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GOLD FAVORABILITY IN THE BIG DELTA QUADRANGLE, ALASKA, AS PREDICTED BY DISCRIMINANT ANALYSIS FOR NON-PORPHYRY GRANITIC ROCKS

by

Diana N. Solie and Laurel E. Burns
Division of Geological and Geophysical Surveys

and

Rainer J. Newberry
University of Alaska Fairbanks

Alaska Division of
Geological and Geophysical Surveys

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3700 Airport Way
Fairbanks, Alaska 99709

Gold favorability in the Big Delta quadrangle, Alaska, as predicted by discriminant analysis for non-porphyry granitic rocks

Introduction

New major and trace element geochemical data from plutonic rocks in the Big Delta quadrangle, Alaska have been added to a compilation of published data in order to study compositional characteristics of the plutons and to evaluate their favorability for gold mineralization (Table 1). Compositions of analyzed samples are metaluminous to peraluminous, and include primarily granite, granodiorite and alkali feldspar granite, with minor tonalite, quartz monzodiorite and monzodiorite (Figure 1). Application of discriminant functions which numerically evaluate the favorability of each rock for non-porphyry plutonic gold mineralization shows that the granodiorites and tonalites have the highest gold potential in the Big Delta quadrangle. Of the group with high Au favorability, most but not all are associated with known high Au anomalies (ie, placers and/or reported rock or pan concentrate geochemical anomalies).

Data

New whole rock geochemical analyses for both major oxides and selected trace elements were attained by ADGGS from previously unanalyzed samples from the Big Delta quadrangle. Forty-two of the samples were obtained from the collections of the United States Geological Survey, collected by Florence Weber, Helen Foster, Terry Keith and Fred Wilson between 1966 and 1977. The cooperation of these individuals for the use of these samples is gratefully acknowledged. Additional new data are from samples collected by Thomas E. Smith (ADGGS) in 1984 and by Rainer Newberry (University of Alaska - Fairbanks) in 1988. Previously published data is from Luthy and others (1981), Forbes (1982) and Dubois and others (1986). Pluton map patterns (Plates 1 and 2) and pluton numbering system (Plate 1 and Table 1) are adapted from Luthy and others, 1981.

Samples for new data were selected from each of the major plutons in the Big Delta quadrangle, on the basis of sample size and apparent freshness. Weathered edges were removed from samples with a water-lubricated rock saw. Geochemical analyses were done by X-Ray Assay Laboratories, Don Mills, Ontario, Canada, except for samples with 88RN prefix, which were analyzed by Bondar-Clegg, Vancouver, British Columbia, Canada.

Discriminant Analysis for non-porphyry plutonic gold potential

Many plutonic rocks in the Big Delta Quadrangle are spatially associated with gold-bearing veins, hornfels, skarns, and gold placers. The gold potential of the plutonic rocks was investigated by using discriminant functions developed and discussed more fully by Newberry and Burns (1989). These discriminant functions predict which non-porphyry, unaltered plutons are gold-related and estimates their corresponding favorability. The following analysis of gold potential is only pertinent to non-porphyry plutonic gold systems. The term non-porphyry is used here as a genetic term. We are excluding only porphyry copper deposits, and by no means are excluding rocks of a porphyritic texture. Highly altered rocks, even some from gold-rich porphyry copper systems, will not appear to be favorable by the discriminant functions described below. However, by analyzing unaltered rocks we can fairly accurately predict the non-porphry gold-related plutons.

In brief, the discriminant functions were constructed from major oxide analyses taken from the literature of about 650 plutonic rocks from 150 geographic locations. The compositions of the rocks range from diorite to granite. Forty percent of the analyses were related to non-porphyry gold deposits/prospects. Five quadratic discriminant functions were computed on random subsets of this data. These discriminant functions are an expression of the compositional characteristics typical of unaltered gold and non-gold-related plutonic rocks. Test cases on rocks with known gold and nongold affinity are then analyzed to establish how well the functions correctly classified the data. The equations yield about a 5 percent TYPE II error, the probability that a gold pluton will be misclassified, and about a 10 percent TYPE I error, probability that a non-gold pluton will be classified as a gold pluton. For exploration purposes, minimizing the TYPE II error, so that gold-related plutons will not be overlooked, is desirable. The error rates on the discriminant function are obviously low and make these discriminant functions a useful approach to estimating pluton-related gold potential.

