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GEOLOGIC MAP OF SLEETMUTE C-7, D-7, C-8, AND D-8 QUADRANGLES, HORN MOUNTAINS AREA, SOUTHWEST ALASKA

by

T.K. Bundtzen, G.M. Laird, E.E. Harris, J.T. Kline, and M.L. Miller

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Geology of the Sleetmute C-7, D-7, C-8, and D-8 Quadrangles, Horn Mountains, Alaska

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INTRODUCTION AND GEOGRAPHY

During the 1990, 1991, and 1992 field seasons, four 1:63,360 scale quadrangles were geologically mapped in the northwest corner of the Sleetmute Quadrangle of southwest Alaska (figure 1). The 2,220 km2 area consists of broad sediment-filled lowlands interdispersed with rounded ridgelines and small mountain massifs that range in elevation from 500 to 1,070 meters. Most of the streams and rivers in the study area drain into the Kuskokwim River, which flows through the southern portion of the map area and is one of Alaska's largest river systems. However, the Iditarod River flows northeastward through the Sleetmute D-8 quadrangle eventually reaching the Innoko and Yukon River drainage basins. Although much of the study area has not been glaciated, the rugged Horn Mountains and adjacent lowlands has experienced at least four separate glaciations.

Most of the field work was conducted from several spike camps in various locations within the study area; heliocopter support was utilized in remote areas west and south of the Kolmokof and Iditarod Rivers.

The preliminary results presented in this report consist of: 1) a brief introductory text; 2) seven tables that depict paleocurrent data (table 1), major oxide and trace element analyses of igneous rocks (tables 2 and 3), 40Ar-39Ar and K40-Ar40 isotopic age determinations (tables 4 and 5), C14-C13 age determinations (table 6), and trace element analyses of mineralized zones (table 7); and 3) the geologic map itself accompanied by complete map unit descriptions (plate 1).

GEOLOGIC SUMMARY

Geologic units in the study area are subdivided into four basic assembleges: 1) Cretaceous flysch; 2) Upper Cretaceous mafic to felsic volcanic rocks; 3) Upper Cretaceous and Lower Tertiary(?) intermediate to felsic plutonic rocks; and 4) widespread unconsolidated lithologies that range in age from Late Tertiary through the Quaternary. During discussion of these geologic units,

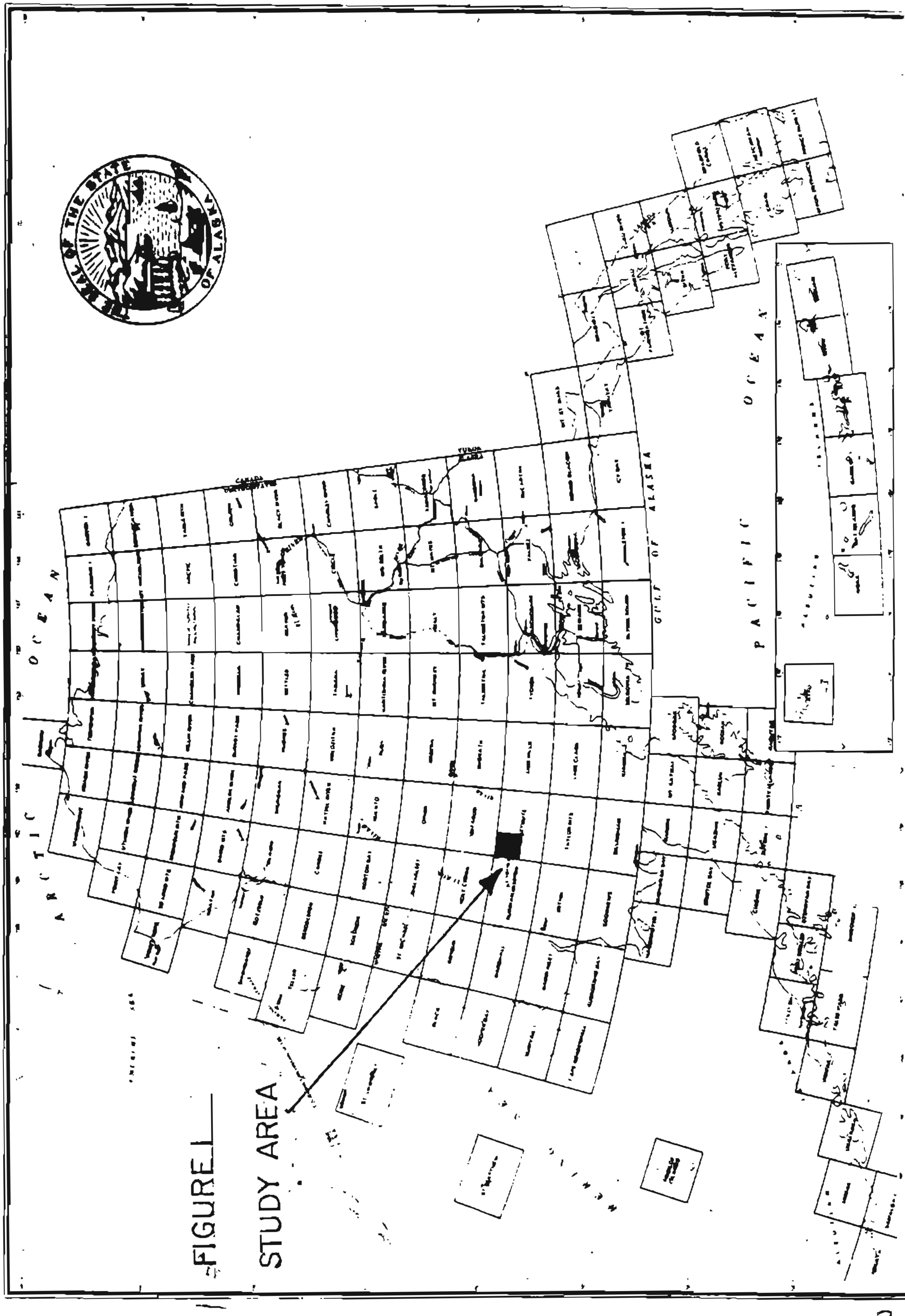
THE SEAL OF THE STATE OF ALASKA
ARCTIC OCEAN
PACIFIC OCEAN
GULF OF ALASKA
STUDY AREA

FIGURE 1

the reader is referred to the geologic map (plate 1) for more complete descriptions.

