1185.2	11.8	0.32	0.1	0.7	1.9	15.86
1185.3	10.0	0.96	0.2	0.6	5.5	16.36
1207.1	12.2	1.46	0.5	0.6	2.9	21.63
1207.2	21.2	1.32	2.1	1.0	6.6	5.99
1208.1	11.2	0.78	2.1	1.2	5.6	24.89
1208.2	20.4	0.48	1.9	0.9	6.8	4.91
1209.1	12.3	0.58	0.5	2.0	2.4	16.08
1209.2	11.8	0.14	0.2	1.0	2.0	8.11
1209.3	10.3	0.03	0.2	2.0	2.6	13.15
1210.1	14.0	0.53	0.4	2.0	3.6	23.41
1210.2	13.9	1.30	1.2	2.3	8.4	7.03
1211.1	9.0	0.92	1.0	0.7	3.0	25.34
1211.2	10.5	0.53	0.9	0.4	2.7	11.45
1211.3	10.2	0.83	0.8	0.4	2.2	14.84