The result from a discriminant function is a number, called the posterior probability, between 0 and 100; 100 meaning that the sample had compositional characteristics that are indistinguishable from those non-porphyry plutons related to gold, and 0 meaning the opposite. The average posterior probability computed after a sample is run through the five discriminant functions is not directly proportional to the amount of gold present, but is a good estimate of whether the sample belongs to a plutonic system which produced some gold. We have come to view these posterior probabilities in the following light:

values over 95 - excellent probability for association with non-porphyry gold

values over 85 or 80 - probably associated with gold,

values above 60 - possibly an altered rock from a good gold system or a good rock from a poor gold system

values below 60 - probably not associated with non-porphry gold.

Major oxide analyses of the plutonic rocks from the Big Delta were run through the discriminant program. Only one or two rocks were available from many of the plutons; in most cases, we do not know how representative that one sample was. However, field notes indicate that most samples were collected to represent the predominant rock types at each sample location. The average results of the discriminant analysis are displayed on Plate 2.

Discussion

Many plutonic rocks in the Big Delta quadrangle appear to be very favorable for association with either gold lodes or gold placers. The composition of the rocks most favorable for gold from this quadrangle is granodiorite (Figure 1). The granites from the quadrangle appear to be too evolved for gold systems; many are possibly associated with weak- to moderate-quality tin systems. Alteration may cause favorable samples to appear less favorable. For instance, the samples from the Birch Lake pluton (pluton 5) show mixed favorabilities (Plate 2) possibly as a result of alteration, even though free gold was observed in quartz veins from locality 88RN303 and analysis of a sample from this locality yielded 495 ppb Au.

Available K-Ar data indicate two major times of intrusion for intermediate to silicic plutons in the Big Delta quadrangle (Foster and others, 1979; Wilson, 1976; Wilson and others, 1985; Bundtzen and Reger, 1977) and the rest of interior Alaska. The older suite of plutons is about 90 Ma, and is commonly related to tungsten skarns [*eg*, Gilmore Dome (Blum, 1983; Newberry and Swanson, 1986) and Table Mountain (Newberry, 1987)], and is generally predicted by the gold discriminant functions to be strongly gold-related. Known gold anomalies occur more commonly near these older plutons in the Big Delta quadrangle (Plate 2; Menzie and Foster, 1978; O'Leary and others, 1987). The younger suite of plutons is about 60 Ma. Several of these younger plutons [*eg*, the Hope granite suite (Burns and Newberry, 1987) and the Circle Hot Springs pluton] have previously been identified as tin-related. In the Big Delta quadrangle, Sn anomalies are known around some plutons of this younger group (Plate 2; Menzie and Foster, 1978; Hessin and others, 1978; O'Leary and others, 1978).

The characteristics of the plutons in the Big Delta quadrangle which appear to be favorable for gold concentration may be similar to those described by Newberry and others (1988) for gold-related plutons in the Kantishna-Circle gold belt. The Kantishna-Circle gold belt plutons have 1) only small amounts of pervasive hydrothermal alteration, 2) relatively deep emplacement, and 3) generally early Tertiary or older ages, and are thus typical of gold systems related to "mesothermal veins".

Conclusion

Based on the discriminant analysis for gold mineralization favorability in non-porphyry granitic plutons, the Big Delta quadrangle contains some very favorable localities. Some characteristics of the rocks with favorable potential in the Big Delta quadrangle are their granodiorite to tonalite compositions, and their generally older age of about 90 my. Spatial association with known gold anomalies (placers and/or rock or pan concentrate geochemical anomalies) is additional substantiating evidence for the favorable potential of many of the plutons.