Kuskokwim Group

The major stratigraphic units exposed in the study area belong to the Kuskokwim Group, after Cady and others (1955), which consists of sandstone, shale, siltstone, and conglomerate. The Kuskokwim Group has been subdivided onto eight lithologic units (see plate 1) that we have interpreted to represent turbidite fan, foreslope, shallow-marine, and possibly shoreline or nonmarine environments deposited in a marine regression during evolution of the sedimentary basin. Paleocurrent data (table 1) suggests southerly or southeasterly directions of sediment transport, which is consistant with data and interpretations presented by Miller and Bundtzen (1993) from the Kuskokwim Group in the Iditarod Quadrangle. Fossils collected during our work and summarized by Miller and Bundtzen (1993) for collections in the nearby Iditarod Quadrangle range in age from Cenomanian to Turonian (early-Late Cretaceous); however the top of the section is poorly constrained.

No total thickness was estimated during our work. We have discovered that the Cretaceous section is probably complexly repeated by open to recumbant folds, and perhaps thrust faults. Cady and others (1955) estimate that the Kuskokwim Group is at least 12,000 meters thick along the Kuskokwim River from Crooked Creek to Chuathbaluk; Bundtzen and Laird (1991), Bundtzen and others (1992), and Miller and Bundtzen (1993) estimate thicknesses from 2,000 to 5,000 meters for equivalent rocks northeast of the study area.

Iditarod Volcanics

Basaltic andesite, andesite to dacite tuff and agglomerate of the Iditarod Volcanics, after Miller and Bundtzen (1988), overlie the Kuskokwim Group in the northwest part of the map area. Three units were subdivided during our work (plate 1). Altered dacite tuffs and agglomerate are overlain by more mafic basaltic andesites; the total thickness is estimated at 350 meters in the study area. Miller and Bundtzen (1988) report that the basal units range in age from 75 to 77 ma, and the upper more mafic volcanics appear to range in age from 58 to 62 ma. We have no age control for the Iditarod Volcanics in the study area.

Horn Mountains Volcanic Field

A remarkably complete, volcanic pile ranging in composition from basaltic andesite to rhyolite covers a circular shaped region in the Horn Mountains in the east-central part of the map area (plate 1). Twelve units were subdivided during our work (plate 1). Based on aerial mapping, isotopic age, and stratigraphic relationships, we have determined a regular stratigraphic succession that spans about 1.5 million years, taking into account analytical error (plate 1; table 4). 40Ar-39Ar ages range from 70.78ma for vitric tuffs near the base to 68.09 from andesite tuff near the top of the section. The basal portion of the Horn Mountains Volcanic field consists of vitric welded (?) tuffs that are successive overlain by basaltic andesite and andesite flows, latite flows and tuff, and finally by more felsic tuffs and flows. We estimate a total thickness at about 800 meters.

The circular 'ring' structure exhibited by the volcanic field as well as local faulted contacts suggest that the Horn Mountains Volcanic Field may represent a collapsed caldera active during latest Cretaceous time.

Intrusive Rocks and Hornfels

Seven plutonic units and hornfels were mapped during our work (plate 1). Granodiorite, minor granite, and rare quartz syenite comprize the Horn Mountains pluton, which underlies and intrudes the Horn Mountains Volcanic Field in the Horn Mountains. Isotopic age control (68.64 ma from granodiorite, table 4), major oxide and trace element chemistry (table 2,3), and field relationships suggest that the plutonic rocks are more-or-less coeval with the volcanics, consistant with other 'volcanic-plutonic' complexes known in the Kuskokwim Mountains.

Unusual, peraluminous granite and alaskite porphyry sills, stocks and dikes intrude the Kuskokwim Group throughout the study area. Their peraluminous character and rare-earth element depletion trends distinquish them from the larger plutonic bodies; however, they appear to be roughly the same age as the former granodiorite intrusions (68.64 to 71.98 ma; tables 4, 5).

Unconsolidated Deposits

A wide variety of unconsolidated deposits ranging in age from Late Tertiary to Holocene cover about 55% of the map area. We have subdivided these into 21 alluvial, glacial, colluvial, and elluvial units (plate 1). These include aerially extensive glacio-fluvial deposits and till in the Horn Mountains and adjacent areas, where evidence for at least four separate glaciations has been recognized. A 40Ar-39Ar isotopic age on volcanic ash interbedded with old glacial outwash in the Qof unit was determined to be at least one million years old (unpublished data), suggesting that the oldest glacial events are mid-to-lower Pleistocene in age. However, we need more sample material to verify or refute this age. The youngest age on till in Getmuna Creek valley is 13,600 yrs bp (no. 7b, table 7), which is equivalent to till of Elmendorf age in the Mantanuska-Susitna River area near Anchorage (R.D. Reger, pers. comm., 1992).

Most unconsolidated deposits are Late Pleistocene or Holocene in age, and some stream alluvium is forming today.

