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PETROGRAPHIC AND CHEMICAL DATA ON CRETACEOUS GRANITIC  
ROCKS OF THE BIG DELTA QUADRANGLE, ALASKA

By

Stephen T. Luthy, Helen L. Foster, and Grant W. Cushing

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Introduction

This report presents petrographic and chemical data on granitic rocks of known Cretaceous age and a few of probable Cretaceous age in the Big Delta Quadrangle (plate 1). The Big Delta Quadrangle is located in the central part of the Yukon-Tanana Upland in east-central Alaska. The Yukon-Tanana Upland is a maturely dissected terrane primarily composed of metamorphic and igneous rocks (Mertie, 1937; Weber and others, 1978). Plutons of Cretaceous and Tertiary age, which range from diorite to granite in composition, intrude metamorphic rocks having both igneous and sedimentary protoliths. The age of the protoliths are unknown but include Paleozoic and possibly Precambrian rocks. Metamorphic grade ranges from greenschist to amphibolite facies. The time or times of major regional metamorphism are not yet determined but were previous to intrusion of the Mesozoic granitic rocks. The most abundant metamorphic rock types are quartzite, quartz-biotite schist and gneiss, marble, amphibole schist, amphibole gneiss, and greenschist.

Unmetamorphosed granitic plutons of the Big Delta Quadrangle are considered to be of Cretaceous and Tertiary ages on the basis of K/Ar age determinations. Plutons of Triassic or Jurassic age have not been found in the Big Delta Quadrangle, although they occur to the east in the Eagle Quadrangle. In this paper only the plutons of granitic composition with Cretaceous K/Ar ages and a few plutons of probable Cretaceous age that have not yet been radiometrically dated are described.

Field data were collected mostly during the course of reconnaissance geologic mapping and geochemical sampling in the Big Delta Quadrangle for the Alaskan Mineral Resource Assessment Program from 1974 to 1977 (Foster and others, 1979). Most of the potassium-argon ages were determined by F. H. Wilson, but J. G. Smith and D. L. Turner also provided some radiometric age data (Foster and others, 1979).

The data presented in this paper are intended to supplement and to be used in conjunction with data on Mesozoic granitic rocks of the adjacent Eagle Quadrangle (Foster, Donato, and Yount, 1978). The largest granitic plutons of the Yukon-Tanana Upland are in the western and northern parts of the Eagle Quadrangle, and parts of these plutons probably extend westward into the Big Delta Quadrangle.

These data should help provide a basis for comparison of the Mesozoic granitic plutons of the Yukon-Tanana Upland with those elsewhere in Alaska and in Canada. Comparison of plutons on both sides of the Shaw Creek fault (Hudson and others, 1976; fig. 1) may aid in determining the time and sense of displacement along this major northeast-trending structure. Interpretation of the data is not included in this report.

#### Type and method of data presentation

Petrographic and chemical data are presented in three tables and one map. Petrographic data, radiometric ages, and modal analyses obtained by point counts on stained slabs and stained thin sections are given in table 1, whole-rock major-element chemical analyses for four samples are given in table 2, and semiquantitative spectrographic analyses for 70 samples (Foster, O'Leary, and others, 1978) are given in table 3. Localities for all thin sections and analyzed samples are shown on the map (plate 1).

The granitic rock samples were collected from 12 different plutons (plate 1). The plutons are differentiated primarily on the basis of map distribution. Because the plutons are not mapped in detail, some which appear spatially distinct may in fact be genetically related. Other plutons which are represented as single bodies may be composite.

A few plutons of uncertain age are included because they appear closely related to dated Cretaceous plutons, including some in the adjacent Eagle Quadrangle, and because knowledge of their petrography may be useful in future studies of the Shaw Creek fault (Hudson and others, 1976).

Nomenclatures and classification of the granitic rocks follows that of the I.U.G.S. Subcommittee on the Systematics of Igneous Rocks (Streckeisen, 1973).

#### Chemical data

Three whole-rock major-element chemical analyses were made by the X-ray fluorescence method described by Fabbi and Elsheimer (1976). Analysis by the rapid rock method (Shapiro, 1967; Shapiro and Brannock, 1967) was done on a fourth sample.

CIPW norms (table 2) were calculated using the Nevada Bureau of Mines and Geology computer program "Petcal". The calculations are explained in the program description (Bingler and others, 1976).

Samples for semiquantitative spectrographic analysis (table 3) were collected as single grab samples as part of a reconnaissance geochemical sampling program for the Big Delta Quadrangle (Foster, O'Leary, and others, 1978). Most of the granitic rocks were obtained for background information. Analysis using a six-step semiquantitative method described by Grimes and Marranzino (1968) are reported for 26 elements. An atomic absorption spectrophotometric method described by Ward and others (1969) was used to more

accurately determine the abundance of gold. For the semiquantitative spectrographic analyses, iron, magnesium, calcium, and titanium values are reported in percent and values for other elements are reported in parts per million (ppm). Results are given as the approximate midpoints of geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc. These midpoints are 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc. The precision of a reported value is approximately plus or minus one reporting value at 68 percent confidence or two reporting values at 99 percent confidence. Samples collected in 1975 and 1977 were analyzed in the laboratories of the Branch of Exploration Research, U.S. Geological Survey, and the approximate visual lower limits of determination for the analyses are as follows:

Fe----0.05 percent	B-----10 ppm	La-----20 ppm	Sn---10 ppm
Mg----0.02 percent	Ba----20 ppm	Mo----- 5 ppm	Sr--100 ppm
Ca----0.05 percent	Be---- 1 ppm	Nb-----10 ppm	V----10 ppm
Ti----0.002 percent	Bi----10 ppm	Ni----- 5 ppm	W----50 ppm
Mn---10 ppm	Co---- 5 ppm	Pb-----10 ppm	Y----10 ppm
Ag--- 0.5 ppm	Cr----10 ppm	Sb---100 ppm	Zn--200 ppm
As--200 ppm	Cu---- 5 ppm	Sc----- 5 ppm	Zr---10 ppm

Some samples collected in 1974 were analyzed by the Branch of Analytical Laboratories, U.S. Geological Survey. For these samples, the approximate visual lower limits of determination are slightly lower than those used by the Branch of Exploration Research for the following elements reported in parts per million: barium, 10; cobalt, 3; chromium, 1; molybdenum, 3; niobium, 7; lead, 7; tin, 5; and strontium, 5.

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Table 1

See attached 2 sheets



Table 2.--Major element chemical analyses in weight percent and CIPW normative minerals for four Cretaceous granitic rocks of the Big Delta Quadrangle, Alaska.

[Analysts: L. Espos and H. Smith. \*, indicates rapid rock analyses, method described by Shapiro and Brannock (1967). Other analyses are by X-ray fluorescence, method described by Fabbi and Elsheimer (1976). —, indicates sample not analyzed for element oxide or normative mineral concentration.]

Sample number	*74AFr613	75ASj538	75AFr2175	75AFr2184
Quadrangle	B-1	D-1	C-2	B-6
Latitude	64°20'37"	64°52'31"	64°40'50"	64°19'02"
Longitude	144°15'12"	144°03'44"	144°45'50"	146°33'06"
SiO <sub>2</sub>	71.1	66.80	66.08	69.95
Al <sub>2</sub> O <sub>3</sub>	15.1	15.64	16.59	14.64
Fe <sub>2</sub> O <sub>3</sub>	.50	.77	.96	.77
FeO	2.0	3.39	2.78	2.27
MgO	.90	1.77	1.56	.89
CaO	3.0	4.22	3.99	2.52
Na <sub>2</sub> O	3.0	2.94	3.15	3.18
K <sub>2</sub> O	3.5	3.28	3.39	4.22
H <sub>2</sub> O+	.68	.81	—	—
H <sub>2</sub> O-	.32	.06	—	—
TiO <sub>2</sub>	.32	.54	.51	.32
P <sub>2</sub> O <sub>5</sub>	.15	.09	.22	.17
MnO	.03	.09	.08	.07
CO <sub>2</sub>	.08	.22	—	—
Sum	100.68	100.62	99.31	99.00
Q	31.64	23.74	22.88	27.63
C	1.28	—	1.01	.67
Or	20.68	19.47	20.03	24.94
Ab	25.38	24.99	26.65	26.91
An	13.90	19.88	18.36	11.39
Di	—	.46	—	—
Hy	5.03	9.09	7.50	5.35
Mt	.72	1.12	1.39	1.12
Il	.61	1.03	.97	.61
Ap	.35	.21	.51	.39
Sum	99.59	99.99	99.30	99.01

Table 3.--Semiquantitative spectrographic analyses for Cretaceous granitic rocks of the Big Delta Quadrangle, Alaska.

[Analysts: J. E. Abrams, N. M. Conklin, E. F. Cooley, G. L. Crenshaw, J. A. Criswell, G. W. Day, R. A. Havens, R. C. Karlson, J. W. McNamara, and R. M. O'Leary. S before an element indicates analysis by emission spectrography. AA indicates analysis by atomic absorption. Analysis given in parts per million (ppm) for all elements except Fe, Mg, Ca, and Ti which are given in percent. Zeros to right of decimal point may or may not be significant. N, element not detected; ---, sample was not analyzed for element; <, element detected in amount less than limit of determination.]

FIELD NUMBER	PLUTON NUMBER	QUAD	S-FE %	S-MG %	S-CA %	S-TI %	S-MNS-AG-S-AS-S-B	S-BAS-BE-S-BI	S-COS-CR-S-CU					
							PPM	PPM	PPM					
ZSAFr 2177	1	D-1	3.00	.70	2.00	.200	N	15	700	3.0	N	5	10	<5
ZSAWt 371C	1	D-1	---	---	---	---	N	10	700	7.0	N	N	N	5
ZSAFr 2175	2	C-2	2.00	1.50	1.00	.150	300	10	500	3.0	N	5	10	N
ZSAMt 369	2	C-2	---	---	---	---	N	10	1000	3.0	N	20	10	10
ZZAFr 388	2	C-2	.50	.05	.20	.020	50	15	100	2.0	N	<5	<10	<5
ZZAFr 450B	2	C-2	2.00	.70	<.05	.2	100	30	700	1.5	N	10	100	15
ZZAFr 453A	2	C-2	.50	.05	.30	.020	100	<10	30	1.0	N	<5	N	<5
ZZAFr 518	2	C-2	1.00	.10	.20	.050	150	15	1000	1.0	N	<5	N	<5
ZZAWt 327	2	C-2	2.00	.50	.70	.200	500	10	700	1.5	N	10	N	<5
ZZAWt 416	2	C-2	2.00	.50	5.00	.15	300	10	1000	1.0	N	10	N	<5
ZZAWt 423	2	C-2	3.00	.50	1.00	.200	500	<10	1000	1.0	N	10	<10	10
ZZAWt 423	2	C-2	3.00	.50	1.00	.200	500	<10	1000	2.0	N	10	<10	<5
ZZAFr 903	3	B-1	3.00	1.00	3.00	.300	700	N	500	<5.0	N	7	7	2
ZZAFr 2392	3	B-1	3.00	1.50	1.50	.300	500	N	1000	<5.0	N	7	10	2
ZZAFr 3230	3	B-1	3.00	1.50	.70	.300	700	N	1000	1.0	N	7	7	5
ZZAFr 176	3	B-2	---	---	---	---	N	<10	1000	1.0	N	10	N	5
ZZAFr 182B	3	B-2	---	---	---	---	N	<10	700	2.0	N	10	10	7
ZZAFr 191B	3	B-2	---	---	---	---	N	10	1500	1.0	N	10	N	---
ZZAFr 569	3	B-2	3.00	.70	2.00	.200	300	<10	700	1.0	N	20	10	20
ZZAFr 3091A	3	B-2	10.00	1.50	.05	.300	300	N	1000	N	N	5	70	30
ZZAFr 3093B	3	B-2	---	---	---	---	N	<10	500	1.0	N	15	70	30
ZZAFr 4092	3	C-1	---	---	---	---	N	<10	700	1.0	N	15	N	<5
ZZAFr 814	4	B-1	1.50	.300	1.00	.150	300	N	1500	<5.0	N	N	10	7
ZZAFr 815	4	B-1	1.50	.300	1.50	.150	700	N	1000	<5.0	N	N	30	15
ZZAFr 816	4	B-1	1.50	.300	1.50	.150	500	N	1000	<5.0	N	N	20	.5
ZZAFr 817	4	B-1	1.50	.300	.50	.150	300	<20	1500	<5.0	N	N	30	15
ZZAFr 3049	4	B-1	1.50	.300	1.00	.150	500	N	700	<5.0	N	N	20	N
ZZAFr 3052	4	B-1	3.00	.700	3.00	.300	700	N	1000	<5.0	N	N	30	1.0
ZZAFr 3133A	4	B-1	2.00	1.000	2.00	.200	700	N	700	<5.0	N	5	30	1.0
ZZAWt 180	4	B-1	1.50	.500	2.00	.150	500	N	700	<5.0	N	3	15	15
ZZAWt 185	4	B-1	3.00	1.500	5.00	.300	700	N	500	N	N	10	30	7.0
ZZAWt 189A	4	B-1	5.00	1.500	3.00	.300	700	N	1000	N	N	10	10	10.0
ZZAWt 195B	4	B-1	3.00	1.500	3.00	.300	700	N	700	N	N	7	50	3.0
ZZAFr 5	5	B-6	3.00	.20	.10	.200	300	N	500	2.0	N	10	30	<5
ZZAFr 3290	6	D-1	---	---	---	---	N	<10	1000	1.0	N	10	10	<5
ZZAFr 3309	6	D-1	---	---	---	---	N	500	1000	5.0	N	30	300	30
ZZAFr 3813	6	D-1	---	---	---	---	N	10	N	N	N	70	2000	5
ZZAWt 623	6	D-1	---	---	---	---	N	10	700	1.0	N	10	N	<5
ZZAFr 371A	6	D-1	1.00	.30	.70	.200	200	10	1000	2.0	N	<5	N	N

Table 3.--Semiquantitative spectrographic analyses for Cretaceous granitic rocks of the Big Delta Quadrangle, Alaska--Continued.

FIELD NUMBER	S-LA Ppm	S-MO Ppm	S-NB Ppm	S-NI Ppm	S-PB Ppm	S-SB Ppm	S-SC Ppm	S-SN Ppm	S-SR Ppm	S-V Ppm	S-W Ppm	S-Y Ppm	S-ZN Ppm	S-ZR Ppm	AA-AU Ppm
75AEF-2177	N	100	N	10	30	N	5	<10	300	30	N	10	N	150	N
75AWF-371C	---	30	<20	5	70	N	---	20	200	30	N	---	N	50	N
75AEF-2175C	20	N	N	5	15	N	5	N	200	70	N	15	N	100	N
75AWF-369	---	N	<20	10	50	N	---	N	500	150	N	---	N	150	N
77AEF-388	50	N	<20	<5	30	N	N	N	N	<10	N	<10	N	20	N
77AEF-450B	70	10	<20	20	10	N	15	N	100	70	N	20	N	150	N
77AEF-453	<20	N	<20	<5	70	N	N	N	100	<10	N	10	N	20	N
77AEF-518	50	N	<20	<5	30	N	<5	N	100	N	N	<10	N	30	N
77AWF-327	70	N	<20	<5	30	N	7	N	300	70	N	15	N	100	N
77AWF-416	50	N	<20	5	20	N	7	N	200	30	N	20	N	100	N
77AWF-422	50	N	<20	<5	50	N	10	N	300	70	N	20	N	50	N
77AWF-423	50	N	<20	<5	50	N	10	N	300	70	N	20	N	50	N
77AEF-803	70	N	10	<5	20	N	15	N	300	100	N	20	N	100	N
77AEF-2382	30	N	7	5	7	N	15	N	200	100	N	20	N	200	N
77AEF-3220	20	N	N	<5	15	N	15	N	300	100	N	20	N	70	N
75AEF-176	---	5	<20	5	20	N	---	N	150	70	N	---	N	200	N
75AEF-182B	---	N	<20	5	20	N	---	N	200	150	N	---	N	150	N
75AEF-191B	50	N	N	5	20	N	10	N	300	50	N	20	N	200	N
75AEF-569	---	N	N	10	20	N	---	N	300	150	N	---	N	150	N
75AEF-2091A	N	N	N	30	10	N	15	N	100	100	N	N	N	150	N
75AEF-3053B	---	N	<20	20	30	N	---	15	150	150	N	---	N	200	N
75AEF-4092	---	N	N	<5	10	N	---	N	200	70	N	---	N	100	N
77AEF-814	30	N	15	N	20	N	5	N	150	15	N	15	N	150	N
77AEF-815	70	N	15	N	20	N	7	N	150	30	N	20	N	200	N
77AEF-816	70	N	15	N	20	N	7	N	150	20	N	30	N	150	N
77AEF-917	50	5	10	N	30	N	7	7	150	15	N	30	N	150	N
77AEF-3049	70	N	10	N	20	N	7	N	150	30	N	15	N	150	N
77AEF-3052	30	N	10	N	20	N	15	N	300	70	N	15	N	150	N
77AEF-3133A	30	N	10	N	20	N	10	N	300	50	N	30	N	150	N
77AWF-180	N	N	7	N	20	N	10	N	200	30	N	30	N	100	N
77AWF-185	50	N	7	N	N	N	20	N	200	70	N	20	N	150	N
77AWF-189A	30	N	10	7	7	N	15	N	300	70	N	30	N	150	N
77AWF-195B	20	N	5	7	7	N	15	N	200	70	N	30	N	100	N
77AEF-5	---	N	<20	10	50	N	10	N	N	30	N	30	N	200	N
75AEF-3290	---	N	N	5	10	N	---	N	200	150	N	---	N	100	N
75AEF-3309	---	N	N	70	30	N	---	10	100	200	N	---	N	150	N
75AEF-3313	---	N	N	2000	N	N	---	N	N	70	N	---	N	N	N
75AWF-623	---	N	N	<5	10	N	---	N	200	70	N	---	N	100	N
77AEF-371	50	N	<20	<5	50	N	5	N	300	30	N	15	N	100	N

Table 3.--Semi-quantitative spectrographic analyses for Cretaceous granitic rocks of the Big Delta Quadrangle, Alaska--Continued.

FIELD NUMBER	PLUTON NUMBER	QUAD	S-FES-MG %	S-CA %	S-TI %	S-MN ppm	S-AG ppm	S-AS ppm	S-B ppm	S-BA ppm	S-BE ppm	S-BI ppm	S-CO ppm	S-CR ppm	S-CU ppm
75AEP 219B	7	C-2							20	700	30	N	10	10	<5
75AEP 220	7	C-2							20	500	20	N	5	20	30
75AEP 221A	7	C-2							<10	00	10	N	15	20	20
75AEP 222	7	C-2							<10	700	10	N	10	20	15
75AEP 223C	7	C-2							<10	1000	10	N	15	20	10
75AEP 236A	8	C-2							<10	1000	10	N	10	10	5
75AEP 3144	8	C-2							<10	700	10	N	N	N	<5
77AEP 173	9	B-4	2.00	1.5	2.00	50		<200	50	200	20	N	<5	20	50
77AEP 233	9	B-4	1.00	1.0	1.00	200			15	500	<10	N	<5	N	<5
77AEP 234A	9	B-4	1.00	1.00	1.00	200			50	1000	30	N	<5	N	<5
74AEP 586	10	B-1	1.50	300	700	300			N	700	<50	N	N	10	N
74AEP 588	10	B-1	1.50	300	2000	500			N	1500	<50	N	N	10	N
74AEP 589	10	B-1	1.50	300	700	300			N	700	<50	N	N	30	15
74AEP 592	10	B-1	1.00	700	2000	500			N	700	<50	N	3	20	7
74AEP 593C	10	B-1	3.00	700	3000	500			N	700	<50	N	7	70	15
74AEP 596	10	B-1	3.00	700	3000	700			N	1500	<50	N	7	30	30
74AEP 597	10	B-1	2.00	700	2000	300			N	1500	<50	N	3	100	150.0
74AEP 636	10	B-1	3.00	1500	3000	700			N	1000	<50	N	7	70	150
74AEP 638A	10	B-1	2.00	700	2000	500			N	1000	<50	N	5	30	15
74AEP 639A	10	B-1	1.50	700	1500	300			10	1000	N	N	N	30	10
74AEP 640	10	B-1	3.00	700	2000	500			N	1000	<50	N	3	50	10
74AEP 641	10	B-1	1.50	300	700	200			N	700	<50	N	N	30	10
74AEP 3049A	10	B-1	2.00	700	3000	700			N	1000	<50	N	5	30	20
74AEP 3049A	10	B-1	3.00	700	3000	700			N	1500	<50	N	7	30	70
74AEP 3049B	10	A-1	3.00	1000	3000	300			N	1500	<50	N	7	30	15
74AEP 169	10	B-1	1.00	200	1500	300			N	700	N	N	N	15	N
75AEP 709A	11	C-1	30	10	1.00	150			10	300	10	N	N	N	N
75AEP 754A	11	C-1							N	700	20	N	10	N	<5
75AEP 9091A	11	C-1							30	300	70	15	N	10	<5
75AEP 9092	11	D-1							150	1000	30	N	5	10	15
75AEP 9098	11	D-1							10	1000	10	N	5	10	30

Table 3.--Semi-quantitative spectrographic analyses for Cretaceous granitic rocks of the Big Delta Quadrangle, Alaska--Continued.

FIELD NUMBER	S-LA PPM	S-MO PPM	S-NB PPM	S-NI PPM	S-PB PPM	S-SB PPM	S-SC PPM	S-SN PPM	S-SR PPM	S-V PPM	S-W PPM	S-Y PPM	S-ZN PPM	S-ZR PPM	AA-AU PPM
75AFe 218B	---	N	<20	20	30	N	---	N	200	50	N	---	N	150	N
75AFe 220	---	N	50	20	20	N	---	N	200	100	N	---	N	150	N
75AFe 221A	---	N	<20	20	30	N	---	N	200	100	N	---	N	200	N
75AFe 222	---	N	<20	20	20	N	---	N	150	100	N	---	N	300	N
75AFe 223C	---	N	<20	20	20	N	---	N	200	100	N	---	N	200	N
75AFe 236A	---	N	<20	5	20	N	---	N	500	150	N	---	N	200	N
75AFe 3144	---	N	<20	5	20	N	---	N	200	50	N	---	N	150	N
77AFe 173	50	N	<20	<5	50	100	5	N	N	50	N	50	N	300	---
77AFe 233	50	N	<20	<5	50	N	N	N	100	<10	N	20	N	100	N
77AFe 234A	50	N	<20	<5	20	N	N	N	<100	<10	N	10	N	70	---
74AFe 586	30	N	10	N	30	N	5	N	150	10	N	20	N	150	N
74AFe 588	70	N	15	N	30	N	5	N	150	N	N	30	N	150	N
74AFe 589	30	N	10	N	30	N	7	N	150	20	N	30	N	150	N
74AFe 592	30	N	10	N	30	N	10	N	300	30	N	30	N	150	N
74AFe 593C	30	N	10	N	30	N	10	5	200	150	N	30	N	150	N
74AFe 596	50	N	15	N	30	N	10	N	300	70	N	20	N	150	N
74AFe 597	N	N	10	N	15	N	7	N	200	30	70	15	N	70	N
74AFe 636	30	N	10	5	20	N	15	N	300	150	N	30	N	150	N
74AFe 638A	70	N	15	<5	30	N	10	N	200	50	N	30	N	150	N
74AFe 639A	30	N	10	N	30	N	7	N	300	30	N	20	N	150	N
74AFe 640	70	N	10	N	20	N	10	N	300	70	N	30	N	150	N
74AFe 641	70	N	10	N	30	N	5	N	150	7	N	20	N	150	N
74AFe 3044A	20	N	15	N	30	N	7	5	200	70	N	20	N	150	N
74AFe 3045A	70	N	15	<5	30	N	15	7	300	100	N	20	N	150	N
74AFe 3044B	30	3	15	<5	15	N	10	N	300	100	N	30	N	150	N
74AFe 169	50	N	7	N	20	N	7	N	200	20	N	15	N	150	N
75AFe 704A	<20	N	N	N	<10	N	N	N	N	<10	N	70	N	70	N
75AFe 754A	---	N	N	N	10	N	---	N	200	30	N	---	N	150	N
75AFe 4041A	---	N	20	10	70	N	---	10	N	20	N	---	N	100	N
75AFe 4042	---	N	N	5	50	N	---	20	100	70	N	---	N	100	N
75AFe 4048	---	N	N	5	20	N	---	10	100	70	N	---	N	100	N