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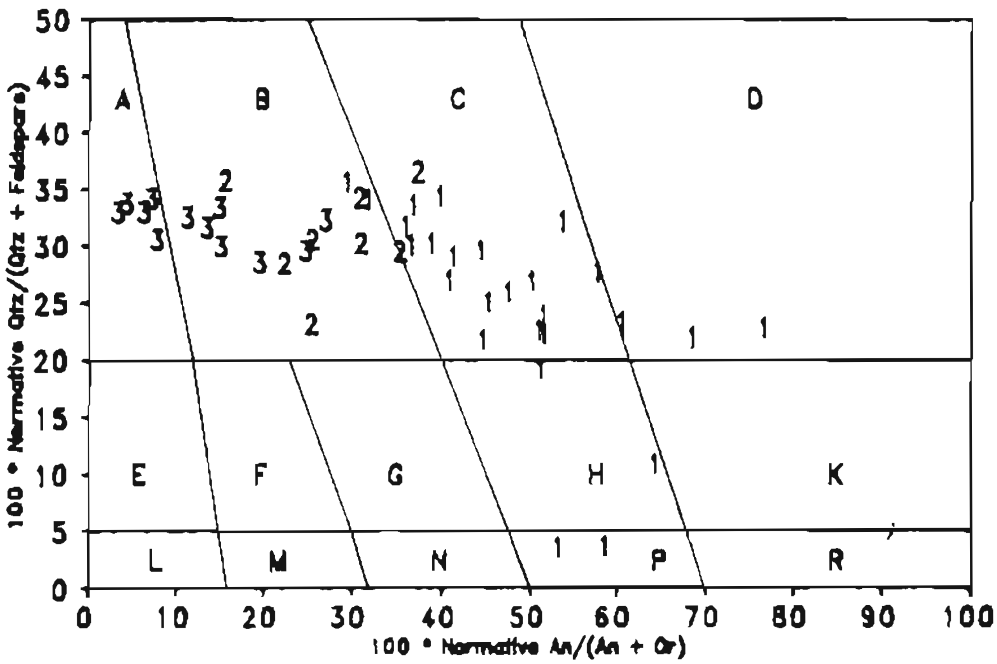

Figure 1: Composition and gold potential of plutonic rocks in Big Delta quadrangle. 1 = excellent favorability, posterior probability 85-100, 2 = moderate favorability, 60-85, 3 = weak favorability, 0-60. A = Alkali-feldspar granite, B = Granite, C = Granodiorite, D = Tonalite, E = Alkali-feldspar quartz syenite, F = Quartz syenite, G = Quartz monzonite, H = Quartz monzodiorite, K = Quartz diorite, L = Alkali-feldspar syenite, M = Syenite, N = Monzonite, P = Monzodiorite, R = Diorite/Gabbro.

Table 1:

SAMPLE	74AFr613*	75ASj538*	75AFr2175*	75AFr2184*	72AFr216	70AWr319
QUAD	B1	D1	C2	B6	C3	B6
PLUTON	4	6	2	5	22	dike
WT. %:						
SIO2	71.10	66.80	66.08	69.95	69.80	75.40
AL2O3	15.10	15.64	16.59	14.64	14.20	13.20
FE2O3	0.50	0.77	0.96	0.77	0.71	0.59
FEO	2.00	3.39	2.78	2.27	2.00	0.10
MNO	0.03	0.09	0.08	0.07	0.07	0.02
MGO	0.90	1.77	1.56	0.89	0.95	0.10
CAO	3.00	4.22	3.99	2.52	2.50	0.00
NA2O	3.00	2.94	3.15	3.18	2.62	3.65
K2O	3.50	3.28	3.39	4.22	4.94	4.54
TIO2	0.32	0.54	0.51	0.32	0.33	0.04
P2O5	0.15	0.09	0.22	0.17	0.09	0.02
LOI	0.00	0.00	0.00	0.00	0.85	1.08
SUM	99.60	99.53	99.31	99.00	99.06	98.74
PPB:						
RB	na	na	na	na	na	na
SR	na	na	na	na	na	na
Y	na	na	na	na	na	na
NB	na	na	na	na	na	na
ZR	na	na	na	na	na	na
BA	na	na	na	na	na	na
NORM:						
QTZ	31.77	23.74	23.04	27.91	28.43	37.53
COR	1.29	0.00	1.02	0.67	0.22	2.34
OR	20.77	19.47	20.17	25.19	29.72	27.47
AB	25.49	24.99	26.84	27.18	22.57	31.62
AN	13.96	19.88	18.49	11.51	12.03	0.00
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	0.46	0.00	0.00	0.00	0.00
HYP	5.05	9.09	7.56	5.40	5.13	0.26
OL	0.00	0.00	0.00	0.00	0.00	0.00
MT	0.73	1.12	1.40	1.13	1.05	0.28
HEM	0.00	0.00	0.00	0.00	0.00	0.41
ILM	0.61	1.03	0.98	0.61	0.64	0.08
AP	0.35	0.21	0.51	0.40	0.21	0.00
DISCR#	85.6	99.0	96.0	78.5	65.8	low CaO