ECONOMIC GEOLOGY

Gold polymetallic resources were investigated in the Horn Mountains, at Juninggulra Mountain, and at the Kolmokof and New York Creek mercury and placer gold mines respectively. In the Horn Mountains, greisen-like veins containing gold, silver, and base metals occur in both shallow, high-level portions of the Horn Mountains pluton, and in adjacent hornfels (map no. 15, 23, 24, 28, 30, 39, 47, plate 1; table 7). Lode mercury deposits containing anomalous gold and tellurium are associated with altered mafic dikes at the Kolmokof Mine (53A,B; plate 1; table 7). Small deposits of cinnabar and stibnite occur in fissures and breccia zones within granite porphyry at Juninggulra Mountain north of the Horn Mountains (plate, 1, table 7).

Small placer deposits have been exploited intermittantly since 1910 at Murray Gulch, tributary to New York Creek, northeast of Napaimiut (plate 1; no. 63, table 7). Miller and others (1989) summarize the geology and history of development of selected mineral properties in the study area in more detail than is discussed here. Gray and others (in process) discusses favorable areas for metallic mineral resources in the Horn Mountains area using pan concentrate and stream sediment geochemistry.

Bundtzen and others (1989) discuss the availability of sand and gravel and riprap in the study area.

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Table 1. *Paleocurrent data from Cretaceous sedimentary rocks, Sleetmute C-7, D-7, C-8, and D-8 Quadrangles, Alaska*

Map no.	Field no.	Azimuth (corrected for tilt)	Azimuth mean	Flow regime and lithology
1	92BT100	128° 120° 150°	133°	Lower (cross beds in Kssq unit)
2	91BT 27	170° 168° 149° 162°	162°	Upper (Flute casts in Kssf unit)
3	91BT83	90° 110° 96°	99°	Upper (Flute casts in Kus unit)
4	92BT89	72° 91° 60° 52° 84° 90°	75°	Upper and Lower Imbricate orientation of (Inoceramus shells and on flutes in Kssp unit)
5	91BT80	81° 84°	83°	Upper (Flutes in Kssf unit)
6	91BT81	148° 128° 104°	127°	Upper (flutes and load casts in Kssf unit)

Table 3. *Rare Earth Element (REE) determinations from selected igneous rocks in Sleetmute C-7, D-7, C-8, and D-8 Quadrangles, Alaska (all analyses in ppm)*

Map no.	4	5	11	11b	15	17	19	21	26	34
Field no.	90GL31	90BT40	90BT49	90BT61	90BT81	80BT83	90HA27	90BT121	90BT93	90BT115
Rock type	Basaltic Andesite (TKvm)	Vitric Porphyry (Tkgp)	Vitric Tuff (TKat)	Basaltic Andesite (TKvm)	Granodiorite (TKsy)	Andesite Tuff (TKvi)	Vitric Tuff (TKat)	Andesite Flow (TKa)	Granodiorite (TKsy)	Andesite (TKva)
Ce	40.2	44.0	86.0	62.0	82.0	56.0	36.0	30.0	94.0	80.0
Eu	1.0	1.0	2.0	1.0	1.5	2.0	0.5	ND	2.0	2.0
La	14.0	18.0	39.0	24.0	35.0	23.0	15.0	9.0	40.0	32.0
Lu	0.3	ND	0.1	0.4	0.2	0.4	ND	0.1	0.6	0.1
Nd	10.0	15.0	30.0	20.0	30.0	25.0	10.0	10.0	30.0	30.0
Sm	4.4	4.5	6.5	5.8	6.4	5.3	2.3	2.4	6.3	6.5
Tb	0.9	ND	0.2	0.7	0.8	2.3	ND	ND	1.5	2.0
Th	2.0	8.0	10.0	6.0	11.0	8.0	4.0	4.0	12.0	10.0
U	1.0	3.0	2.0	3.0	3.0	3.0	2.0	ND	2.0	4.0
Yb	2.1	ND	0.8	2.6	1.3	3.0	0.1	0.8	1.6	2.9

[1]Analyses by W.G. Armanin, Chemex Labs Ltd., Sparks, Nevada, using induced nuclear activation techniques.

Table 4. ^{40}Ar - ^{39}Ar *age determinations from selected igneous rocks in the Sleetmute C-7, C-8, D-7, and D-8 Quadrangles, Alaska*[1]

Map no.	1	1	2	3	4	5	6	8
Sample no.	90BT40	90BT40	90BT44	90HA3	90BT55	90BT61	90BT83	90BT70
Rock type	Granite Porphyry (TKgp)	Granite Porphyry (TKgp)	Vitric Tuff (TKat)	Coarse Vitric Tuff (TKgrt)	Basaltic Andesite (TKvm)	Basaltic Andesite (TKvm)	Andesite Tuff (TKvit)	Granodiorite Porphyry (TKsyp)
Mineral dated	biotite	whole rock	biotite	biotite	whole rock	whole rock	whole rock	biotite
Sample weight (g)	0.0703	0.2725	0.0777	0.0607	0.2107	0.2264	0.2026	0.0656
Number of fractions	9	9	9	10	10	10	10	10
Integrated age (Ma)	69.46 ± 0.32	68.92 ± 0.26	69.37 ± 0.31	70.33 ± 0.57	71.16 ± 0.35	70.89 ± 0.36	70.01 ± 0.35	68.79 ± 0.64
K_2O(weight %)	7.37	4.28	7.04	7.02	2.40	1.97	2.28	3.61
CaO (weight %)	0.11	1.08	0.18	0.16	5.34	5.15	4.50	3.58
Plateau/isochron age (Ma)	69.64 ± 0.30	68.72 ± 0.25	70.12 ± 0.29	70.78 ± 0.55	69.52 ± 0.96	68.93 ± 0.53	68.09 ± 0.82	68.98 ± 0.63
Initial ratio (number of fractions in plateau)	6	6	5	6	307 ± 4(6)	330 ± 7(5)	372 ± 12	8

[1]Analyses by Dr. Paul layer, DGGS-UAF Cooperative Geochronology Laboratory, Fairbanks, Alaska.

