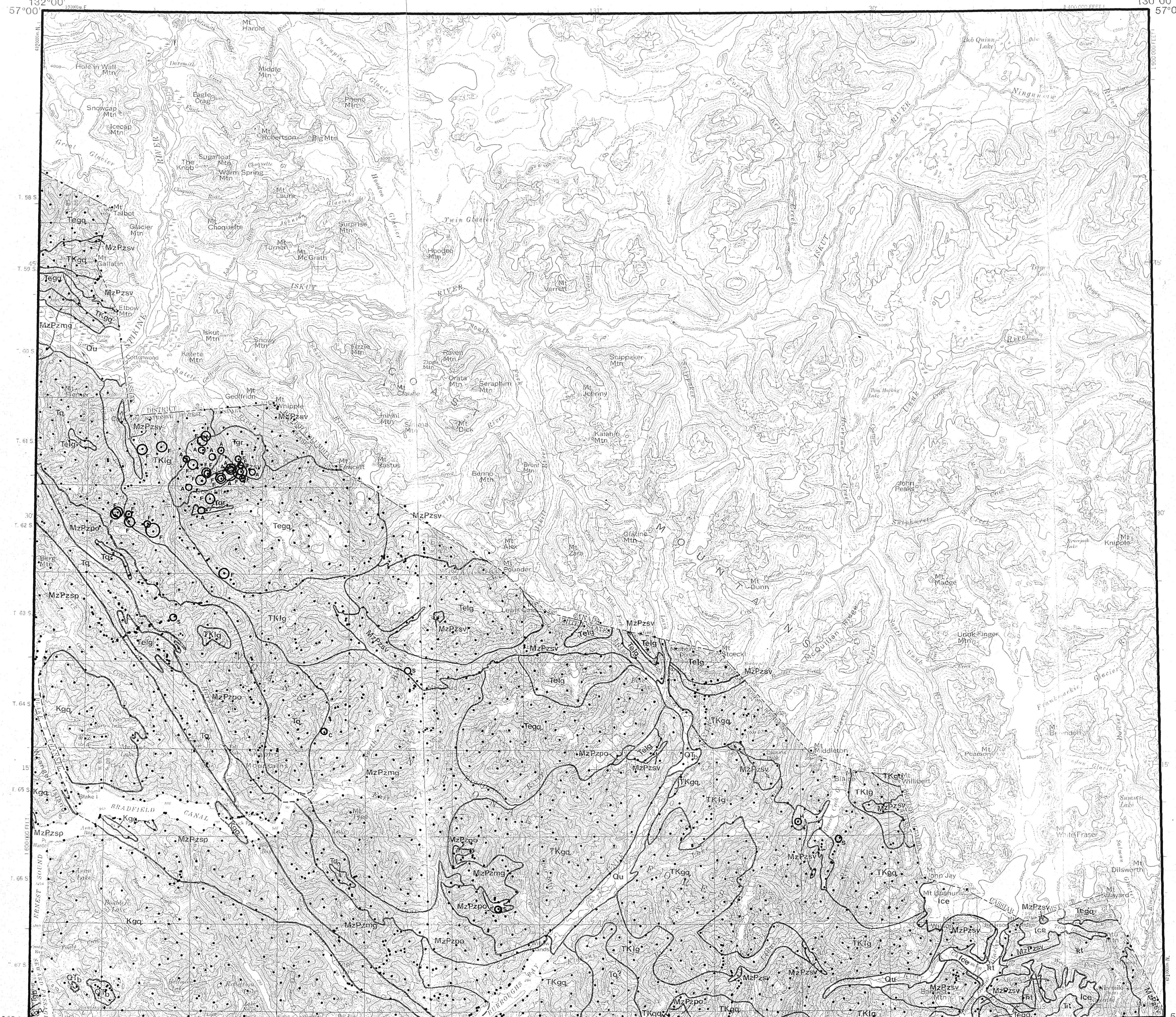
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN-FILE REPORT
81-728 K
sheet 1 of 2

FOLIO OF THE BRADFIELD CANAL QUADRANGLE, ALASKA
KOCH AND ELLIOTT--GEOCHEMISTRY-Y

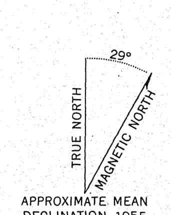
YTTRIUM IN ROCK SAMPLES
(spectrographic determinations)



Base from USGS 1:250,000 topo series: Bradfield Canal, 1955, ALASKA-CANADA.