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	66AWr78	73AWr88H	73AWr88K	74AFr638A	74AFr646A	74AFr771A
QUAD	B6	C6	C6	B1	A1	A1
PLUTON	5	23	23	10	16a	16b
WT. %:						
SIO2	67.00	73.20	74.40	70.00	73.80	65.80
AL2O3	15.10	13.20	13.70	14.70	13.00	16.10
FE2O3	0.98	0.43	0.62	0.39	0.52	1.26
FEO	2.30	1 30	0.40	2.20	0.60	2.60
MNO	0.08	0.04	0.02	0.07	0.03	0.12
MGO	0.89	0.12	0.11	0.86	0.23	1.25
CAO	2.26	1.00	0.36	2.21	1.15	3.76
NA2O	3.38	3.68	3.72	3.16	3.33	4.00
K2O	5.07	4.89	5.12	3.65	5.09	2.75
TIO2	0.35	0.12	0.12	0.37	0.12	0.58
P2O5	0.13	0 05	0.05	0.12	0.04	0.17
LOI	0.77	1 23	1.23	0.93	0.08	0.70
SUM	98.31	99.26	99.85	98.66	97.99	99.09
PPB:						
RB	197	258	276	139	125	118
SR	393	21	52	262	146	345
Y	30	31	41	30	28	42
NB	30	11	21	10	12	14
ZR	194	117	115	148	89	211
BA	1360	212	280	1050	1090	767
NORM:						
QTZ	21.30	30 64	32.80	31 21	32.70	21.55
COR	0.26	0.16	1 53	1 86	0.02	0.12
OR	30.72	29.48	30.68	22.07	30.72	16.52
AB	29.32	31.76	31 92	27.36	28.78	34.40
AN	10.62	4.73	1 48	10.42	5.56	17.83
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	0.00	0.00	0.00	0.00	0.00
HYP	5.33	2 25	0.34	5.50	1.13	6.21
OL	0.00	0 00	0.00	0.00	0.00	0.00
MT	1.46	0 64	0.91	0.58	0.77	1.86
HEM	0.00	0.00	0 00	0 00	0.00	0.00
ILM	0.68	0 23	0.23	0.72	0.23	1.12
AP	0.31	0.12	0.12	0.28	0.10	0.40
DISCR#	84.2	56.4	0.0	94.2	0.0	85.6

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	74AFr777C	AFr3001	74AWr177A	74AWr196	74AWr202A	74AWr233	74AWr254A
QUAD	A1	B2	B1	B1	A1	A1	A1
PLUTON	16b	18	4	4	15	10	15
WT. %:							
SIO2	71.40	64.10	68.60	69.40	75.60	74.90	73.00
AL2O3	14.40	15.30	15.70	14.90	12.70	13.20	14.40
FE2O3	0.10	1.07	0.52	0.64	0.58	0.43	0.21
FEO	1.90	3.20	2.80	2.50	0.50	0.90	0.90
MNO	0.07	0.09	0.07	0.10	0.06	0.08	0.05
MGO	0.57	2.83	0.99	1.01	0.05	0.19	0.32
CAO	1.92	4.05	3.62	2.77	0.43	0.76	1.85
NA2O	3.35	3.22	3.43	3.51	4.29	4.12	3.79
K2O	3.53	3.51	2.42	3.39	4.56	4.51	3.98
TIO2	0.25	0.61	0.49	0.39	0.07	0.13	0.15
P2O5	0.11	0.16	0.16	0.13	0.02	0.04	0.05
LOI	0.93	0.93	0.85	0.54	0.31	0.47	0.54
SUM	98.53	99.07	99.65	99.28	99.17	99.73	99.24
PPB:							
RB	133	159	105	186	197	207	124
SR	316	465	392	236	0	69	419
Y	17	0	57	60	52	75	0
NB	16	28	12	15	30	28	22
ZR	134	146	189	131	82	95	52
BA	1300	1450	614	744	303	622	1230
NORM:							
QTZ	33.13	18.41	29.12	27.65	32.45	31.55	31.23
COR	1.89	0.00	1.25	0.74	0.00	0.26	0.62
OR	21.37	21.13	14.47	20.29	27.26	26.85	23.83
AB	29.04	27.76	29.37	30.08	36.72	35.12	32.49
AN	9.02	17.25	17.12	13.06	1.95	3.54	8.97
NE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	1.76	0.00	0.00	0.06	0.00	0.00
HYP	4.66	10.56	6.58	6.20	0.53	1.72	2.15
OL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MT	0.15	1.58	0.76	0.94	0.85	0.63	0.31
HEM	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ILM	0.49	1.18	0.94	0.75	0.13	0.25	0.29
AP	0.26	0.38	0.38	0.31	0.05	0.09	0.12
DISCR#	88.3	98.1	98.8	92.0	0.0	45.7	57.5