Table 5. *K-Ar determination from granite porphyry pluton, Sleetmute C-7 Quadrangle, Alaska*[1]

Map no.	13
Sample no.	87MDT25
Rock type	granite porphyry(TKgp)
Mineral dated	biotite
Sample weight (g)	0.1144
K_2O (weight %)	8.822
^{40}AR (10^{-11} mol/g)	93.2541
^{40}Ar(%)	49.73
$^{40}Ar/^{40}K \times 10^{-3}$	4.2667
Age (ma)[2]	71.98 ± 2.16

[1]Analyses by Robin Cotrell and Donald L. Turner, DGGS-UAF Cooperative Geochronology Laboratory, Fairbanks, Alaska.

[2]Contants used in age calculations

$\lambda_\varepsilon = 0.581 \times 10^{-10}\ yr^{-1}$

$\lambda_\beta = 4.962 \times 10^{-10}\ yr^{-1}$

$^{40}K/K_{total} = 1.167 \times 10^{-4}$ mol/mol

Table 6. *C^{14} - C^{13} analytical determinations from Quaternary sediments in Sleetmute C-7, D-7, C-8, and D-8 Quadrangles, Alaska*[1]

Map no.	Field no.	Laboratory no.	C14 age (years B.P. ± 15)	C13/C12	C13 adjusted age	Sample description and location
7a	90BT71	Beta 40059	1900 ± 41 B.P.	NA	NA	Palsa on till of Tolstoi Lake age on upper Getmuna Creek at 2,150 ft elevation; sample taken from 1.5 m depth on top of blue, varved, lacustrine deposit.
7b	90BT75	Beta 40060	13,600 ± 293 B.P.	NA	NA	From organic peat layer in till of Tolstoi Lake age in upper Getmuna Creek at 2,150 ft elevation; sample taken 2m below 90BT71 (see figure x).
10	91BT1	Beta 47634	23,690 ± 510 B.P.	-26.9	23,660 ± 510 B.P.	From organic loess 6 m below surface on top Jungjuk Creek outwash fan.
11	92BT4a	Beta 47635	33,800 ± 2,000 B.P.	-26.6	33,770 ± 2,000 B.P.	91BT4a from peat layer 3 M below surface
	92BT4b	Beta 47636	34,710 ± 1,240 B.P.	-28.5	34,650 ± 1,240 B.P.	91BT4b from top of thin outwash 1 m below 91BT4a
	91BT4c	Beta 47367	≥39,600 B.P.	-27.2	NA	91BT4c from peat layer below outwash All samples from along west bank Kuskokwim River in NE corner of Sleetmute C-7 Quadrangle.
12	91BT5b	Beta 47638	≥38,600 B.P.	-27.2	NA	From bluish clay layer in outwash gravel 1/2 km below 91BT4a-c site.
14	91BT31a	Beta 47639	11,760 ± 70 B.P.	-26.8	11,730 ± 70 B.P.	91BT31a from forest layer 1.2 m below loess cap
	91BT31b	Beta 47640	16,410 ± 150 BP	-26.9	16,380 ± 150 B.P.	91BT31b from peat layer 1.5 m below 91BT31a, about 5 km below mouth of Sue Creek, Kuskokwim River.
15	91BT32a	Beta 47641	≥40,920 B.P.	-28.3	NA	91BT32a from organic silt horizon 0.3 m above outwash gravel 6 m below modern forest layer
	91BT32b	Beta 47642	26,446 ± 530 B.P.	-27.6	26,400 ± 530 B.P.	91BT32b from organic peat 3 m below modern forest layer; and about 3 m above 91BT32a; site is 1 km below 91BT31 sample sites.
16	91BT86	Beta 47643	16,670 ± 360 B.P.	-27.2	16,640 ± 360 B.P.	From organic silt layer directly underneath sandy eolian dune complex; about 6 km downriver from Napamiut.

[1]Analytical work by Beta Analytic Inc. Coral Gables Flordia, 33124; dates are reported as RCYBP (radiocarbon years before 1950 AD). Half-life of radiocarbon is 5,568 years; accuracy of results are one standard deviation. Adjusted ages are normalized to -25 per mil carbon 13.

Table 2. *Major oxide and trace element determinations and CIPW normative mineralogy for selected igneous rocks from Sleetmute C-7, C-8, D-7, and D-8 Quadrangles* - *page 1 of 5*