ROCK SAMPLES

Geology by H. C. Berg, D. A. Brew, A. L. Clark, W. H. Condon, J. E. Decker, M. F. Diggles, G. C. Dunne, R. L. Elliott, J. D. Gallinatti, M. H. Herdrick, S. M. Karl, R. D. Koch, M. L. Miller-Hoare, R. P. Morrell, J. G. Smith, and R. A. Sonnevil, 1968-1979.



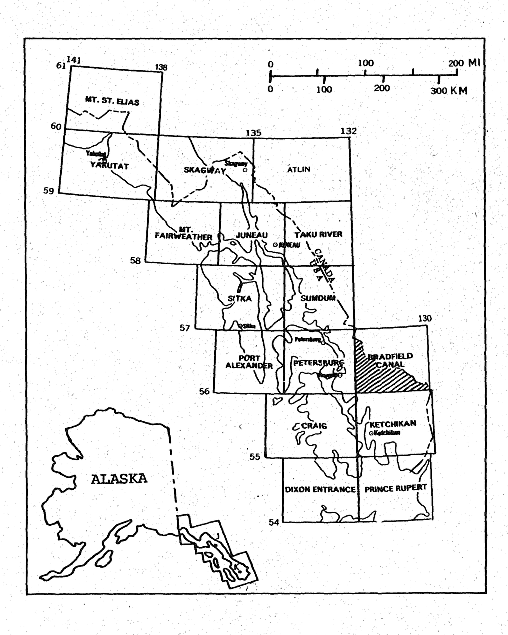
APPROXIMATE MEAN DECLINATION, 1955

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL



KEY TO LITHOLOGY GROUP SYMBOLS

A - ALKALI-FELDSPAR GRANITE - includes related dikes

B - BASALT and ANDESITE - includes dikes and flows, and lamprophyre dikes

C - CALCSILICATE and SKARN

D - DIORITE and GABBRO - includes minor metadiorite, hornblendite, and ultramafic rocks

F - FELSITE - some quartz-porphyritic. Includes dikes, flows(?), and breccias

G - GRANITIC ROCKS - mainly massive and foliated quartz monzonite, granodiorite, and quartz diorite, with lesser alaskite, aplite, and pegmatite

H - HORNBLENDE-RICH SCHIST and GNEISS - includes amphibolite, greenschist, and other mafic metamorphic rocks

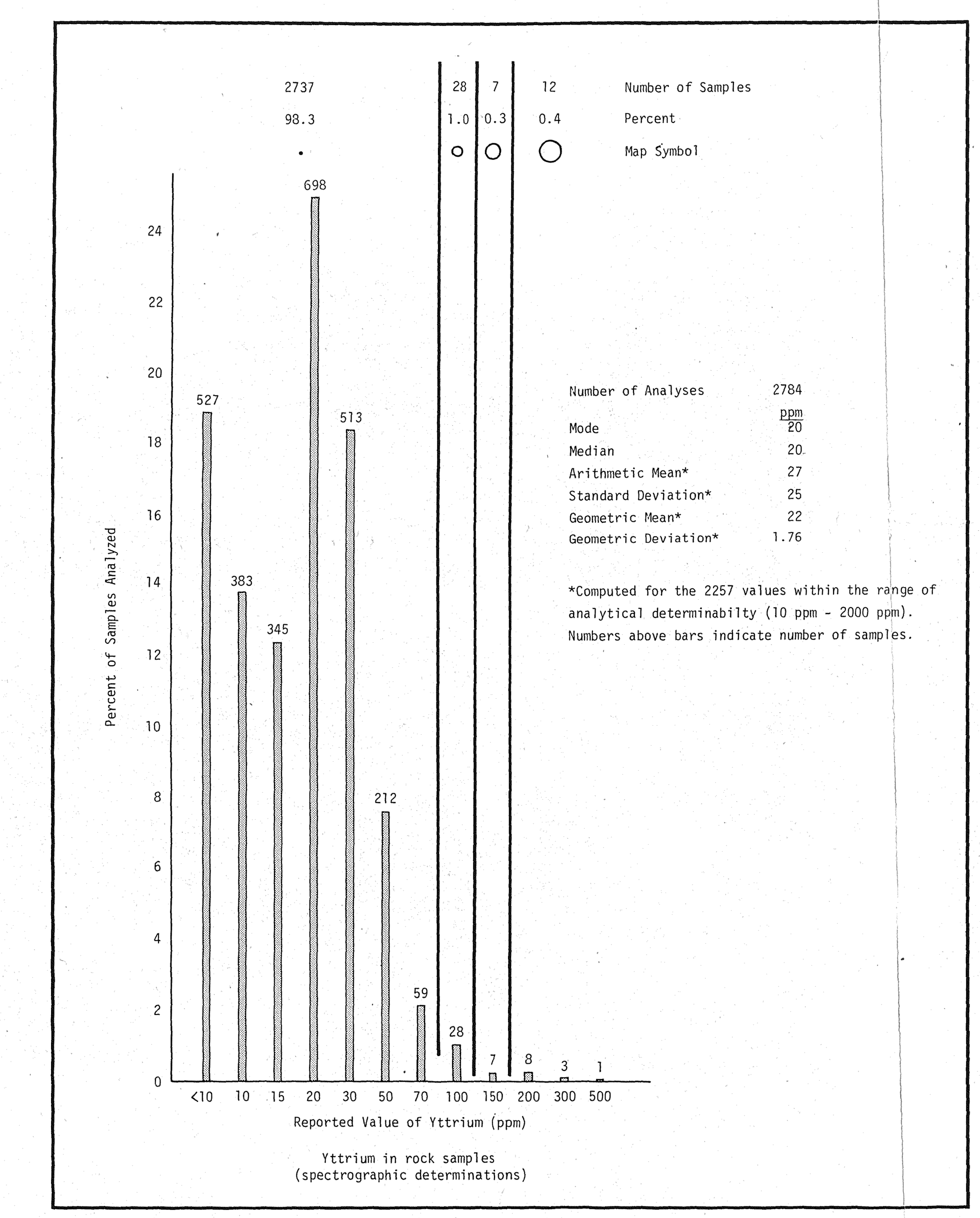
M - MIGMATITE and ORTHOGNEISS - includes granitic gneiss (eg: granodiorite gneiss, quartz diorite gneiss, etc.)

S - SCHIST and GNEISS - mainly pelitic and quartzofeldspathic schist and gneiss, and lesser non-schistose metasedimentary rocks

V - VEINS

Unit Descriptions

Qu	UNCONSOLIDATED DEPOSITS, UNDIVIDED (Quaternary)
QTb	BASALT (Quaternary and Tertiary?)
Tgr	ALKALI-FELDSPAR GRANITE WITH ASSOCIATED QUARTZ-PORPHYRITIC RHYOLITE DIKES AND FLOWS(?) (Miocene?)
Tgb	BIOTITE-PYROXENE GABBRO, LOCALLY CONTAINS HORNBLENDE AND/OR OLIVINE (Miocene)
Telg	LEUCOCRATIC QUARTZ MONZONITE AND GRANODIORITE (Eocene)
Tegq	GRANODIORITE AND QUARTZ DIORITE (Eocene)
Tq	QUARTZ DIORITE (Eocene or Paleocene)
TKlg	LEUCOCRATIC QUARTZ MONZONITE AND GRANODIORITE (Tertiary and/or Cretaceous)
TKgq	GRANODIORITE AND QUARTZ DIORITE (Tertiary and/or Cretaceous)
Kgq	BIOTITE-HORNBLENDE QUARTZ DIORITE, PLAGIOCLASE-PORPHYRITIC BIOTITE GRANODIORITE/QUARTZ DIORITE, BOTH LOCALLY CONTAIN GARNET AND/OR EPIDOTE (Cretaceous)
T̶Rt	TEXAS CREEK GRANODIORITE (Triassic)
MzPzmg	MIGMATITE AND ORTHOGNEISS, WITH LESSER PARAGNEISS (Mesozoic and/or Paleozoic)
MzPzpo	PARAGNEISS AND ORTHOGNEISS, WITH LESSER AMPHIBOLITE AND MARBLE (Mesozoic and/or Paleozoic)
MzPzsp	SCHIST AND PARAGNEISS, WITH LESSER AMPHIBOLITE AND MARBLE (Mesozoic and/or Paleozoic)
MzPzsv	METASEDIMENTARY AND LESSER METAVOLCANIC ROCKS, WITH LOCAL MARBLE (Mesozoic and/or Paleozoic)



Yttrium in rock samples
(spectrographic determinations)

Average abundance* of yttrium (in ppm) in the Earth's crust and various crustal components. (From Levinson, 1974)

	Earth's crust	Basalt	Granodiorite	Granite	Shale	Limestone
Y	30	25	30	40	25	15

*Note: Because the analyses on which these averages are based may not be directly compatible with the analyses used for this report, these figures serve only as a general guide.

Discussion

During U.S. Geological Survey investigations in the Bradfield Canal quadrangle between 1968 and 1979, 2784 rock geochemical samples, 1295 stream-sediment samples, and 219 stream-sediment heavy-mineral concentrate samples were collected. The samples were analyzed for up to 31 elements by a 6-step, semi-quantitative emission spectrographic method (Grimes and Marranzino, 1968) and for up to 5 elements by atomic-absorption techniques (Ward and others, 1969). Complete analytical data for all samples, plus location maps, station coordinates, and a discussion of sampling and analytical procedures are available in 3 reports (Koch and others, 1980a,b,c). These data are also available on magnetic computer tape (Koch, O'Leary, and Risoli, 1980).

Maps on this and the accompanying sheet show the amounts of yttrium (Y) detected in all geochemical samples collected in the Bradfield Canal quadrangle. All yttrium analyses were by the 6-step spectrographic method. The spectrographic analytical values are reported as the approximate midpoints of geometrically spaced class intervals, with values in the series 1, 1.5, 2, 3, 5, 7, 10, 15, ... (see Koch and others, 1980a,b,c, Grimes and Marranzino, 1968).

Average geochemical abundances vary for different lithologies and in different areas. The degree of chemical weathering also affects the elemental abundances, although probably with minor effect in this recently glaciated terrain. Analytical variance and variations in sampling practice limit the repeatability of these results. Complex interactions between these sources of variation make it impossible to select a single threshold value which will discriminate between areas which are barren and areas with potentially significant mineral concentrations.

In order to estimate which analytical values are sufficiently above general background levels to warrant further interest, the following procedure was followed for each sample type. Histograms of the data were examined for apparent breaks (discontinuities or abrupt changes in level) in the distribution. A cutoff value was selected at an arbitrarily chosen level near the 95th percentile or at a break close to that level when one was present. The geographic distribution of the samples above the cutoff level was examined for clumping and scatter. The cutoff level was adjusted up or down to minimize apparent geographic scatter ("noise").

Samples in which the Y content was at or above the cutoff level are marked by one of three sizes of circles. Each circle size represents a range of analytical values, with larger circles indicating higher values. Samples in which the Y content was below the cutoff level are indicated on the map by dots. The range, number, and percentage of values associated with each map symbol are indicated on the corresponding histogram. Confidence levels are low for values near analytical limits of determinability and for results not supported by high values in nearby samples.

Each rock sample was assigned to one of ten broad lithologic groups of similar rock types on the basis of the rock name given to the sample at the time that it was collected. The types of rock included in each of the groups are summarized in the table labelled "Key to Lithology Group Symbols". On the map, circles representing rock samples with Y content above the cutoff value are labelled with the letter indicating the lithology group for that sample.

Yttrium is closely associated with the lanthanides or rare-earth elements (REE), especially the "heavy" rare-earths, in chemical behavior, physical properties, and geologic occurence (Adams and Staatz, 1973). Yttrium and REE are lithophilic elements and occur most commonly in phosphates, carbonates, and silicates. The concentration of these elements in igneous rocks generally increases with increasing silica content. They are especially concentrated in certain granites, syenites, and phosphorites. Significant concentrations of Y occur in euxenite, gadolinite, monazite, xenotime, and other minerals including bannerite (a uranium mineral) and sometimes in apatite and garnet.

Forty-seven of the rock samples collected in the Bradfield Canal quadrangle have reported Y concentrations at or above the 100 ppm cutoff level. All but six of these are either felsite dikes or alkali-granite. The alkali-granite samples are from the granite body at Cone Mountain, southwest of boundary peak Mount Whipple. The felsite samples are from within that same body, and from dikes cutting country rock in the vicinity of Cone Mountain. The remaining six samples, five schists and one skarn, all have Y values of 100 ppm and are scattered across the quadrangle.

Rock Sample Yttrium Values At and Above 100 ppm

Lithology	Samples	Percent	Geometric Mean	Range
Alkali-granite	12	26	116 ppm	100 - 300 ppm
Felsite	29	62	149	100 - 500
Metamorphic rocks	4	8	100	100 - 100
Mafic schist	1	2	--	100
Skarn	1	2	--	100

Most of the stream-sediment samples with reported Y values at or above the 100 ppm cutoff level were collected in and around the alkali-granite at Cone Mountain. Nine samples scattered across the quadrangle also had Y of 100 ppm (one had 150 ppm). Six of these values were reported from sites where two samples were collected, but only one sample from each site contained a high Y value. Only one sample was collected at each of the other three sites.

Because high concentrations of Y usually occur in minerals of high specific gravity, Y values are significantly higher in the heavy-mineral concentrate samples than in the rock and normal stream-sediment samples. Sites of heavy-mineral concentrate samples with Y values at or above the 1000 ppm cutoff level are clustered near the northern edge of the alkali-granite at Cone Mountain. Two sites within unit Tegq, slightly east of the main cluster of high values are in creeks which do not directly drain the granite body. High values do not occur in the rock or normal stream-sediment data from this area.

The common association of Y with lanthanide elements suggests that the felsite dikes and alkali-granite in the Cone Mountain area may also be enriched in REE. Analyses of seven samples of the alkali-granite by a different spectrographic technique (Myers, Havens, and Dunton, 1961) show this to be true. These data are listed in the table below. Results from equivalent analyses of thirteen samples of normal Coast Range granitic rocks from the region near Cone Mountain are listed in the table for comparison. The alkali-granite at Cone Mountain contains the only significant concentration of Y, and thus presumably the only significant concentration of REE as well, detected by geochemical sampling in the Bradfield Canal, Ketchikan, and Prince Rupert quadrangles (Koch and Elliott, 1978a,b,c).

	Cone Mountain 1/			Coast Range 2/			Average Values 3/		
Element	Samples	Average	Range	Samples	Average	Range	High-Ca Granitic	Low-Ca Granitic	Syenites
La	7	82	50-110	13	30	24- 43	45	55	70
Ce	7	126	110-240	7	76	47-110	81	92	161
Nd	5	76	63- 98	0	46	---	33	37	65
Sm	1	11	11	0	22	---	8.8	10	18
Gd	4	25	21- 31	0	15	---	8.8	10	18
Er	1	14	14	0	10	---	3.5	4	7
Yb	7	11	9- 15	13	2	.9- 3.1	3.5	4	7
Y	7	70	49- 80	13	13	6.5- 17	35	40	20

1/ Seven samples of alkali-granite analyzed from the body at Cone Mountain. Analyses by semiquantiative spectrographic method (Myers, Havens, and Dunton, 1961). Only values above analytical determination limits are included in the table. Values in ppm.

2/ Thirteen samples of Coast Range granitic rocks from the region near Cone Mountain analyzed as above. Samples include quartz monzonite (2), granodiorite (7), and quartz diorite (4).

3/ From Turekian and Wedepohl (1961). Values in ppm.

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MAPS SHOWING DISTRIBUTION AND ABUNDANCE OF YTTRIUM IN GEOCHEMICAL SAMPLES FROM THE BRADFIELD CANAL QUADRANGLE, SOUTHEASTERN ALASKA

by

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