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	74AWr370	75AFr207A	72AFr215	75AFr238	75AFr630	75AFr636B
QUAD	A3	B3	C3	C2	C1	C1
PLUTON	17	18	22	8	14	14
WT. %:						
SIO2	55.80	73.30	69.50	68.60	75.00	75.60
AL2O3	16.40	14.00	14.60	15.20	12.30	12.40
FE2O3	1.03	0 30	0.57	0.25	0.48	0.29
FEO	6.00	0.60	2.20	2.60	1.10	1.00
MNO	0.12	0.04	0.06	0.07	0.03	0.02
MGO	4.08	0.12	0.79	0.96	0.03	0.03
CAO	6.91	0.95	2.83	2.76	0.50	0.60
NA2O	2.92	3.94	3.16	3.21	3.85	3.81
K2O	2.31	5.24	4.08	3.72	5.12	4.87
TIO2	1.38	0.09	0.36	0.41	0.12	0.10
P2O5	0.41	0.04	0.10	0 13	0.02	0.01
LOI	0.54	0.47	1.00	0.77	0.62	1.08
SUM	97.90	99.09	99.25	98.68	99.17	99.81
PPB:						
RB	88	310	163	168	506	558
SR	713	65	367	305	0	0
Y	29	46	14	29	132	198
NB	28	32	22	0	63	56
ZR	142	72	139	154	240	191
BA	1690	479	1080	991	43	73
NORM:						
QTZ	8.24	28.27	27.63	27 46	32.00	33.38
COR	0.00	0.22	0.08	1 21	0.00	0.00
OR	14.02	31 40	24.54	22.45	30.70	29.15
AB	25.38	33.80	27.21	27 74	33.06	32.65
AN	25.49	4.51	13.63	13.12	1.18	2.38
NE	0.00	0 00	0 00	0.00	0 00	0.00
AC	0.00	0 00	0 00	0 00	0.00	0.00
DIOP	5.72	0 00	0.00	0 00	1.07	0.50
HYP	15.95	1 09	5.14	6 55	1.01	1.30
OL	0.00	0 00	0 00	0 00	0.00	0.00
MT	1.53	0 44	0 84	0 37	0.71	0.43
HEM	0.00	0 00	0 00	0 00	0.00	0.00
ILM	2.69	0 17	0.70	0.80	0.23	0.19
AP	0.98	0 09	0.24	0 31	0.05	0.02
DISCR#	100.0	39.6	84.1	97 6	43.5	49.1

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	75AFr663A	75AFr675	75AFr733	75AFr754B	75AFr761A	75AFr330B
QUAD	D1	D1	C1	D1	D1	D1
PLUTON	21	6	11a	11a	11a	6
WT. %:						
SIO2	67.90	62.50	65.60	75.00	69.80	61.90
AL2O3	15.60	15.80	15.90	13.40	14.50	16.10
FE2O3	0.65	0.95	0.37	0.19	0.76	0.47
FEO	2.80	4.20	3.70	0.20	1.60	4.80
MNO	0.04	0.10	0.10	0.02	0.07	0.12
MGO	1.20	2.24	1.34	0.08	0.63	2.28
CAO	3.35	4.99	4.07	0.60	1.66	4.75
NA2O	3.20	2.71	3.43	4.18	3.42	3.01
K2O	3.30	3.32	2.32	5.06	4.92	3.29
TIO2	0.48	0.68	0.55	0.06	0.43	0.67
P2O5	0.13	0.16	0.16	0.05	0.15	0.17
LOI	0.93	0.85	0.77	0.54	0.62	1.00
SUM	99.58	98.50	98.31	99.38	98.56	98.56
PPB:						
RB	133	128	117	217	234	159
SR	359	469	334	62	918	405
Y	35	34	39	0	30	23
NB	22	0	21	13	33	18
ZR	150	142	194	24	227	151
BA	1250	1430	668	149	1840	1080
NORM:						
QTZ	26.65	18.72	24.48	30.35	26.77	16.04
COR	1.00	0.00	0.75	0.08	0.91	0.00
OR	19.77	20.09	14.06	30.25	29.68	19.93
AB	27.45	23.48	29.75	35.78	29.55	26.11
AN	15.99	21.65	19.63	2.68	7.41	21.22
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	2.18	0.00	0.00	0.00	1.50
HYP	6.97	10.76	9.33	0.35	3.37	12.80
OL	0.00	0.00	0.00	0.00	0.00	0.00
MT	0.96	1.41	0.55	0.28	1.13	0.70
HEM	0.00	0.00	0.00	0.00	0.00	0.00
ILM	0.92	1.32	1.07	0.12	0.83	1.30
AP	0.31	0.38	0.38	0.12	0.36	0.40
DISCR#	37.4	99.9	100.0	0.0	56.7	100.0

na=not analyzed; *=Luthy and others, 1981, (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	5AFr2005/6	75AFr2025	75AFr2175	75AFr2182	75AFr3067	75AFr3142
QUAD	D5	D4	C2	B6	B2	B1
PLUTON	24	25	2	Harding	20	S of 3
WT. %:						
SIO2	74.10	70.00	64.80	54.30	59.40	69.90
AL2O3	13.90	14.50	16.40	16.00	15.20	14.60
FE2O3	0.32	0.56	0.96	0.96	1.03	0.95
FEO	0.70	2.60	2.90	6.80	5.80	1.60
MNO	0.04	0.08	0.09	0.15	0.14	0.08
MGO	0.31	0.66	1.59	4.68	4.30	0.81
CAO	1.03	2.77	4.13	8.28	7.06	1.76
NA2O	4.38	2.85	3.51	2.34	2.17	3.66
K2O	4.38	3.79	3.14	3.39	1.99	4.18
TIO2	0.17	0.30	0.53	0.96	0.75	0.26
P2O5	0.06	0.08	0.15	0.28	0.13	0.07
LOI	0.54	0.70	0.62	0.23	0.77	0.93
SUM	99.93	98.89	98.82	98.37	98.74	98.80
PPB:						
RB	305	146	151	122	79	185
SR	121	388	430	655	275	145
Y	24	18	21	37	11	29
NB	34	0	11	11	17	21
ZR	65	148	158	157	97	86
BA	277	1530	845	1630	915	639
NORM:						
QTZ	29.17	30.98	20.20	2.59	16.10	27.57
COR	0.23	0.88	0.08	0.00	0.00	1.05
OR	26.04	22.81	18.90	20.41	12.00	25.24
AB	37.29	24.56	30.24	20.17	18.74	31.64
AN	4.75	13.46	19.87	23.58	26.39	8.45
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	0.00	0.00	13.53	6.98	0.00
HYP	1.60	5.71	7.93	15.79	16.50	3.97
OL	0.00	0.00	0.00	0.00	0.00	0.00
MT	0.47	0.83	1.42	1.42	1.52	1.41
HEM	0.00	0.00	0.00	0.00	0.00	0.00
ILM	0.33	0.58	1.03	1.86	1.45	0.51
AP	0.14	0.19	0.35	0.66	0.31	0.17
DISCR#	53.3	94.5	95.7	100.0	100.0	37.7

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	75AFr3151	75AFr3159	75AWr181A	75AWr544	76AFr516	77AWr174
QUAD	B2	C2	B2	C1	D4	B4
PLUTON	3	8	dike	13	25	9
WT. %:						
SIO2	66.80	63.80	72.20	70.20	57.30	73.90
AL2O3	15.40	16.90	14.10	15.70	16.90	14.30
FE2O3	0.46	0.46	0.37	0.30	1.15	0.22
FEO	2.60	3.70	1.10	1.60	6.80	0.80
MNO	0.07	0.09	0.05	0.04	0.15	0.03
MGO	1.23	1.62	0.36	0.59	2.56	0.20
CAO	3.32	3.60	1.18	1.96	7.05	0.78
NA2O	3.14	3.16	3.14	3.07	1.89	2.93
K2O	3.76	3.27	4.58	5.25	1.66	4.78
TIO2	0.46	0.65	0.19	0.33	1.12	0.13
P2O5	0.14	0.25	0.11	0.09	0.24	0.15
LOI	1.16	1.00	1.00	0.54	1.39	1.08
SUM	98.54	98.50	98.38	99.67	98.21	99.30
PPB:						
RB	170	166	181	159	58	242
SR	233	371	137	323	545	122
Y	20	23	0	14	30	0
NB	17	19	18	0	18	0
ZR	132	197	72	170	181	42
BA	760	539	583	1320	933	228
NORM:						
QTZ	24.53	21.51	33.36	26.65	17.89	37.17
COR	0.48	2.27	2.15	1.63	0.00	3.31
OR	22.82	19.82	27.79	31.30	10.13	28.76
AB	27.28	27.42	27.28	26.20	16.52	25.24
AN	15.98	16.64	5.27	9.22	33.80	2.94
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	0.00	0.00	0.00	0.59	0.00
HYP	7.01	9.79	2.45	3.72	16.58	1.66
OL	0.00	0.00	0.00	0.00	0.00	0.00
MT	0.69	0.58	0.55	0.44	1.72	0.33
HEM	0.00	0.00	0.00	0.00	0.00	0.00
ILM	0.90	1.27	0.37	0.63	2.20	0.25
AP	0.33	0.59	0.26	0.21	0.57	0.35
DISCR#	96.5	100.0	66.6	76.6	100.0	high COR.

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	77AWr423	74AFr3133A	HL-1(a)	79AWs80(b)	84TS43	84TS44
QUAD	C2	B1	B6	D6	D3	D2
PLUTON	2	4	Harding	?	26	19
WT. %:						
SIO2	64.10	67.80	54.35	72.40	67.10	67.40
AL2O3	16.70	15.20	17.09	14.20	15.00	15.20
FE2O3	1.26	0.68	0.97	0.41	0.88	0.62
FEO	2.80	2.50	7.61	1.74	3.00	3.00
MNO	0.10	0.09	0.14	0.04	0.08	0.08
MGO	1.58	1.16	4.90	0.36	1.46	1.23
CAO	4.52	3.10	8.00	2.85	3.45	3.31
NA2O	3.74	3.29	2.13	2.69	2.64	2.69
K2O	2.32	3.44	3.23	3.85	4.42	4.13
TIO2	0.56	0.43	0.76	0.16	0.53	0.49
P2O5	0.16	0.14	0.26	0.06	0.14	0.12
LOI	0.77	0.54	0.00	0.00	0.47	0.62
SUM	98.61	98.47	99.44	98.76	99.17	98.89
PPB:						
RB	142	147	na	na	206	176
SR	407	289	na	na	330	391
Y	12	16	na	na	33	30
NB	20	16	na	na	16	19
ZR	185	159	na	na	200	180
BA	536	852	na	na	1080	1580
NORM:						
QTZ	20.80	26.40	2.52	34.77	24.16	25.84
COR	0.21	0.78	0.00	0.58	0.00	0.58
OR	14.01	20.76	19.19	23.04	26.46	24.83
AB	32.34	28.43	18.12	23.05	22.63	23.16
AN	21.85	14.77	27.69	13.92	16.24	15.91
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	0.00	8.70	0.00	0.15	0.00
HYP	7.46	6.70	20.21	3.61	7.72	7.53
OL	0.00	0.00	0.00	0.00	0.00	0.00
MT	1.87	1.01	1.41	0.60	1.29	0.92
HEM	0.00	0.00	0.00	0.00	0.00	0.00
ILM	1.09	0.83	1.45	0.31	1.02	0.95
AP	0.38	0.33	0.61	0.14	0.33	0.28
DISCR*	92.0	94.3	100.0	31.5	94.2	97.9

na=not analyzed; *=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	84TS45	84TS46	2890	2911	88RN300A	88RN300B
QUAD	D2	D2	D2	D2	B6	B6
PLUTON	19	27	N of 19	19	5	5
WT. %:						
SIO2	67.50	69.40	71.34	68.96	76.29	67.43
AL2O3	15.20	15.10	14.97	14.41	13.09	16.61
FE2O3	0.61	0.41	0.32	0.73	0.52	1.21
FEO	2.90	2.60	1.22	2.73	0.15	1.65
MNO	0.08	0.06	0.03	0.07	0.01	0.06
MGO	1.19	0.79	0.43	1.03	0.11	0.71
CAO	3.24	2.71	1.32	2.87	0.58	2.93
NA2O	2.69	2.35	3.73	2.71	3.60	4.08
K2O	4.35	3.88	4.16	4.07	4.73	3.43
TIO2	0.45	0.41	0.21	0.44	0.04	0.31
P2O5	0.11	0.11	0.07	0.08	0.05	0.14
LOI	0.62	0.93	0.51	0.14	0.83	0.95
SUM	98.94	99.25	98.81	98.24	100.00	99.51
PPB:						
RB	172	177	na	na	210	140
SR	381	351	na	na	20	295
Y	28	21	na	na	30	13
NB	26	18	na	na	25	22
ZR	194	162	na	na	135	185
BA	1480	1250	na	na	<100	390
NORM:						
QTZ	25.30	30.05	29.11	28.98	36.29	23.23
COR	0.45	1.57	1.21	0.53	1.12	1.21
OR	26.14	23.32	25.01	24.52	28.18	20.56
AB	23.15	24.53	32.11	23.37	30.72	35.03
AN	15.62	12.94	8.72	13.98	2.57	13.82
NE	0.00	0.00	0.00	0.00	0.00	0.00
AC	0.00	0.00	0.00	0.00	0.00	0.00
DIOP	0.00	0.00	0.00	0.00	0.00	0.00
HYP	7.31	5.94	2.80	6.50	0.28	3.45
OL	0.00	0.00	0.00	0.00	0.00	0.00
MT	0.90	0.61	0.47	1.08	0.40	1.78
HEM	0.00	0.00	0.00	0.00	0.25	0.00
ILM	0.87	0.79	0.41	0.85	0.08	0.60
AP	0.26	0.26	0.17	0.19	0.12	0.33
DISCR#	97.2	97.3	64.3	91.5	aplite	28.40

na=not analyzed; $^{+}$=Luthy and others, 1981; (a)=Forbes, 1982; (b)=DuBois and others, 1986.

Table 1:

SAMPLE	88RN301	88RN301M	88RN303A
QUAD	B6	B6	B6
PLUTON	5	5	5
WT. %:			
SIO2	68.61	61.72	76.81
AL2O3	15.03	15.34	12.84
FE2O3	1.75	2.03	0.27
FEO	1.40	4.10	0.15
MNO	0.07	0.14	0.01
MGO	0.70	1.83	0.01
CAO	2.58	4.01	0.20
NA2O	3.31	3.73	2.93
K2O	4.41	3.73	5.72
TIO2	0.29	0.52	0.04
P2O5	0.18	0.27	0.05
LOI	0.97	0.91	0.58
SUM	99.30	99.33	99.61
PPB:			
RB	150	180	160
SR	290	255	60
Y	27	54	35
NB	22	19	23
ZR	220	200	78
BA	1200	650	220
NORM:			
QTZ	26.51	13.29	37.94
COR	0.56	0.00	1.60
OR	26.50	22.40	34.13
AB	28.48	32.07	25.03
AN	11.82	17.10	0.57
NE	0.00	0.00	0.00
AC	0.00	0.00	0.00
DIOP	0.00	1.10	0.00
HYP	2.56	9.42	0.03
OL	0.00	0.00	0.00
MT	2.58	2.99	0.40
HEM	0.00	0.00	0.00
ILM	0.56	1.00	0.08
AP	0.42	0.64	0.12
DISCR#	0.00	97.60	aplite

na=not analyzed; * =Luthy and others, 1981, (a)=Forbes, 1982; (b)=DuBois and others, 1986