Map no.	1	2	3	4	5	6	7	8	9	10	11	12
Field no.	91BT109[a]	91BT113[a]	90GL51[b]	90GL31[b]	90BT40[b]	90HA3[b]	90BT41A[b]	90HA4[b]	90HA6[b]	90HA7[b]	90BT49[b]	90BT60[b]
Rock type	Basaltic Andesite (TKvm)	Granite Porphyry (TKgp)	Quartz Diorite (TKgd)	Basaltic Andesite (TKvm)	Granite Porphyry (TKgp)	Coarse Vitric Tuff (TKgrt)	Coarse Vitric Tuff (TKat)	Basaltic Andesite (TKvm)	Vesicular Andesite (TKgvm)	Latite Tuff (TKdt)	Latite (TKdt)	Basaltic Andesite (TKvm)
SiO_2	54.40	77.20	58.30	54.29	73.07	75.00	59.83	56.60	59.20	68.00	70.06	56.30
Al_2O_3	14.50	12.00	13.90	14.12	14.30	12.70	17.48	15.10	16.00	13.60	14.19	15.30
Fe_2O_3	3.91	0.56	2.06	2.44	0.82	0.93	2.64	2.28	2.01	1.75	1.93	3.30
FeO	4.20	<.10	4.90	5.38	0.51	1.10	3.37	5.10	5.00	2.30	1.09	4.00
MgO	5.78	0.14	6.32	8.07	0.17	0.66	3.08	5.98	3.03	0.83	0.91	5.84
CaO	8.40	0.40	6.61	7.57	1.44	1.51	4.97	6.53	5.36	2.47	2.51	6.32
Na_2O	2.11	3.05	2.63	2.91	3.42	2.30	3.88	2.72	3.04	3.38	2.40	2.81
K_2O	1.72	4.96	1.69	0.71	4.60	3.22	3.27	1.79	2.76	3.83	2.62	2.19
TiO_2	0.96	0.20	0.60	0.73	0.07	0.40	0.88	1.14	1.37	0.73	0.52	1.07
MnO	0.12	0.02	0.15	0.16	0.01	0.03	0.05	0.13	0.12	0.06	0.04	0.12
P_2O_5	0.25	0.04	0.16	0.23	0.12	0.10	0.38	0.24	0.33	0.16	0.23	0.21
LOI	2.47	1.23	2.08	1.10	0.65	1.77	0.24	2.70	1.77	2.40	1.66	2.21
TOTAL	98.82	99.80	99.40	97.71	99.18	99.72	100.07	100.31	99.99	99.51	98.16	99.67
Trace Elements (in ppm)												
Cr	249	<10	507	NA	NA	41	NA	384	101	29	NA	343
Rb	62	158	51	NA	NA	94	NA	86	94	147	NA	65
Sr	533	40	418	NA	NA	237	NA	359	332	178	NA	309
Y	19	23	15	NA	NA	<10	NA	17	33	46	NA	33
Zr	129	171	142	NA	NA	144	NA	222	286	366	NA	291
Nb	21	21	20	NA	NA	19	NA	12	18	21	NA	<10
Ba	1,530	1,820	1,620	NA	NA	1,900	NA	799	1,060	1,490	NA	900
CIPW Norms (weight/percent)												
Quartz	11.77	40.10	12.91	NA	32.98	46.02	9.63	10.83	14.07	27.66	41.49	10.24
Corundum	0.00	1.00	0.00	NA	1.39	2.99	0.00	0.00	0.00	0.00	3.52	0.00
Orthoclase	10.60	29.73	10.32	NA	27.60	19.45	19.43	10.91	16.70	23.35	16.06	13.34
Albite	18.62	26.18	22.99	NA	29.39	19.89	33.01	23.74	26.34	29.50	21.07	24.51
Anorthite	26.09	1.75	21.83	NA	6.46	6.99	20.73	24.45	22.38	10.96	11.36	23.36
Diopside	12.48	0.00	8.85	NA	0.00	0.00	1.26	5.92	2.17	0.50	0.00	6.00
Olivine	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hyperstene	12.73	0.35	19.25	NA	0.65	2.44	10.08	18.77	12.74	3.97	2.35	15.68
Magnetite	5.22	0.57	2.28	NA	1.12	1.20	3.31	2.57	2.17	2.24	2.57	4.27
Ilmenite	1.90	0.22	1.18	NA	0.14	0.78	1.68	2.23	2.66	1.43	1.03	2.10
Apatite	0.60	0.09	0.38	NA	0.28	0.24	0.89	0.57	0.78	0.38	0.55	0.50
TOTAL	100.01	99.99	99.99	NA	100.01	100.00	100.02	99.99	100.01	99.99	100.00	100.00
Differentiation Index	40.99	96.01	46.22	NA	89.97	85.36	62.06	45.48	57.11	80.51	78.62	48.09
Plagioclase composition	58.35	6.26	48.71	NA	18.01	26.00	38.58	50.74	45.94	27.09	35.03	48.80

[a]Analyses by X-ray Analytical Laboratories, 1885 Leslie St., Don Mills, Ontario, Canada. All oxide values except FeO determined by Induced Coupled Plazma techniques: trace elements determined by x-ray fluorescence techniques. FeO determined using wet chemistry technique.

[b]Analyses by W.G. Armanin, Chemex Labs Inc., Sparks, Nevada: all oxide samples determined by Induced Coupled Piazma techniques; trace elements by x-ray fluorescence techniques; FeO by wet chemistry.

Table 2. *Major oxide and trace element determinations and CIPW normative mineralogy for selected igneous rocks from Sleetmute C-7, C-8, D-7, and D-8 Quadrangles - Continued - page 2 of 5*

