# Geochemical Survey of the Baird Mountains 1°X3° Quadrangle, Northwest Alaska

U.S. GEOLOGICAL SURVEY BULLETIN 2003

**Cover:** View northwest of the Baird Mountains along the Squirrel River, Alaska.

# Geochemical Survey of the Baird Mountains 1°X3° Quadrangle, Northwest Alaska

By PETER F. FOLGER, RICHARD J. GOLDFARB, and BARRETT A. CIEUTAT

Results of a reconnaissance
geochemical survey in northwest Alaska

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# CONTENTS



## PLATE

[Plate is in pocket]

FIGURES



TABLES



## CONVERSION FACTORS

For readers who wish to convert measurements from U.S. customary units to the metric system of units, the conversion factors are listed below.

| U.S. customary unit | Multiply by | To obtain metric unit |
|---|---|---|
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| square mile ($mi^2$) | 2.59 | square kilometer ($km^2$) |
| ounce (oz) | 28.35 | gram (g) |

# Geochemical Survey of the Baird Mountains 1°×3° Quadrangle, Northwest Alaska

*By* Peter F. Folger, Richard J. Goldfarb, *and* Barrett A. Cieutat

## Abstract

A reconnaissance stream-sediment geochemical survey was conducted in the Baird Mountains 1°×3° quadrangle in northwestern Alaska. The quadrangle is largely underlain by complexly deformed Paleozoic marine carbonate, pelitic, and clastic rocks. Subordinate amounts of Precambrian metamorphic and igneous rocks crop out in the northeastern part of the quadrangle, and minor Mesozoic marine sedimentary and mafic volcanic rocks occur in the northwestern part of the quadrangle. Sediment-hosted base-metal sulfide mineral occurrences and local placer-gold accumulations are known within the Baird Mountains quadrangle.

A total of 1,493 stream-sediment samples and 1,185 nonmagnetic heavy-mineral-concentrate samples were analyzed for 33 elements by semiquantitative emission spectrography. The spatial distribution of the data was examined using both individual-element concentrate plots and R-mode factor-analysis score plots. Geochemical data were also interpreted for 913 sediment samples and 916 water samples collected during the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) survey of the quadrangle. These samples were analyzed by neutron-activation analysis and X-ray fluorescence. Geochemical anomalies from the various data sets define 17 anomalous areas characterized by metal associations that suggest the presence of metallic-mineral occurrences.

Sediment and (or) concentrate samples that are anomalous in base metals and silver were collected within many areas of the quadrangle. Detailed follow-up investigations would be needed to distinguish the areas that might contain large metalliferous accumulations from those that have widespread disseminations of the metals. Many drainages underlain by Paleozoic carbonate and clastic rocks within the Aklumayuak Creek watershed, in the northeastern corner of the quadrangle, yielded concentrate samples with anomalous silver and lead values. NURE sediment samples from the same area are anomalous in lead, antimony, and zinc. To the southeast of Aklumayuak Creek, sediment samples throughout the Nanielik Creek watershed, derived from both Precambrian and Paleozoic sedimentary rocks and greenstone, are enriched in cobalt, copper, iron, molybdenum, nickel, lead, and zinc.

Tributaries to the Tutuksuk River, Anaktok Creek, Sheep Creek, Kanaktok Creek, and the Salmon River within the eastern part of the quadrangle, underlain mainly by Paleozoic schist and lesser amounts of carbonate rocks, yielded sediment samples that commonly contain anomalous amounts of cobalt, copper, iron, nickel, and zinc, and corresponding concentrate samples that are commonly anomalous in silver and lead. These metal suites suggest the presence of mineralized rock that may include metal-bearing quartz veins, base-metal-rich pods, and(or) rock containing disseminated metals.

In the central part of the quadrangle, base-metal anomalies in samples occur throughout the watersheds of Nakolikurok Creek, the Nakolik River, and the headwaters of the Omar River. Concentrate samples from the former two areas, which are underlain by Paleozoic clastic and carbonate rocks, commonly contain anomalous amounts of silver, barium, cobalt, copper, iron, nickel, lead, and zinc. Concentrate samples from the headwaters of the Omar River contain the same suite of metals. This area includes the Omar, Powdermilk, and Frost base-metal and silver occurrences.

Anomalous amounts of copper, lead, and zinc in sediment samples and silver, barium, cobalt, copper, iron, nickel, lead, and zinc in concentrate samples occur in tributaries to the Agashashok and Eli Rivers within the western part of the quadrangle. A silver-lead-zinc association seems to be most common in samples from drainages underlain by clastic rocks, whereas samples anomalous in the other elements were most commonly found in watersheds dominated by carbonate and mafic volcanic rocks. Sediment samples derived from sedimentary rocks of the Maiyumerak Mountains, mainly along Kivivik and Ahaliknak Creeks, contain anomalous concentrations of silver, copper, molybdenum, and zinc. A few concentrate samples derived from phyllite and sandstone in the

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headwaters of Porgo and Okiotok Creeks are strongly enriched in barium, lead, and zinc.

Concentrate samples from the Kallarichuk Hills in the southern part of the quadrangle are commonly anomalous in tungsten and tin and less commonly anomalous in silver and gold. The high tin values may reflect volumetrically minor outcrops of felsic igneous rocks within the schists. The anomalous silver, gold, and tungsten values were probably derived from weathering of widespread quartz veins. The few anomalous gold-bearing samples are from only upper Timber and Klery Creeks, both past producers of placer gold. The distribution of samples with anomalous tungsten may define the extent of potential gold-bearing quartz veins.

## INTRODUCTION

A stream-sediment geochemical reconnaissance survey was conducted in the Baird Mountains 1°×3° quadrangle, northwest Alaska, in 1983–85. The survey was part of the Level III Alaska Mineral Resources Assessment Program (AMRAP) studies conducted using maps at 1:250,000 scale. Composite stream-sediment and heavy-mineral-concentrate samples were collected during this survey; the data are listed in Bailey and others (1987) and are evaluated in detail in this report. Stream-sediment data collected by the Los Alamos National Laboratory for the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) program (Aamodt and others, 1978; Zinkl and others, 1981) have also been evaluated. Stream-sediment grab samples (single, uncomposited samples) collected by the U.S. Geological Survey between 1976 and 1981 in parts of the Baird Mountains quadrangle (Inyo Ellersieck, U.S. Geological Survey, unpub. data, 1976–81) are also discussed in this report.

The Baird Mountains quadrangle, in the western Brooks Range, is characterized by gently rolling tundra lowlands rising to rubble-covered rugged peaks. Treeline is at about 300 m elevation. Mt. Angayukaqsraq is the highest peak within the quadrangle, at 1,451 m. The Baird Mountains quadrangle is accessible only by aircraft or foot; no permanent roads or settlements exist in the quadrangle.


## Acknowledgments

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## GEOLOGY

The Baird Mountains quadrangle is underlain mainly by metamorphosed Paleozoic marine carbonate, pelitic, and clastic rocks (Karl and others, 1985, 1989; pl. 1). Most of the eastern, southeastern, and southern parts of the quadrangle are underlain by pelitic rocks of Proterozoic or Paleozoic age. Minor amounts of Cretaceous and (or) Tertiary conglomerate occur in the southeastern corner of the quadrangle. Paleozoic marine carbonate rocks, including undivided rocks of the Baird Group, underlie the central and central-western parts of the quadrangle. These carbonate rocks, which include Ordovician, Silurian, and Devonian dolostones, metalimestones, and marbles, host significant base-metal mineral occurrences.

In the northeastern part of the quadrangle, near Mt. Angayukaqsraq, relict amphibolite-grade Precambrian schist and minor metaplutonic rocks of intermediate composition are in structural contact with greenschist-blueschist-grade Paleozoic rocks (Folger and others, 1987). Devonian and Mississippian metasandstone and phyllite of the Endicott Group underlie much of the north-central and northwestern parts of the Baird Mountains (Mull, 1982). This unit includes the Hunt Fork Shale, Noatak Sandstone, Kanayut Conglomerate, Kekiktut Conglomerate, and Kayak Shale. Minor Mississippian carbonate rocks (including the Kogruk Formation), shale (including the metalliferous Kuna Formation), and chert, and Mesozoic marine volcanic rocks, sills, and dikes crop out in the northwestern part of the Baird Mountains.

The Baird Mountains quadrangle lies within the Brooks Range fold and thrust belt, an area of complexly folded and faulted Late Proterozoic and Paleozoic to Mesozoic metasedimentary and metaigneous rocks. The central and western Brooks Range underwent extensive thrust faulting and an estimated crustal shortening of hundreds of kilometers (Tailleur and Snelson, 1969; Mull, 1982). Sedimentological evidence from foreland flysch deposits suggests that deformation and thrusting occurred in Middle Jurassic to Cretaceous time (Mull, 1982). High-pressure and low-temperature metamorphism (glaucophane schist facies in mafic and pelitic rocks) accompanied deformation during this late Mesozoic Brookian orogeny. Conodont alteration indices from several hundred samples of limestone and dolostone throughout the quadrangle (Dumoulin and Harris, 1987) indicate that most carbonate rocks were metamorphosed at temperatures of at least 250–300 °C.

Geologic mapping in the western Brooks Range since 1950 has identified many thrust faults and complex folding between rock units. Mayfield and others (1983) divided the region into structural units or allochthons based on structural and stratigraphic similarities between sequences of rock types. More recent mapping (Karl and others, 1989) confirmed many thrust faults, but stratigraphic correlations and relative age sequences between thrust plates are still unclear.

## KNOWN MINERAL RESOURCES

Mineral occurrences within the Baird Mountains quadrangle have been compiled by Cobb (1972, 1975) and Schmidt and Allegro (1988). The most significant occurrences are sedimentary rock-hosted base-metal sulfide deposits that are partly coeval with continental-margin sedimentation. These occurrences have features similar to other syngenetic mineral deposits throughout northern Alaska (Einaudi and Hitzman, 1986). In addition to the base-metal deposits, placer-gold deposits occur within the Klery Creek area.

Copper-rich mineral occurrences were discovered by the Bear Creek Mining Co. in the early 1960's in Paleozoic carbonate rocks at the Omar prospect along a tributary of the Omar River (pl. 1). Occurrences at the Omar prospect consist of minor disseminated pyrite, replacement chalcopyrite, and later crosscutting chalcopyrite, bornite, and tetrahedrite-tennantite veins in brecciated dolostone (Folger and Schmidt, 1986). The characteristics of the Omar prospect are similar to those of the Ruby Creek copper deposit, 150 km (kilometers) east-southeast in the Ambler River quadrangle (Hitzman, 1986). Folger (1988) suggested that silver, arsenic, cobalt, copper, lead, zinc, and to a lesser extent manganese, compose the most consistent pathfinder-element suite for mineralized rock at Omar. Drilling, detailed mapping, and sampling at the Omar prospect were conducted through the early 1970's by Bear Creek Mining Co. There has been no production from the prospect.

Base-metal mineral occurences at the Frost prospect, about 10 km east of the Omar prospect, are hosted in Paleozoic carbonate and mixed phyllitic rocks. They consist of a lens of massive barite with local pods and stringers of galena, sphalerite, pyrite, and fluorite (Degenhart and others, 1978). Ore samples from the Frost prospect are enriched in silver, arsenic, barium, cadmium, copper, lead, antimony, strontium, and(or) zinc (Schmidt and Allegro, 1988). Folger and others (1985) presented evidence for both mechanical and chemical transport of base metals downstream from the Frost prospect.

Stratabound disseminated sphalerite and galena and local barite occur within Ordovician dolostone approximately 15 km south of the Frost prospect at the Powdermilk prospect (Schmidt and Folger, 1986). Soil and rock samples collected at the prospect are anomalous in silver, cadmium, lead, zinc, and less commonly in barium.

In the northwestern part of the quadrangle, anomalous silver, copper, lead, and zinc concentrations in stream-sediment grab samples were identified by Ellersieck and others (1984) in the Kivivik Creek and Eli River drainage basins. They noted disseminated pyrite in a black shale outcrop, but no outcrops containing base-metal sulfide minerals were discovered in the basins. The metals may have been derived from Mississippian black shale units underlying the catchment basins. Very fine grained to massive pyrite was later discovered within carbonaceous phyllite in the streambed of a tributary to the Eli River (Karl and others, 1985). Mineralized rock samples from this locality, referred to as the Ahua occurrence, are anomalous in silver, arsenic, barium, copper, lead, and zinc. In addition, Karl and others (1985) reported anomalous silver, arsenic, cadmium, manganese, lead, and zinc in samples of sulfide-bearing vein quartz cutting phyllite and limestone near the headwaters of the Agashashok River.

Gold was discovered at Klery Creek in the southern part of the quadrangle in 1909 (Smith, 1913) and has been recovered from small placer operations within the Klery Creek-Timber Creek area up to the present. The bedrock underlying Klery Creek consists of pelitic schist and carbonate rocks. Some nuggets were reported to have attached quartz (Cobb, 1975), suggesting that gold-bearing quartz veins may exist upstream. Private company reports confirm the presence of gold-bearing veins along the eastern bank of Klery Creek (Anaconda Geological Document Collection, American Heritage Center—University of Wyoming, unpub. data). Gold production from the Klery Creek-Timber Creek placers, through 1931, was estimated at 31,300 ounces (Cobb and others, 1981); little production has occurred more recently.

## GEOCHEMICAL METHODS

This report is based primarily on the interpretation of the analyses of 1,493 stream-sediment and 1,185 heavy-mineral-concentrate samples collected between 1983 and 1985. The analytical results for these samples were presented in Bailey and others (1987). Data from earlier work, including 913 stream-sediment and 916 water samples from the NURE program (Zinkl and others, 1981), and 906 stream-sediment grab samples (Inyo Ellersieck, unpub. data, 1976–81) were also evaluated to aid with the geochemical interpretation. The NURE samples were collected at sites uniformly distributed throughout the quadrangle, whereas Ellersieck's sample sites are clustered in certain areas (described in the section on "Other Geochemical Data."

## U.S. Geological Survey AMRAP Studies

Stream-sediment samples collected during this survey from first- or second-order drainages averaged one sample per 5 $km^2$ (square kilometers) in most areas. However, sample densities ranged from one sample per 100 $km^2$ in swampy and poorly drained areas to one sample per 3 $km^2$ in highly dissected terrain. Stream-sediment samples are a composite of at least five grab samples collected along a 10-m section of active stream channel using an aluminum scoop or shovel. Each sample was air dried, sieved to minus 35-mesh, and pulverized prior to analysis.

Heavy-mineral-concentrate samples were collected at most stream-sediment sites using a 35-cm (centimeter) diameter gold pan. A 3–4 kg (kilogram) sample was collected in the field and panned to 30–60 g (grams) of concentrated sample. The samples were air dried, and the highly magnetic material was removed with an electromagnet. Samples were passed through bromoform (specific gravity 2.86), and the heavy material was separated into magnetic, weakly magnetic, and nonmagnetic fractions using a Frantz isodynamic separator at a current of 0.6 ampere and slope settings of 15° forward and 15° side. In more than 300 samples, particularly those collected from creeks draining carbonate-dominated catchment basins, the remaining nonmagnetic heavy-mineral fraction was of insufficient size for analysis.

All 1,493 stream-sediment samples and the nonmagnetic fractions of the 1,185 heavy-mineral-concentrate samples were analyzed semiquantitatively for 31 elements using a DC-arc optical emission spectrograph, according to the methods outlined by Grimes and Marranzino (1968). A split of most nonmagnetic concentrate samples was saved and was later examined by microscope to identify specific mineral phases (Gregory Bennett, U.S. Geological Survey, unpub. data, 1985).

## U.S. Department of Energy NURE Studies

Most of the interpretation in this report is based on data collected during the AMRAP program; however, previous work is also included where it supplements or contributes different information from the AMRAP data. Results from the U.S. Department of Energy's Hydrogeochemical and Stream Sediment Reconnaissance part of the NURE program (Zinkl and others, 1981) are statistically evaluated. In that survey, 913 stream-sediment samples from the Baird Mountains quadrangle were analyzed by delayed neutron counting for uranium; by energy-dispersive X-ray fluorescence for Ag, Bi, Cd, Cu, Nb, Ni, Pb, Sn, and W; by arc-source emission spectrography for beryllium and lithium; and by instrumental neutron activation analysis for Al, Au, Ba, Ca, Ce, Cl, Co, Cr, Cs, Dy, Eu, Fe, Hf, K, La, Lu, Mg, Na, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, Ti, V, Yb, and Zn. A total of 916 stream-water samples, commonly collected at the same sites as the sediments, were analyzed for uranium by delayed neutron counting.

## Other Geochemical Data

Inyo Ellersieck (U.S. Geological Survey, unpub. data, 1976–81) collected 906 grab sediment samples in the Baird Mountains quadrangle between 1974 and 1981. Most of these samples were collected from small areas near the Omar River and the northwestern part of the quadrangle. The samples were analyzed by semiquantitative emission spectrography, as well as by atomic absorption for selected elements. Anomalies identified in these samples from the northwestern part of the quadrangle are discussed in Ellersieck and others (1984) and in Karl and others (1985). They are also described below in the detailed descriptions of areas 14 and 16.

# STATISTICAL METHODS

## Statistical Summary of the AMRAP data

Univariate statistics were computed for the 1,493 stream-sediment samples and 1,185 heavy-mineral-concentrate samples from the AMRAP survey (tables 1, 2). Detection ratios, the number of unqualified results divided by the total number of analytical results, were also computed (tables 1, 2). Univariate statistics were not computed for highly censored elements (detection ratios less than 0.15). Cohen's (1959) maximum-likelihood method was used to approximate the geometric mean and geometric deviation for censored data for elements having detection ratios greater than 0.15. Minimum, median, 85th-percentile, 90th-percentile, 95th-percentile, and maximum values were computed to present the range in the geochemical data (tables 1, 2).

Trace- and minor-element frequency distributions are typically positively skewed (figs. 1, 2), and therefore both stream-sediment and heavy-mineral-concentrate data sets were logarithmically transformed prior to statistical analysis. The expected range for 95 percent of all values in the lognormal distribution (Miesch, 1976) are shown for each element (tables 1, 2).

Anomalous element values are those that deviate from the norm or exceed some geochemical background value. Commonly for geochemical data, the 95th percentile for a

**Table 1.** Univariate statistical estimates for elements in 1,493 stream-sediment samples, Baird Mountains quadrangle, Alaska

[All values in parts per million, except minimum, median, percentiles, maximum, geometric mean, geometric deviation, and expected range for Fe, Mg, Ca, and Ti, which are in percent. All elements were determined by semiquantitative emission spectrography. Samples were also analyzed for As, Au, Sb, W, and Th; all data were below the lower determination limit. Detection ratio is the number of uncensored concentrations divided by the total number of samples analyzed for a given element. N is the number of samples in which concentrations could not be detected at the lower determination limit. L is the number of samples in which concentrations were reported as observable but were less than the lower determination limit. G is the number of samples in which concentrations were reported as observable but were greater than the upper determination limit. Geometric mean and geometric deviation were calculated using Cohen's maximum-likelihood method for censored distributions. Expected range is the distribution of 95 percent of all data expected for lognormal data. Leaders (--), not determined]

| Element | Detection ratio | N | L | G | Minimum | Median | 85th percentile | 90th percentile | 95th percentile | Maximum | Geometric mean | Geometric deviation | Expected range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fe...... | 1.0 | 0 | 0 | 0 | 0.05 | 3.0 | 5 | 7 | 7 | 15 | 2.8 | 2.3 | 0.53-15 |
| Mg...... | .99 | 0 | 0 | 4 | .1 | 1.5 | 3 | 5 | 7 | 10G | 1.6 | 2.2 | .33-7.7 |
| Ca...... | .98 | 0 | 34 | 0 | .05L | .50 | 10 | 10 | 15 | 20 | .74 | 7.8 | .01-45 |
| Ti...... | .99 | 0 | 1 | 19 | .005L | .30 | .7 | .7 | 1 | 1.0G | .35 | 2.4 | .06-2.0 |
| Mn...... | .99 | 0 | 1 | 1 | 5L | 500 | 1,000 | 1,500 | 1,500 | 5,000G | 575 | 2.3 | 108-3,048 |
| Ag...... | .06 | 1,215 | 187 | 0 | .5N | .5N | .5L | .5L | .5 | 7.0 | .67 | 1.8 | .21-5.8 |
| B....... | .96 | 29 | 37 | 0 | 10N | 70 | 200 | 200 | 200 | 300 | 85 | 2.2 | 18-408 |
| Ba...... | .97 | 13 | 36 | 0 | 20N | 500 | 1,000 | 1,500 | 1,500 | 5,000 | 455 | 2.8 | 58-3,549 |
| Be...... | .71 | 156 | 277 | 0 | 1.0N | 1.0L | 2 | 2 | 3 | 5.0 | 1.2 | 1.6 | .46-3.1 |
| Bi...... | .01 | 1,483 | 9 | 0 | 10N | 10N | 10N | 10N | 10N | 10 | -- | -- | -- |
| Cd...... | .01 | 1,471 | 15 | 0 | 20N | 20N | 20N | 20N | 20N | 70 | -- | -- | -- |
| Co...... | .95 | 50 | 20 | 0 | 5.0N | 15 | 30 | 50 | 50 | 150 | 19 | 1.9 | 5.3-58 |
| Cr...... | .98 | 2 | 20 | 1 | 10N | 70 | 150 | 150 | 200 | 5,000G | 76 | 2.1 | 17-334 |
| Cu...... | .99 | 0 | 19 | 0 | 5.0L | 20 | 50 | 50 | 70 | 700 | 22 | 2.1 | 5-97 |
| La...... | .72 | 399 | 15 | 0 | 20N | 30 | 100 | 100 | 150 | 500 | 37 | 2.5 | 3.5-231 |
| Mo...... | .09 | 1,207 | 148 | 0 | 5.0N | 5.0N | 5L | 5L | 5 | 20 | 7.0 | 1.5 | 3.1-23 |
| Nb...... | .06 | 1,019 | 385 | 0 | 20N | 20N | 20L | 20L | 20 | 100 | 26 | 1.5 | 8-85 |
| Ni...... | .99 | 4 | 14 | 0 | 5.0N | 50 | 70 | 100 | 100 | 300 | 42 | 2.0 | 11-168 |
| Pb...... | .97 | 5 | 39 | 0 | 10N | 20 | 50 | 50 | 50 | 500 | 23 | 1.8 | 7.2-50 |
| Sc...... | .95 | 17 | 56 | 0 | 1.0N | 15 | 20 | 20 | 30 | 50 | 12 | 2.1 | 2.7-50 |
| Sn...... | .01 | 1,488 | 2 | 0 | 10N | 10N | 10N | 10N | 10N | 100 | -- | -- | -- |
| Sr...... | .51 | 386 | 352 | 0 | 100N | 100L | 200 | 300 | 500 | 3,000 | 93 | 2.6 | 14-632 |
| V....... | .99 | 3 | 5 | 0 | 10N | 100 | 200 | 200 | 200 | 500 | 98 | 2.1 | 22-431 |
| Y....... | .96 | 13 | 49 | 0 | 10N | 30 | 50 | 70 | 70 | 200 | 32 | 1.9 | 8.9-115 |
| Zn...... | .06 | 1,194 | 212 | 0 | 200N | 200N | 200L | 200L | 200 | 1,000 | 256 | 1.5 | 111-576 |
| Zr...... | .99 | 3 | 18 | 1 | 10N | 100 | 200 | 200 | 300 | 1,000G | 117 | 2.2 | 24-562 |

**Table 2.** Univariate statistical estimates for elements in 1,185 nonmagnetic heavy-mineral-concentrate samples, Baird Mountains quadrangle, Alaska

[All values in parts per million, except minimum, median, percentiles, maximum, geometric mean, geometric deviation, and expected range for Fe, Mg, Ca, and Ti, which are in percent. All elements were determined by semiquantitative emission spectrography. Detection ratio is the number of uncensored concentrations divided by the total number of samples analyzed for a given element. N is the number of samples in which concentrations could not be detected at the lower determination limit. L is the number of samples in which concentrations were reported as observable but were less than the lower determination limit. G is the number of samples in which concentrations were reported as observable but were greater than the upper determination limit. Geometric mean and geometric deviation were calculated using Cohen's maximum-likelihood method for censored distributions. Expected range is the distribution of 95 percent of all data expected for lognormal data. Leaders (--), not determined; >, greater than]

| Element | Detection ratio | N | L | G | Minimum | Median | 85th percentile | 90th percentile | 95th percentile | Maximum | Geometric mean | Geometric deviation | Expected range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fe....... | 0.99 | 0 | 4 | 0 | 0.1L | 0.7 | 3 | 5 | 7 | 30 | 1.0 | 2.9 | 0.2-8.4 |
| Mg....... | .99 | 0 | 15 | 1 | .05L | .5 | 7 | 10 | 15 | 20G | .73 | 6.1 | .02-27 |
| Ca....... | 1.0 | 0 | 0 | 0 | .1 | 7.0 | 20 | 20 | 20 | 50 | 6.7 | 2.6 | 1.0-45 |
| Ti....... | .49 | 0 | 0 | 599 | .015 | 2.0 | 2G | 2G | 2G | 2G | 2.3 | 3.2 | .23-23.5 |
| Mn....... | .99 | 0 | 1 | 0 | 20L | 150 | 500 | 500 | 1,000 | 5,000 | 218 | 2.1 | 50-961 |
| Ag....... | .16 | 794 | 207 | 0 | 1.0N | 1.0N | 1 | 1.5 | 5 | 5,000 | 3.0 | 3.1 | .3-29 |
| As....... | .01 | 1,168 | 10 | 0 | 500N | 500N | 500N | 500N | 500N | 3,000 | -- | -- | -- |
| Au....... | .01 | 1,176 | 2 | 1 | 20N | 20N | 20N | 20N | 20N | 1,000G | -- | -- | -- |
| B........ | .94 | 5 | 62 | 0 | 20N | 100 | 200 | 300 | 500 | 3,000 | 92 | 2.8 | 12-721 |
| Ba....... | .71 | 1 | 28 | 320 | 50N | 5,000 | 10,000G | 10,000G | 10,000G | 10,000G | 3,450 | 8.1 | 53-556,320 |
| Be....... | .18 | 506 | 463 | 0 | 20N | 2.0L | 2 | 2 | 3 | 500 | .47 | 4.4 | .02-9.1 |
| Bi....... | .02 | 1,090 | 73 | 0 | 20N | 20N | 20N | 20N | 20L | 1,000 | -- | -- | -- |
| Cd....... | .11 | 937 | 118 | 4 | 50N | 50N | 50L | 50 | 100 | 1,000G | 107 | 2.5 | 17.1-669 |
| Co....... | .65 | 268 | 151 | 0 | 10N | 15 | 70 | 70 | 100 | 500 | 16 | 3.4 | 1.4-185 |
| Cr....... | .93 | 13 | 68 | 0 | 20N | 70 | 200 | 300 | 500 | 2,000 | 90 | 2.8 | 11.5-706 |
| Cu....... | .72 | 45 | 283 | 0 | 10N | 15 | 100 | 150 | 300 | 7,000 | 19 | 4.9 | .79-456 |
| La....... | .64 | 404 | 15 | 13 | 50N | 70 | 500 | 700 | 1,000 | 2,000G | 88 | 4.3 | 4.8-1,628 |
| Mo....... | .05 | 978 | 143 | 0 | 10N | 10N | 10L | 10L | 10 | 500 | -- | -- | -- |
| Nb....... | .53 | 310 | 243 | 0 | 50N | 50L | 100 | 150 | 150 | 700 | 51 | 2.1 | 11.6-224 |
| Ni....... | .58 | 439 | 57 | 0 | 10N | 15 | 100 | 100 | 150 | 1,000 | 15 | 4.8 | .65-345 |
| Pb....... | .84 | 68 | 122 | 2 | 20N | 50 | 700 | 1,000 | 3,000 | 50,000G | 83 | 6.9 | 1.7-3,984 |
| Sb....... | .01 | 1,175 | 4 | 0 | 200N | 200N | 200N | 200N | 200N | 2,000 | -- | -- | -- |
| Sc....... | .75 | 128 | 165 | 0 | 10N | 10 | 30 | 30 | 50 | 100 | 14 | 1.9 | 3.9-50 |
| Sn....... | .23 | 677 | 232 | 0 | 20N | 20N | 20 | 30 | 50 | 1,500 | 6.4 | 4.3 | .35-118 |
| Sr....... | .84 | 830 | 93 | 8 | 200N | 500 | 2,000 | 2,000 | 5,000 | 10,000G | 624 | 3.0 | 208-5,616 |
| V........ | .98 | 0 | 23 | 0 | 20L | 100 | 200 | 200 | 300 | 5,000 | 97 | 2.2 | 20-466 |
| W........ | .05 | 1,095 | 27 | 0 | 100N | 100N | 100N | 100N | 100 | 10,000 | -- | -- | -- |
| Y........ | .93 | 10 | 68 | 0 | 20N | 150 | 300 | 500 | 500 | 2,000 | 140 | 2.8 | 18-1,092 |
| Zn....... | .31 | 754 | 58 | 4 | 500N | 500N | 1,500 | 2,000 | 3,000 | 20,000G | -- | -- | -- |
| Zr....... | .64 | 3 | 22 | 349 | 20N | 1,500 | 2,000 | >2,000 | >2,000 | 2,000G | 1,171 | 5.4 | 40-34,146 |
| Th....... | .01 | 1,171 | 11 | 0 | 200N | 200N | 200N | 200N | 200N | 500 | -- | -- | -- |

**Table 3.** Geochemical thresholds for selected elements, Baird Mountains quadrangle, Alaska

[All values are in parts per million except Fe, in percent; L, concentrations were observable but at levels below the associated lower determination limit; G, concentrations were observable but at levels above the associated upper determination limit. Leaders (--), highly censored frequency distributions]

| Element | Stream sediments | | Nonmagnetic heavy-mineral concentrate | |
|---|---|---|---|---|
| | Threshold value | Lower percentile of anomalous value | Threshold value | Lower percentile of anomalous value |
| Fe....... | 7 | 87 | 7 | 94 |
| Mn....... | 2,000 | 96 | 1,000 | 95 |
| Ag....... | 0.5 | 94 | 1 | 85 |
| As....... | -- | -- | 500L | 98 |
| Au....... | -- | -- | 20L | 99 |
| B........ | 300 | 99 | 500 | 87 |
| Ba....... | 2,000 | 97 | 10,000G | 73 |
| Be....... | 3 | 94 | 3 | 93 |
| Bi....... | 10L | 99 | 20L | 92 |
| Cd....... | 20L | 98 | 70 | 93 |
| Co....... | 50 | 89 | 100 | 92 |
| Cr....... | 200 | 92 | 500 | 94 |
| Cu....... | 70 | 91 | 200 | 91 |
| Mo....... | 5 | 91 | 10 | 95 |
| Ni....... | 100 | 89 | 150 | 91 |
| Pb....... | 70 | 95 | 500 | 80 |
| Sb....... | -- | -- | 200L | 99 |
| Sn....... | 10L | 99 | 30 | 88 |
| V........ | 300 | 98 | 300 | 93 |
| W........ | -- | -- | 100 | 95 |
| Zn....... | 200 | 94 | 1,000 | 78 |
| Th....... | -- | -- | 200L | 99 |

given geochemical distribution (tables 1, 2) is chosen as a threshold, and all values greater than the threshold are considered anomalous. However, inspection of the histograms (figs. 1, 2) indicates that for many elements the thresholds should be adjusted from the 95th percentile to accommodate distinct breaks in the frequency distribution of the data. The resulting thresholds for the ore-related elements are listed in table 3.

R-mode factor analysis with Varimax rotation was used to identify the predominant geochemical associations in both log-transformed data sets. Prior to log transformation, the more highly censored elements (detection ratios less than 0.15) were removed from each data base. All remaining censored data in each matrix were treated as follows:

1. Concentrations for an element that could not be detected at the lower determination limit for the specific element (elements qualified with N) were assumed to be 0.5 of the lower limit.
2. Concentrations for an element that were observable but not measurable at the lower determination limit for the specific element (elements qualified with L) were assumed to be 0.7 of the lower limit.
3. Concentrations for an element that could not be detected at the upper determination limit for the specific element (elements qualified with G) were assumed to be 1.3 times the upper limit.

Factor analysis places similarly behaving experimental variables (chemical elements in this study) into groups termed "factors." Specific rock or ore-deposit types may be represented by a distinct suite of trace elements, and therefore certain factors might be used to define the more common geochemical signatures in the study area. Factor loadings (tables 4, 5), which depict the influence of each variable on a factor, may be interpreted similarly to correlation coefficients. The optimal number of factors that were chosen from each data matrix, and discussed below, were based on the breaks in slope on plots of factor number versus total variance. Factor scores measure the effect a particular factor has on each sample site. A high score for a given sample signifies that the element association represented by that factor is strong.

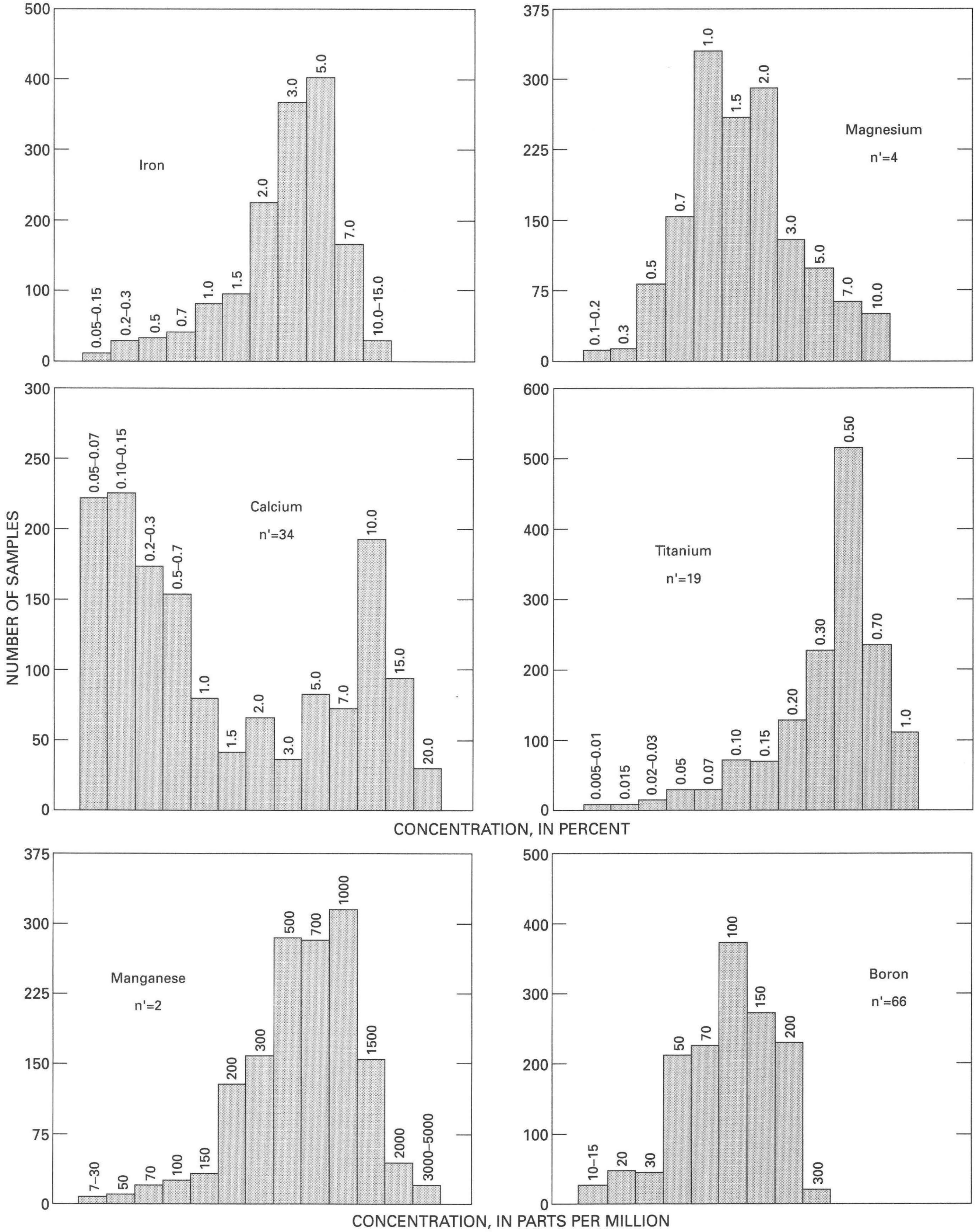
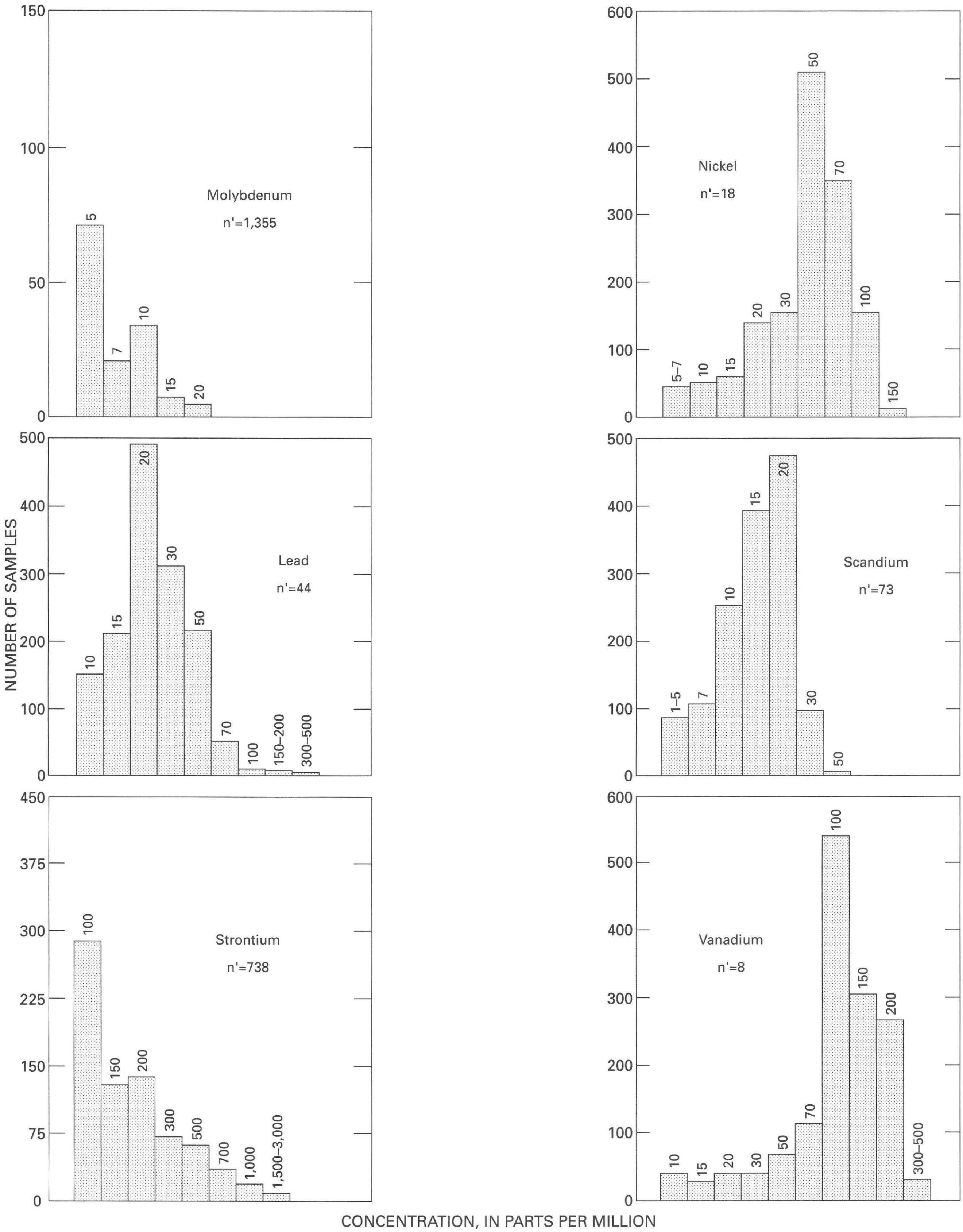
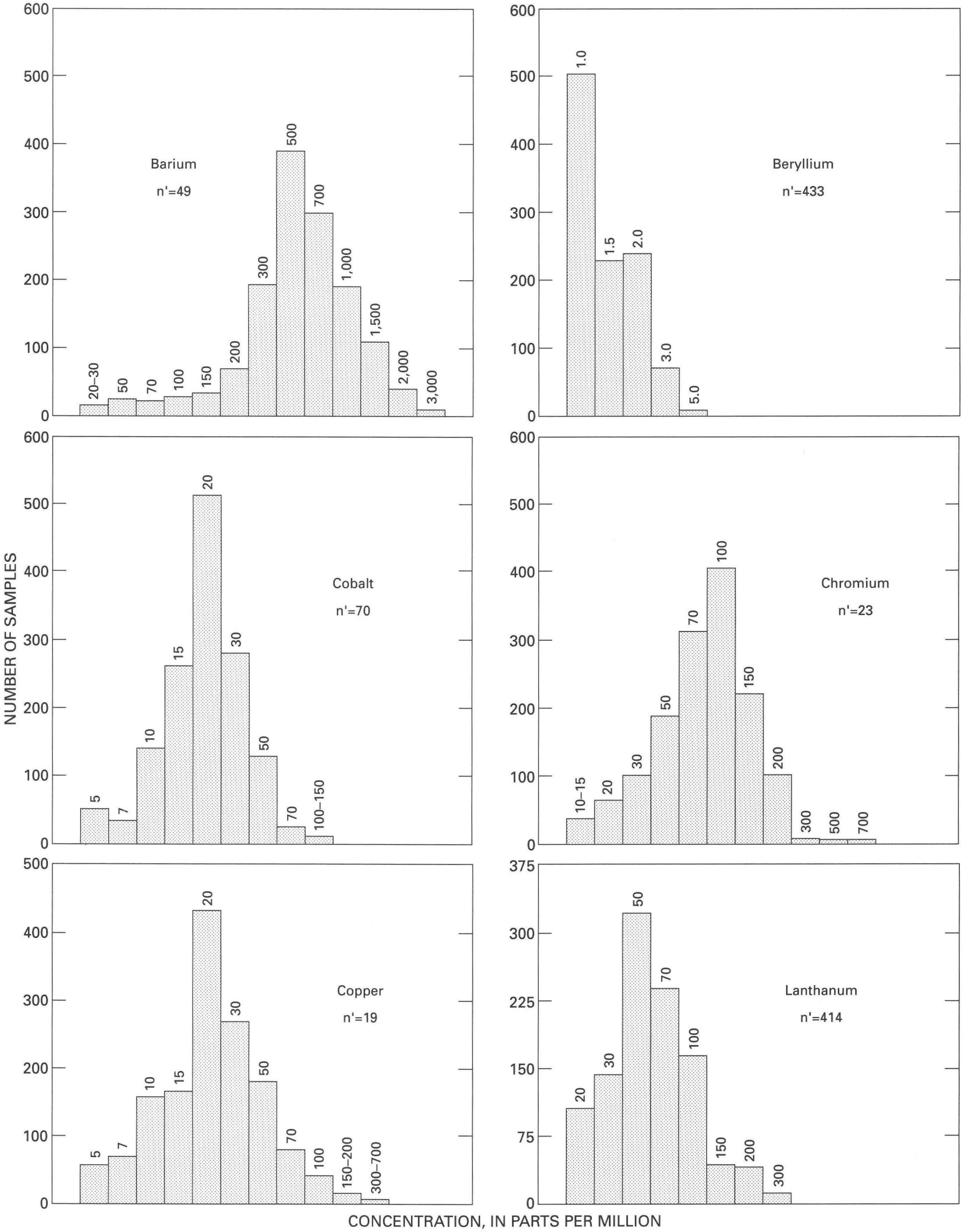



**Figure 1 (above and following pages).** Frequency distribution for element concentrations in stream-sediment samples, Baird Mountains quadrangle, Alaska. n', number of samples censored either below or above analytical determination limits.


Molybdenum
n'=1,355
Nickel
n'=18
Lead
n'=44
Scandium
n'=73
Strontium
n'=738
Vanadium
n'=8
NUMBER OF SAMPLES
CONCENTRATION, IN PARTS PER MILLION


Barium
n'=49
20–30
50
70
100
150
200
300
500
700
1,000
1,500
2,000
3,000
Beryllium
n'=433
1.0
1.5
2.0
3.0
5.0
Cobalt
n'=70
5
7
10
15
20
30
50
70
100–150
Chromium
n'=23
10–15
20
30
50
70
100
150
200
300
500
700
Copper
n'=19
5
7
10
15
20
30
50
70
100
150–200
300–700
Lanthanum
n'=414
20
30
50
70
100
150
200
300
NUMBER OF SAMPLES
CONCENTRATION, IN PARTS PER MILLION

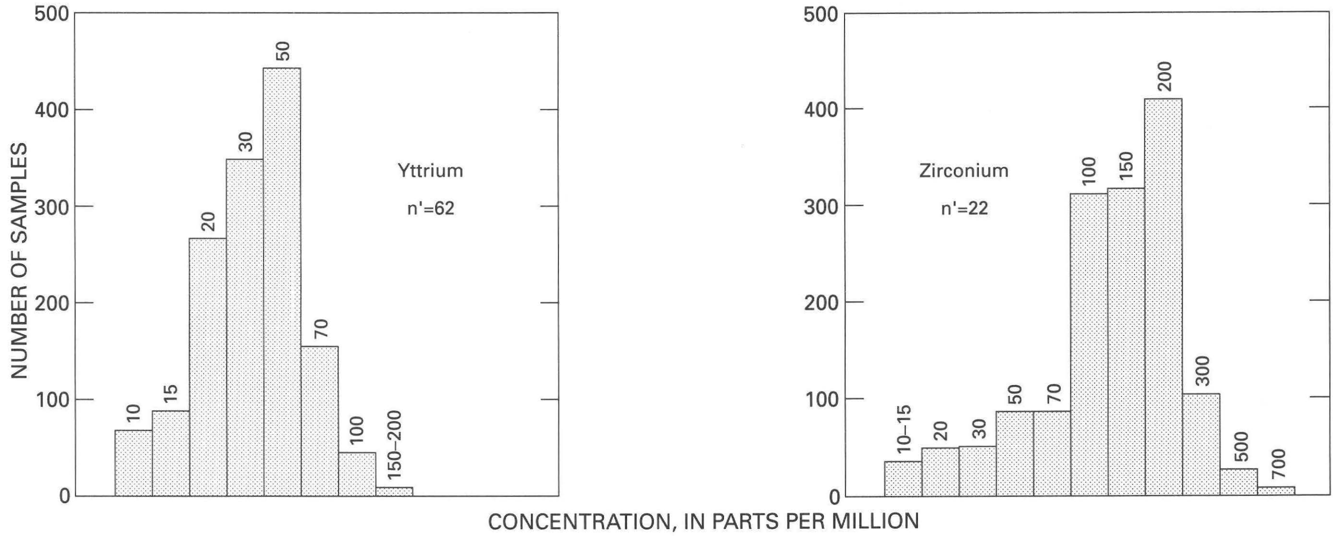



**Table 4.** Factor loadings for 1,493 stream-sediment samples, Baird Mountains quadrangle, Alaska

[Loadings depict the influence of each factor on each variable and may be interpreted similarly to correlation coefficients. Leaders (--), loadings less than |0.3|]

| Element | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| Fe....... | 0.81 | 0.37 | --- | --- |
| Mg....... | --- | -.47 | 0.52 | --- |
| Ca....... | -.32 | -.36 | .80 | --- |
| Ti....... | .71 | .55 | --- | --- |
| Mn....... | .72 | .38 | --- | --- |
| B........ | .67 | .56 | --- | --- |
| Ba....... | .69 | .51 | --- | --- |
| Be....... | .41 | .66 | --- | --- |
| Co....... | .79 | .30 | --- | --- |
| Cr....... | .80 | --- | -.30 | --- |
| Cu....... | .70 | --- | --- | 0.42 |
| La....... | --- | .73 | --- | --- |
| Ni....... | .78 | .31 | --- | --- |
| Pb....... | --- | --- | --- | .88 |
| Sc....... | .73 | .47 | --- | --- |
| Sr....... | --- | --- | .87 | --- |
| V........ | .81 | .38 | --- | --- |
| Y........ | .49 | .65 | --- | --- |
| Zr....... | .62 | .57 | --- | --- |
| Percent total variance. | 38 | 20 | 12 | 6 |

## Factor-Analysis Associations for the AMRAP Data

A four-factor model that explains 76 percent of the total variance was selected as most appropriate for summarizing the AMRAP stream-sediment data (table 4). Three of these four factors describe the lithogeochemical variance across the Baird Mountains quadrangle. Samples with highest scores for factor 1 (Fe-V-Cr-Co-Ni-Sc-Mn-Ti-Cu) are from sites that cluster within watersheds underlain by mafic rocks. The factor 3 (Ca-Mg-Sr) association reflects sediments collected from carbonate-dominant watersheds, mainly in the southwestern and west-central part of the quadrangle. Samples with the highest factor 2 (La-Be-Y-Zr-B) scores are from sites irregularly scattered within areas underlain by pelitic schist, black shale, and mixed carbonate-clastic units.

The lead-copper correlation within factor 4 is the only association that may relate directly to areas having metallic-mineral potential. Sample sites with high scores onto this factor cluster in five areas in the Baird Mountains quadrangle:

1. Kilyaktalik Peaks (northwestern part of area 14, pl. 1).
2. Agashashok River (northern part of area 13, southern part of area 12).
3. Headwaters of the Omar River, Tukpahlearik Creek, and Anaktok Creek (areas 6, 9, and southwestern part of area 4).
4. Kallarichuk Hills (southeastern part of area 8).
5. Nanielik Creek and the headwaters of the Tutuksuk River (area 2 and northeastern part of area 3).

The geology of these areas and further discussion of metal associations within them are given in the sections of the report describing the anomalous areas.

Six factors explain 70 percent of the variance within the heavy-mineral-concentrate data (table 5). Factors 1, 3, and 6 probably reflect lithogeochemical variations of heavy minerals. However, some samples with high scores onto factor 6 (Sn-Be), from areas draining the Kallarichuk Hills (area 8, pl. 1), contain microscopically visible cassiterite.

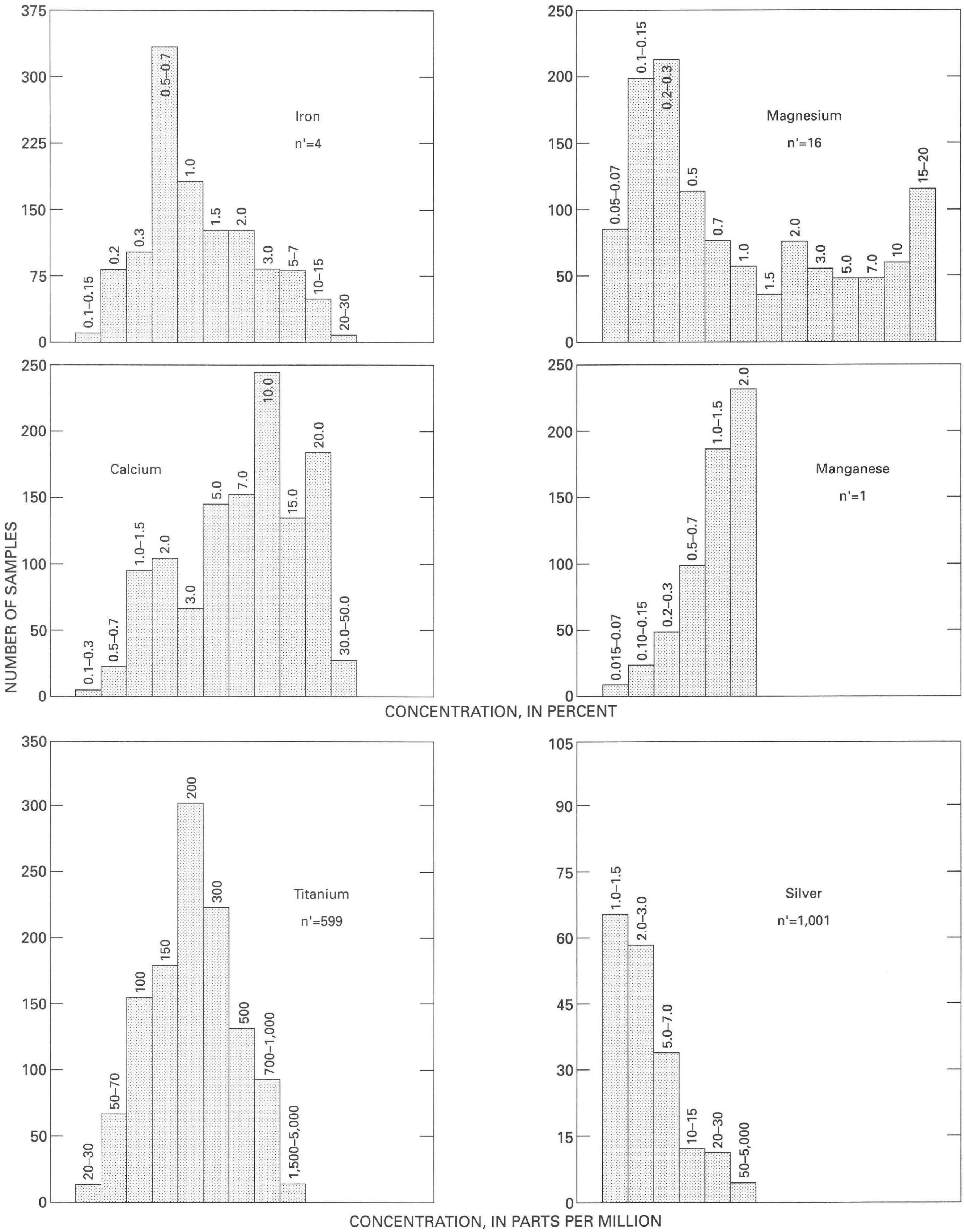
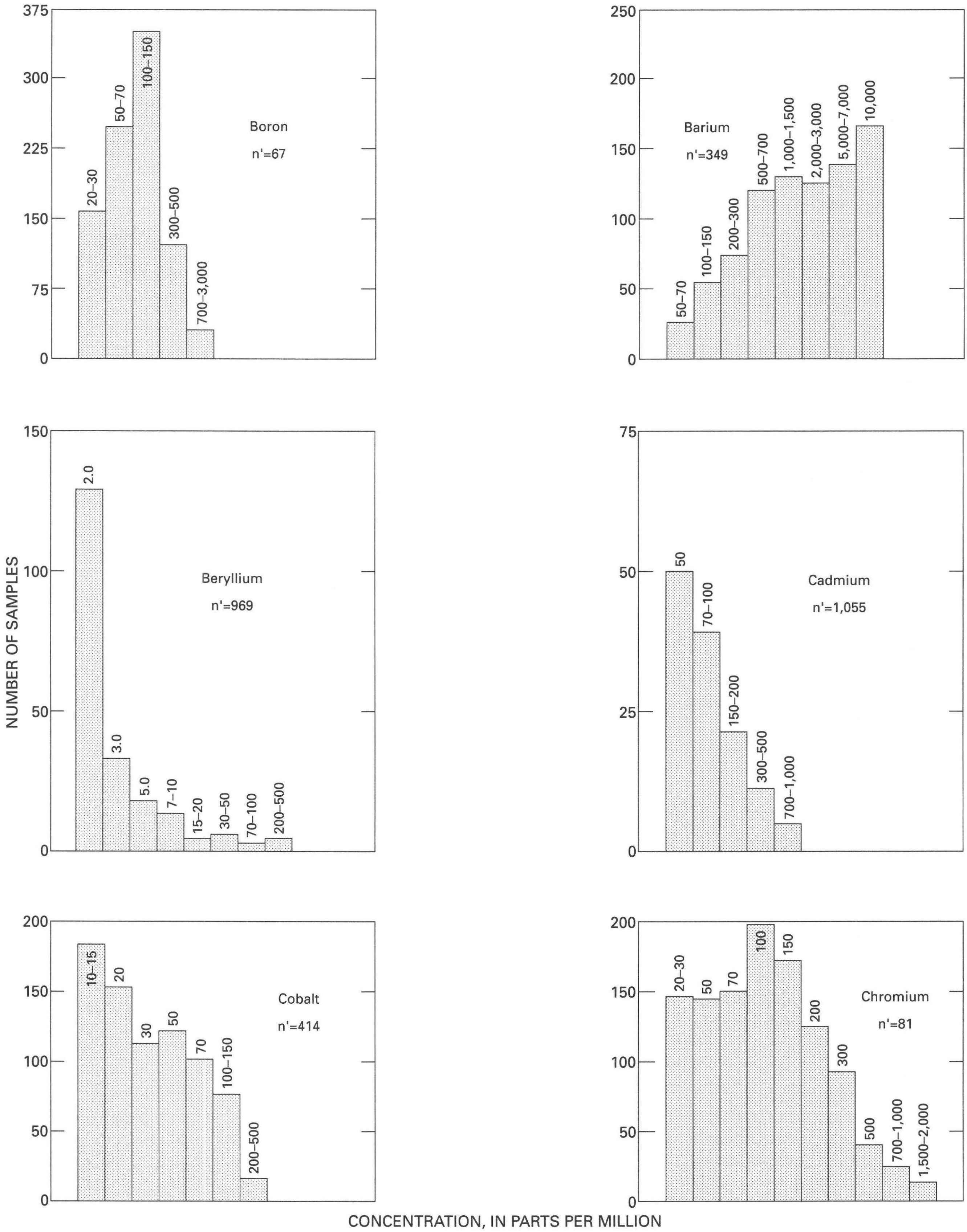
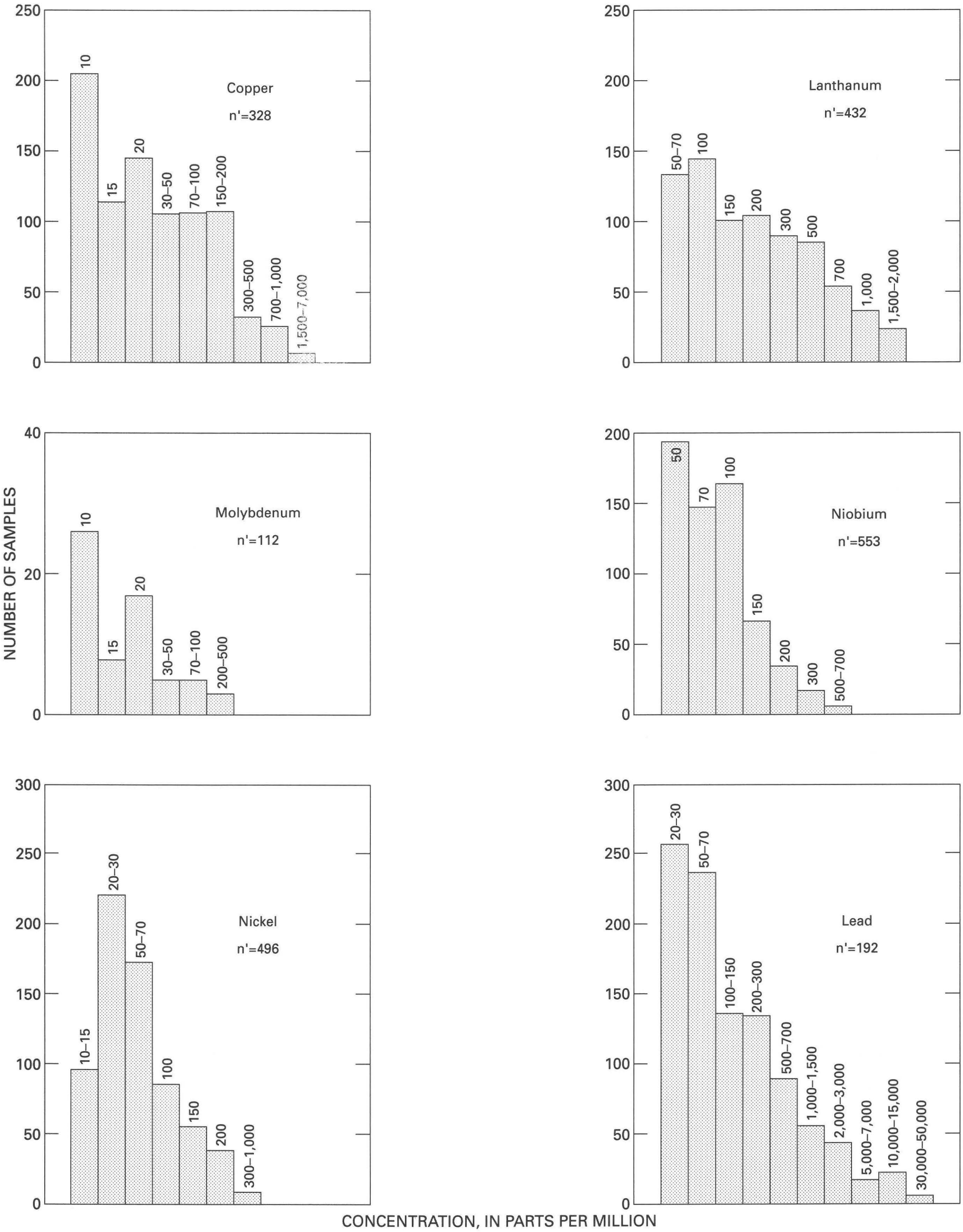
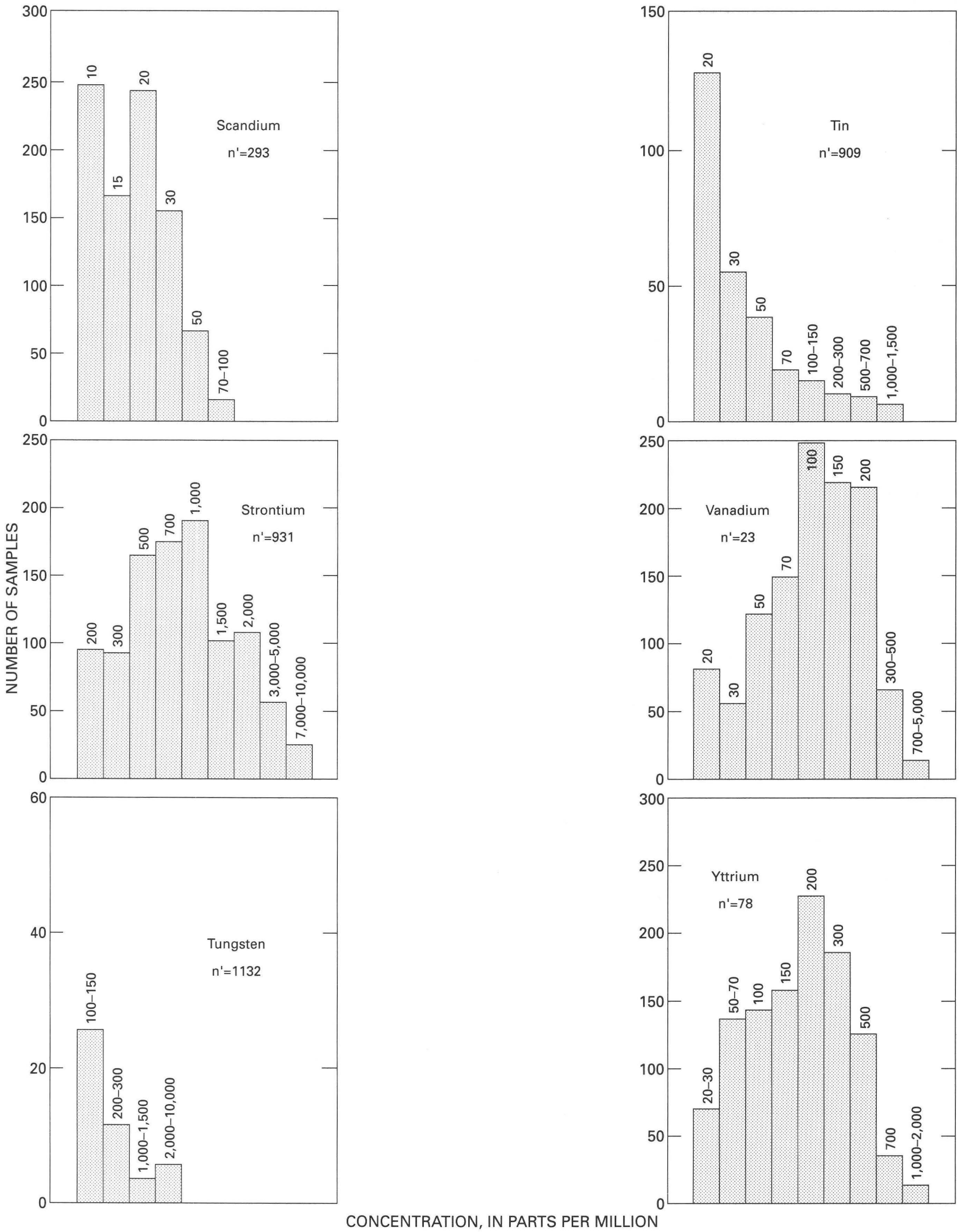



**Figure 2 (above and following pages).** Frequency distribution for element concentrations in nonmagnetic heavy-mineral-concentrate samples, Baird Mountains quadrangle. n′, number of samples censored either below or above analytical determination limits.


Boron
n'=67
20–30
50–70
100–150
300–500
700–3,000
Barium
n'=349
50–70
100–150
200–300
500–700
1,000–1,500
2,000–3,000
5,000–7,000
10,000
Beryllium
n'=969
2.0
3.0
5.0
7–10
15–20
30–50
70–100
200–500
Cadmium
n'=1,055
50
70–100
150–200
300–500
700–1,000
Cobalt
n'=414
10–15
20
30
50
70
100–150
200–500
Chromium
n'=81
20–30
50
70
100
150
200
300
500
700–1,000
1,500–2,000
NUMBER OF SAMPLES
CONCENTRATION, IN PARTS PER MILLION


NUMBER OF SAMPLES
CONCENTRATION, IN PARTS PER MILLION
Copper
n'=328
10
15
20
30–50
70–100
150–200
300–500
700–1,000
1,500–7,000
Lanthanum
n'=432
50–70
100
150
200
300
500
700
1,000
1,500–2,000
Molybdenum
n'=112
10
15
20
30–50
70–100
200–500
Niobium
n'=553
50
70
100
150
200
300
500–700
Nickel
n'=496
10–15
20–30
50–70
100
150
200
300–1,000
Lead
n'=192
20–30
50–70
100–150
200–300
500–700
1,000–1,500
2,000–3,000
5,000–7,000
10,000–15,000
30,000–50,000



NUMBER OF SAMPLES
CONCENTRATION, IN PARTS PER MILLION
Scandium
n'=293
10
15
20
30
50
70–100
Tin
n'=909
20
30
50
70
100–150
200–300
500–700
1,000–1,500
Strontium
n'=931
200
300
500
700
1,000
1,500
2,000
3,000–5,000
7,000–10,000
Vanadium
n'=23
20
30
50
70
100
150
200
300–500
700–5,000
Tungsten
n'=1132
100–150
200–300
1,000–1,500
2,000–10,000
Yttrium
n'=78
20–30
50–70
100
150
200
300
500
700
1,000–2,000

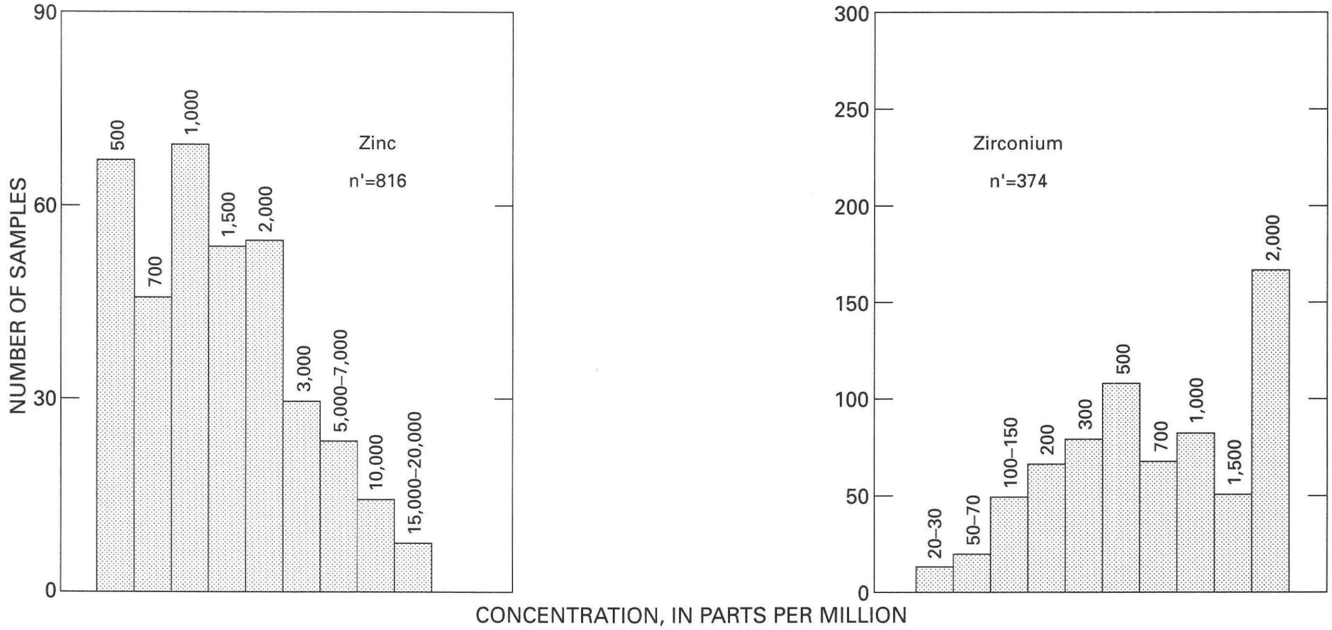



**Table 5.** Factor loadings for 1,185 heavy-mineral-concentrate samples, Baird Mountains quadrangle, Alaska

[Leaders (---), loadings less than |0.3|]

| Element | Factor 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Fe....... | --- | 0.88 | --- | --- | ------ | |
| Mg....... | --- | --- | -0.88 | --- | ------ | |
| Ca....... | --- | --- | -0.33 | -0.56 | --- | -0.49 |
| Ti....... | 0.65 | --- | .56 | --- | ------ | |
| Mn....... | .41 | .33 | --- | --- | ------ | |
| Ag....... | --- | --- | --- | --- | .80 | --- |
| B........ | .72 | --- | --- | --- | ------ | |
| Ba....... | --- | --- | --- | .74 | --- | --- |
| Be....... | .32 | --- | --- | --- | ---.61 | |
| Co....... | --- | .85 | --- | --- | ------ | |
| Cr....... | .80 | --- | --- | --- | ------ | |
| Cu....... | --- | .83 | --- | --- | ------ | |
| La....... | .46 | .42 | --- | .36 | --- | --- |
| Nb....... | .45 | --- | .46 | --- | ---.32 | |
| Ni....... | --- | .88 | --- | --- | ------ | |
| Pb....... | --- | --- | --- | --- | .81 | --- |
| Sc....... | .73 | --- | --- | --- | ------ | |
| Sn....... | --- | --- | --- | --- | ---.70 | |
| V........ | .81 | --- | --- | --- | ------ | |
| Y........ | .46 | --- | .74 | --- | ------ | |
| Zn....... | --- | --- | --- | .57 | .44 | --- |
| Zr....... | .37 | --- | .65 | .36 | --- | --- |
| Percent total variance. | 18 | 17 | 12 | 9 | 8 | 6 |

**Table 6.** Anomalous element suites defining the 17 areas of geochemical interest, