DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

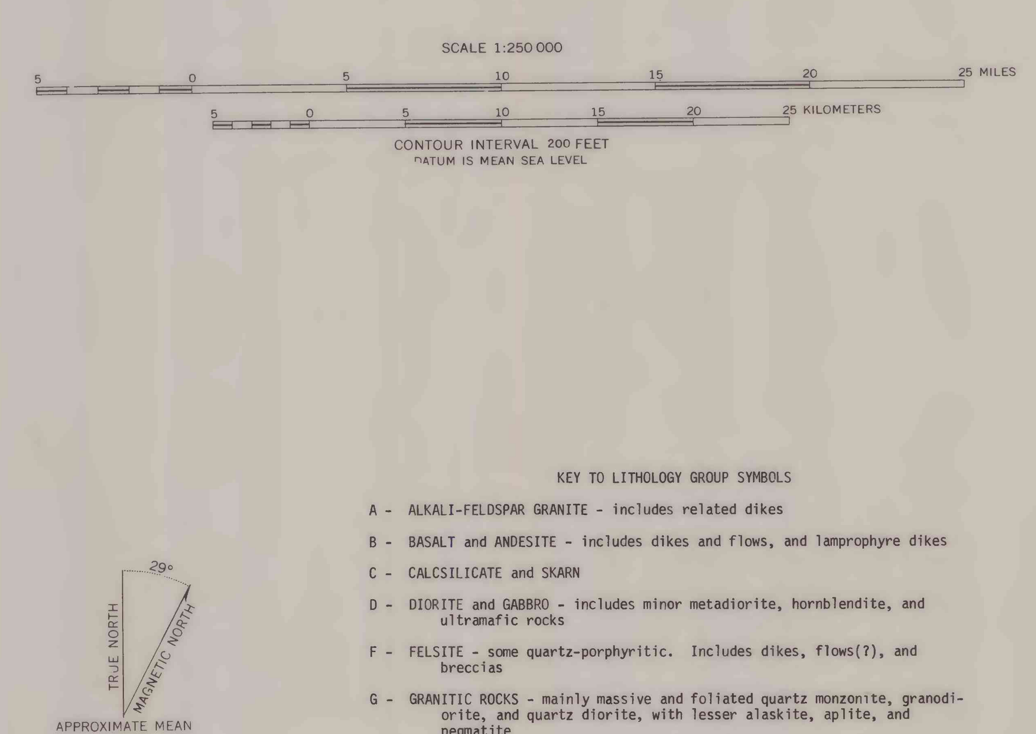
OPEN-FILE REPORT
81-728 J
sheet 1 of 2

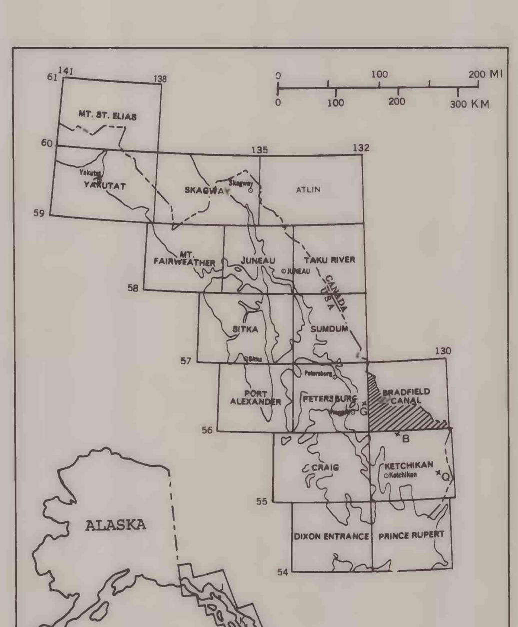
NIOBIUM IN ROCK SAMPLES
(spectrographic determinations)

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. O. 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.





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

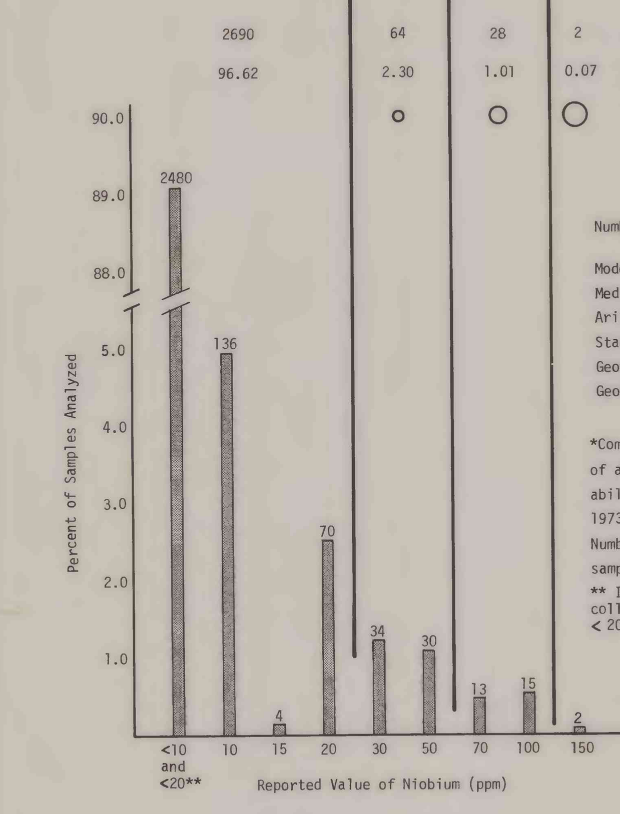
M - MIGMATITE and ORTHOGNEISS - includes granitic gneiss (eg: granodiorite gneiss, quartz diorite gneiss, etc.)

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)
Ꞓt	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)



Number of Analyses	2784
	ppm
Mode **	<10
Median **	<10
Arithmetic Mean*	26
Standard Deviation*	25
Geometric Mean*	19
Geometric Deviation*	2.1

*Computed for the 304 values within the range of analytical determinability (lower determinability limit 10 ppm until 1973, 20 ppm after 1973).

Numbers above the bars indicate the number of samples.

** Includes values reported <10 in samples collected through 1973, and values reported < 20 in samples collected after 1973.

Niobium in rock samples
(spectrographic determinations)

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

	Earth's crust	Ultramafic	Basalt	Granodiorite	Granite	Shale
Nb	20	15	20	20	20	20

*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.

Selected References

Berg, H. C., Elliott, R. L., Smith, J. G., Pittman, T. L., and Kimball, A. L., 1977, Mineral resources of the Granite Fiords wilderness study area, Alaska: U.S. Geological Survey Bulletin 1403, 151 p.

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Hudson, Travis, Smith, J. G., and Elliott, R. L., 1979, Petrology, composition, and age of intrusive rocks associated with the Quartz Hill Molybdenum Deposit, southeastern Alaska: Canadian Journal of Earth Sciences, v. 16, p. 1805-1822.

Koch, R. D., and Elliott, R. L., 1978a, Analyses of rock samples from the Ketchikan quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 78-156A, 163 p.

_____, 1978b, Analyses or rock and stream-sediment samples from the Prince Rupert quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 78-156B, 98 p.

_____, 1978c, Analyses of stream-sediment samples from the Ketchikan quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 78-156C, 214 p.

Koch, R. D., Elliott, R. L., O'Leary, R. M., and Risoli, D. A., 1980a, Trace element data for rock samples from the Bradfield Canal quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 80-910A, 256 p.

_____, 1980b, Trace element data for stream-sediment samples from the Bradfield Canal quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 80-910B, 172 p.

_____, 1980c, Trace element data for stream-sediment heavy-mineral concentrate samples from the Bradfield Canal quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 80-910C, 68 p.

Koch, R. D., O'Leary, R. M., and Risoli, D. A., 1980, Magnetic tape containing trace element data for rock, stream-sediment, and stream-sediment heavy-mineral concentrate samples from the Bradfield Canal quadrangle, southeastern Alaska: Menlo Park, California, U.S. Geological Survey Report, 23 p., computer tape. Available from the U.S. Department of Commerce, National Technical Information Service, Springfield VA 22151, as report USGS-GD-80-004 or NTIS-PB81-108641.

Levinson, A. A., 1974, Introduction to exploration geochemistry: Wilmette, Illinois, Allied Publishing Ltd., 614 p.

Motooka, J. M., and Grimes, D. J., 1976, Analytical precision of the one-sixth order semiquantitative spectrographic analysis: U.S. Geological Survey Circular 738, 25 p.

Parker, R. L. and Adams, J. W., 1973, Niobium (colombium) and tantalum, in Brobst, D. A. and Pratt, W. P., eds., United States mineral resources: U.S. Geological Survey Professional Paper 820, p. 433-454.

Smith, J. G., 1977, Geology of the Ketchikan D-1 and Bradfield Canal A-1 quadrangles, southeastern Alaska: U.S. Geological Survey Bulletin 1425, 49 p.

Ward, F. N., Nakagawa, H. M., Harms, T. F., and Van Sickle, G. H., 1969, Atomic-absorption methods of analysis useful in geochemical exploration: U.S. Geological Survey Bulletin 1289, 45 p.

FOLIO OF THE BRADFIELD CANAL QUADRANGLE, ALASKA

KOCH AND ELLIOTT--GEOCHEMISTRY-Nb

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 niobium (Nb) detected in all geochemical samples collected in the Bradfield Canal quadrangle. All niobium 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 Nb 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 Nb 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 rocks 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 Nb content above the cutoff value are labelled with the letter indicating the lithology group for that sample.

Niobium normally occurs in rocks in only trace amounts. Most of it is in iron- and iron-titanium-bearing minerals, some is in zirconium minerals, and small amounts occur in rare, discrete niobium minerals. The Nb concentration in an "average crustal rock" is about 20 ppm (Levinson, 1974). It is concentrated in alkalic rocks and late-stage differentiates of granitic magmas (Parker and Adams, 1973).

There are no known concentrations of niobium in the Bradfield Canal quadrangle which have potential economic value because of their Nb content. Small, mid-Tertiary, felsic stocks occur in a number of places in and near the Coast Plutonic Complex in the vicinity of the Bradfield Canal quadrangle. Several of these stocks, and many quartz-porphyritic felsite dikes associated with them, have unusually high concentrations of a number of metallic elements, notably molybdenum. Two of these stocks (located at points "B" and "Q" on the index map) are low-grade stockwork molybdenite deposits (Hudson, Smith, and Elliott, 1979). Niobium in these felsic rocks is concentrated to levels noticeably above the levels in normal granitic rocks of the Coast Range. It is concentrated throughout these rocks, not just in the mineralized portions. High levels of Nb usually show up in more samples than do high values of potentially economic commodities. Thus Nb may provide a better indicator for locating lithologies which are favorable potential hosts to valuable mineral deposits.

In the Bradfield Canal quadrangle, about 85 percent of the rock samples with Nb values at or above the 30 ppm cutoff level are from two lithologies: alkali-granite and felsite dikes. All of the alkali-granite samples are from the stock at Cone Mountain, southwest of boundary peak Mount Whipple. Almost all of the felsite dike samples are from within and near this body. The few remaining Nb values at and above the cutoff level occur as isolated, single-sample spots scattered across the quadrangle.

Rock Sample Niobium Values At and Above 30 ppm

Lithology	Samples	Percent	Geometric Mean	Range
Alkali-granite.	37	39	44 ppm	30 - 100 ppm
Felsite	43	46	61	30 - 150
Granitic rocks	4	4	42	30 - 70
Metamorphic rocks	6	6	33	30 - 50
Skarn	1	1	--	100
Other	3	3	36	30 - 50

The majority of normal stream-sediment samples collected in and near the alkali-granite at Cone Mountain contain Nb concentrations at or above the 30 ppm cutoff level. Only seven samples from elsewhere in the quadrangle have as much as 30 ppm Nb, and none have more Nb than that.

Stream-sediment heavy-mineral concentrate sample data show a significant cluster near Cone Mountain, of values equal to or greater than the 300 ppm cutoff level. These represent almost all of the samples taken from the immediate area of the alkali-granite stock. Of the other five values at and above the cutoff level, three represent the three samples collected in streams draining the leucocratic potassium-feldspar-porphyritic quartz monzonite at Mount Stoeckl. High Nb levels for this body are not indicated by the data from rock and normal stream-sediment samples.

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

by

R.D.KOCH AND R.L.ELLIOTT

1981