Map no.	13	14	15	16	17	18	19	20	21	22	23	24
Field no.	90BT61[b]	90BT63[a]	91BT73[a]	91BT119[a]	92BT120[a]	90BT35B[a]	90BT81[b]	91BT101[a]	90BT83[b]	90BT70[b]	90HA27[b]	90BT85B[b]
Rock type	Basaltic Andesite (TKgvm)	Basaltic Andesite (TKvm)	High K Andesite (TKdt)	Basaltic Andesite (TKvm)	Vitreous Andesite flow (TKvv)	Andesite Tuff (TKdt)	Granodiorite (TKsy)	Basaltic Andesite (TKvm)	Andesite Flow (TKa)	Granodiorite Porphyry (TKsvp)	Vitric Lithic Tuff (TKat)	Andesite (TKdt)
SiO_2	56.27	57.70	62.20	58.40	61.40	62.00	65.45	56.00	56.09	65.77	73.71	62.19
Al_2O_3	15.62	15.40	14.70	16.30	15.80	15.80	14.77	15.30	14.72	15.14	13.92	16.56
Fe_2O_3	2.47	2.55	2.34	2.73	6.05	2.09	0.82	2.96	2.80	1.60	0.79	2.39
FeO	4.46	4.20	4.40	2.90	1.50	3.60	3.28	4.30	4.02	2.90	0.16	3.67
MgO	5.66	5.11	1.12	3.84	1.85	1.46	2.10	4.80	4.56	2.44	0.51	1.62
CaO	6.26	5.83	3.65	6.84	4.04	4.04	2.88	6.44	5.89	3.32	1.14	4.17
Na_2O	3.11	2.52	3.94	2.94	3.68	4.45	2.79	2.59	2.83	3.14	3.63	4.11
K_2O	1.99	2.21	3.18	2.04	3.05	2.11	3.29	1.90	2.31	3.45	2.82	3.00
TiO_2	1.05	1.06	1.21	0.75	1.03	0.94	0.66	1.31	1.10	0.78	0.11	0.99
MnO	0.10	0.12	0.11	0.09	0.09	0.11	0.06	0.12	0.13	0.04	0.01	0.05
P_2O_5	0.28	0.22	0.34	0.23	0.24	0.24	0.28	0.28	0.35	0.28	0.13	0.32
LOI	1.44	1.93	2.85	2.08	1.90	2.54	2.70	3.23	4.14	1.83	2.10	1.26
TOTAL	98.71	98.85	100.04	99.14	100.63	99.38	99.08	99.23	98.94	100.69	99.03	100.33
Trace Elements (in ppm)												
Cr	NA	349	<10	174	38	32	NA	194	NA	NA	NA	NA
Rb	NA	85	178	69	106	158	NA	44	NA	NA	NA	NA
Sr	NA	348	232	571	291	327	NA	355	NA	NA	NA	NA
Y	NA	27	68	10	34	52	NA	38	NA	NA	NA	NA
Zr	NA	266	380	136	296	341	NA	262	NA	NA	NA	NA
Nb	NA	18	20	25	39	40	NA	31	NA	NA	NA	NA
Ba	NA	916	1,450	1,790	1,220	1,410	NA	882	NA	NA	NA	NA
CIPW Norms (weight/percent)												
Quartz	8.91	14.29	17.62	14.76	18.32	17.07	27.16	13.54	12.89	23.29	40.21	15.10
Corundum	0.00	0.00	0.00	0.00	0.00	0.00	2.12	0.00	0.00	0.89	3.23	0.00
Orthoclase	12.15	13.54	19.43	12.46	18.57	12.93	20.03	11.75	14.34	20.69	17.19	17.97
Albite	27.09	22.11	34.47	25.71	32.08	39.04	24.32	22.94	25.16	26.96	31.69	35.24
Anorthite	23.54	25.07	13.48	26.11	18.12	17.53	12.84	25.66	21.68	14.86	4.96	18.12
Diopside	5.34	2.75	2.49	5.90	0.71	1.35	0.00	4.70	5.28	0.00	0.00	0.60
Olivine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hyperstone	17.17	16.50	6.54	9.42	4.42	7.11	9.35	14.34	12.75	9.27	1.31	7.39
Magnetite	2.97	3.14	2.79	3.61	5.21	2.54	2.35	3.78	4.84	1.88	0.97	2.92
Ilmenite	2.06	2.09	2.38	1.47	2.02	1.85	1.17	2.60	2.20	1.50	0.22	1.91
Apatite	0.67	0.53	0.81	0.55	0.57	0.58	0.66	0.68	0.85	0.66	0.31	0.75
TOTAL	100.10	100.02	100.01	99.99	100.02	100.00	100.00	99.99	100.00	100.00	100.00	100.00
Differentation Index	48.25	49.94	71.52	52.93	68.97	69.04	71.52	48.23	52.39	70.94	89.10	68.31
Plagioclase Composition	46.40	53.13	28.11	50.39	36.10	30.99	34.55	52.80	46.29	35.53	13.53	33.95

Table 2. *Major oxide and trace element determinations and CIPW normative mineralogy for selected igneous rocks from Sleetmute C-7, C-8, D-7, and D-8 Quadrangles - Continued - page 3 of 5*

Map no.	25	26	27	28	29	30	31	32	33	34	35	36
Field no.	90BT121[b]	90BT109[a]	90BT108[b]	90BT107[b]	90GL73[a]	90BT93[b]	90BT96a	90HA32a[a]	90HA37B[a]	90BT111[b]	92BT123[a]	92BT125[a]
Rock type	Granodiorite Porphyry (TKsyp)	Latite Tuff (TKvit)	Latite (TKvi)	Latite (TKvi)	High K Andesite (TKa)	Granodiorite (TKsy)	Latite (TKvi)	High K Andesite (TKvi)	Latite Tuff (TKvit)	Tuffaceous Andesite (TKvit)	Tuffaceous Andesite (TKvi)	Dacite Flows (TKvi)
SiO_2	64.25	64.50	64.10	63.94	60.10	66.90	64.61	60.50	64.80	62.87	62.30	62.50
Al_2O_3	14.86	15.60	16.04	16.18	13.60	14.91	16.26	15.80	15.50	15.87	15.60	15.60
Fe_2O_3	1.28	2.73	1.81	2.25	2.18	1.13	2.63	1.96	2.52	2.08	5.32	5.46
FeO	3.00	3.30	3.61	3.67	3.90	2.67	3.22	3.93	2.70	3.78	2.30	2.90
MgO	2.29	1.24	1.36	1.52	6.00	1.87	1.52	1.99	1.34	2.07	1.38	1.45
CaO	2.84	3.00	2.88	3.67	4.73	2.12	3.54	4.25	3.33	3.49	3.44	3.74
Na_2O	3.17	4.07	3.97	3.84	2.64	3.01	4.03	3.29	3.92	3.91	3.72	3.99
K_2O	3.39	3.60	3.55	3.56	3.33	3.36	3.56	3.06	3.44	3.38	3.41	3.14
TiO_2	0.75	0.86	0.90	0.94	0.58	0.58	0.93	0.95	0.83	0.96	0.91	0.94
MnO	0.08	0.09	0.04	0.05	0.13	0.07	0.05	0.10	0.09	0.06	0.23	0.11
P_2O_5	0.29	0.24	0.31	0.32	0.22	0.28	0.31	0.21	0.19	0.29	0.22	0.22
LOI	2.52	0.77	1.43	0.64	2.54	2.30	0.69	3.93	1.47	1.44	1.75	1.30
TOTAL	98.72	100.00	100.00	100.58	99.95	99.20	101.35	99.97	100.13	100.20	100.58	101.35
Trace Elements (in ppm)												
Cr	NA	26	NA	NA	464	NA	NA	45	43	NA	15	21
Rb	NA	125	NA	NA	93	NA	NA	89	113	NA	115	107
Sr	NA	246	NA	NA	351	NA	NA	322	250	NA	283	288
Y	NA	26	NA	NA	12	NA	NA	23	38	NA	35	38
Zr	NA	414	NA	NA	124	NA	NA	280	314	NA	301	296
Nb	NA	27	NA	NA	<10	NA	NA	28	21	NA	24	57
Ba	NA	1,500	NA	NA	1,420	NA	NA	1,270	1,250	NA	1,330	1,320
CIPW Norms (weight/percent)												
Quartz	23.47	18.36	18.60	17.13	13.09	29.45	17.33	16.32	21.25	15.85	16.00	17.66
Corundum	1.57	0.13	1.19	0.10	0.00	3.25	0.08	0.00	1.44	0.13	0.00	0.00
Orthoclase	20.90	21.52	21.37	21.13	20.29	20.55	20.98	18.92	20.46	20.31	20.82	19.16
Albite	27.98	34.83	34.22	32.64	23.03	26.36	34.00	29.13	33.38	33.64	37.95	34.85
Anorthite	12.72	13.47	12.49	16.19	15.90	8.99	15.49	20.20	10.71	15.68	13.45	15.88
Diopside	0.00	0.00	0.00	0.00	5.46	0.00	0.00	0.35	0.00	0.00	2.14	1.46
Olivine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypersthene	9.74	6.01	7.58	7.57	17.95	8.32	6.38	11.15	5.84	9.41	3.18	5.27
Magnetite	1.44	3.48	2.08	2.70	2.62	1.26	3.25	1.53	3.24	2.45	4.15	3.35
Ilmenite	1.49	1.65	1.74	1.79	1.14	1.14	1.76	1.89	1.59	1.85	1.79	1.84
Apatite	0.70	0.56	0.73	0.74	0.53	0.67	0.72	0.51	2.10	0.68	0.53	0.53
TOTAL	100.01	100.01	100.00	100.00	100.00	100.00	100.01	100.01	100.01	100.00	100.01	100.00
Differentation Index	72.35	74.71	74.18	70.90	56.41	76.37	72.31	64.37	75.09	69.80	74.77	71.67
Plagioclase Composition	31.26	27.89	26.74	33.16	40.85	25.44	31.30	40.95	24.30	31.79	26.17	31.30

Table 2. *Major oxide and trace element determinations and CIPW normative mineralogy for selected igneous rocks from Sleetmute C-7, C-8, D-7, and D-8 Quadrangles - Continued - page 4 of 5*

Map no.	37	38	39	40	41	42	43	44	45	46	47	48
Field no.	90BT114[b]	91GL27[a]	91GL26[a]	90BT115[b]	92BT101[a]	91BT42[a]	92GL86[a]	91BT35[a]	91BT34a[a]	91BT34b[a]	91BT34c[a]	91BT16[a]
Rock type	Latite Tuff (TKft)	Latite Tuff (TKft)	Andesite (TKvi)	Andesite (TKva)	Andesite (Kac)	Granodiorite (TKsyp)	Andesite (Kac)	Mafic flow (TKvm)	Mafic flow (TKvm)	Mafic flow (TKvm)	Latite Tuff (TKdt)	Gabbro (TKgb)
SiO_2	64.54	64.30	62.80	61.85	57.60	67.70	55.10	54.70	54.00	57.20	63.00	53.00
Al_2O_3	16.31	15.90	15.90	15.95	17.70	14.70	18.70	14.70	14.40	15.60	15.40	14.70
Fe_2O_3	3.25	1.87	2.85	2.46	6.22	1.12	6.65	2.43	2.74	3.44	2.14	2.63
FeO	2.46	3.80	3.00	3.48	2.30	2.70	2.00	5.40	4.80	4.00	3.20	4.60
MgO	1.38	1.40	1.53	1.73	2.32	1.19	2.50	8.22	8.34	5.27	1.40	6.96
CaO	3.44	3.41	3.89	3.87	5.25	2.41	3.74	6.85	6.91	5.95	3.42	7.10
Na_2O	3.97	3.85	3.80	3.84	3.77	3.69	4.34	2.41	2.34	3.10	3.77	2.46
K_2O	3.69	3.54	3.22	3.31	2.20	4.39	2.44	1.16	1.09	2.05	3.02	1.30
TiO_2	0.95	0.91	0.96	0.93	0.86	0.74	1.18	0.70	0.66	1.19	0.87	0.91
MnO	0.05	0.10	0.11	0.09	0.14	0.08	0.23	0.14	0.13	0.12	0.09	0.15
P_2O_5	0.32	0.22	0.24	0.37	0.30	0.14	0.18	0.13	0.13	0.24	0.21	0.18
LOI	0.74	0.77	1.39	0.90	1.45	0.85	3.65	3.23	3.31	1.93	3.47	5.23
TOTAL	101.10	100.07	99.69	98.78	100.11	99.71	100.71	100.07	98.85	100.09	99.99	99.22

Trace Elements (in ppm)

Cr	NA	28	27	NA	<10	38	<10	686	643	281	39	480
Rb	NA	123	99	NA	61	156	83	34	33	72	144	54
Sr	NA	299	294	NA	552	167	469	318	361	338	272	459
Y	NA	20	42	NA	15	45	26	16	22	40	38	18
Zr	NA	374	383	NA	132	423	147	109	92	251	381	154
Nb	NA	25	11	NA	19	29	29	16	13	14	31	22
Ba	NA	1,460	1,390	NA	1,740	1,580	2,190	599	482	891	1.448	788

CIPW Norms (weight/percent)

Quartz	18.58	17.76	18.07	15.98	13.91	21.85	9.79	8.13	8.72	11.39	20.04	8.61
Corundum	0.30	0.06	0.00	0.00	0.30	0.00	2.69	0.00	0.00	0.00	0.22	0.00
Orthoclase	21.73	21.16	19.42	20.06	13.53	26.32	15.20	7.12	6.76	12.40	18.56	8.22
Albite	33.47	32.94	32.82	33.33	33.19	31.68	38.72	21.19	20.79	26.84	33.17	22.27
Anorthite	14.92	15.66	17.17	16.93	25.06	10.74	18.32	26.88	26.85	23.12	16.22	26.99
Diopside	0.00	0.00	0.76	0.23	0.00	0.39	0.00	6.06	6.70	4.36	0.00	7.55
Olivine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypersteneo	3.78	8.04	5.61	7.70	6.06	6.07	6.57	26.17	24.88	14.56	6.88	20.78
Magnetite	4.70	2.13	3.73	3.09	5.54	1.21	5.91	2.77	3.37	4.45	2.70	3.29
Ilmenite	1.80	1.75	1.86	1.81	1.68	1.43	2.36	1.36	1.66	2.31	1.72	1.85
Apatite	0.74	0.52	0.57	0.88	0.72	0.33	0.44	0.31	0.27	0.57	0.51	0.45
TOTAL	100.00	100.02	100.01	100.01	99.99	100.02	100.00	99.99	100.00	100.00	100.02	100.01
Differentiation Index	73.77	71.86	70.31	69.36	60.63	79.85	63.71	36.44	36.27	50.63	71.77	39.10
Plagioclase Composition	30.84	32.22	34.35	33.69	43.09	25.32	32.12	55.92	56.36	46.28	32.84	54.79

Table 2. *Major oxide and trace element determinations and CIPW normative mineralogy for selected igneous rocks from Sleetmute C-7, C-8, D-7, and D-8 Quadrangles - Continued - page 5 of 5*

Map no.	49	50	51	52	53	54	55	56
Field no.	91BT13[a]	91BT9[a]	91BT63[a]	91BT50a[a]	91BT50b[a]	91BT50[a]	91BT51[a]	91BT54[a]
Rock type	Felsite (TKgp)	Granite Porphyry (TKgp)	Granite Porphyry (TKgp)	Granite Porphyry (TKgp)	Granite (TKgr)	Granite Porphyry (TKgp)	Granite (TKgp)	Granite Porphyry (TKgp)
SiO_2	72.60	72.70	63.20	73.60	72.20	73.70	73.80	79.20
Al_2O_3	14.20	14.50	15.90	15.00	14.40	15.00	15.20	11.90
Fe_2O_3	1.06	1.43	2.40	0.53	1.02	0.54	0.42	0.38
FeO	0.90	0.50	3.50	0.60	1.10	0.60	0.10	0.40
MgO	0.63	0.46	1.48	0.13	0.32	0.13	0.14	0.11
CaO	0.27	1.03	3.28	1.00	1.28	0.99	0.48	0.81
Na_2O	2.35	2.77	3.93	3.97	4.60	4.03	4.25	3.18
K_2O	5.02	4.07	3.41	4.26	4.34	4.33	4.27	3.40
TiO_2	0.25	0.25	0.91	0.05	0.21	0.05	0.03	0.04
MnO	0.05	0.02	0.10	0.02	0.06	0.02	0.02	0.01
P_2O_5	0.13	0.12	0.24	0.08	0.07	0.08	0.06	0.06
LOI	2.00	2.00	1.47	0.93	0.54	0.77	1.54	1.00
TOTAL	99.46	99.85	99.82	100.17	100.14	100.24	100.31	100.49
Trace Elements (in ppm)								
Cr	<10	<10	26	13	<10	<10	<10	<10
Rb	157	129	119	177	138	183	221	135
Sr	142	239	276	100	189	89	80	76
Y	<10	12	37	<10	34	<10	<10	<10
Zr	139	134	331	55	220	66	42	44
Nb	<10	24	19	26	13	31	22	13
Ba	3,880	2,390	1,450	574	1,180	604	427	615
CIPW Norms (weight/percent)								
Quartz	39.36	39.33	17.53	32.06	25.49	31.49	32.07	46.03
Corundum	4.85	4.04	0.36	2.25	0.00	2.09	2.89	1.67
Orthoclase	30.47	24.59	20.57	25.38	25.78	25.74	25.55	20.20
Albite	20.42	23.97	33.94	33.87	39.13	34.30	36.41	27.06
Anorthite	0.50	4.42	15.01	4.48	5.86	4.42	2.02	3.65
Diopside	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Olivine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hyperstene	2.17	1.17	7.28	1.01	1.82	1.00	0.35	0.68
Magnetite	1.43	1.71	2.99	0.67	1.31	0.69	0.51	0.50
Ilmenite	0.49	0.49	1.76	0.10	0.40	0.10	0.06	0.08
Apatite	0.31	0.28	0.57	0.19	0.16	0.19	0.14	0.14
TOTAL	100.00	100.00	100.01	100.01	100.01	100.02	100.01	100.01
Differentation Index	90.25	87.89	72.04	91.31	90.40	91.53	94.03	93.29
Plagioclase Composition	0.98	15.57	30.66	11.68	13.03	11.42	5.26	11.89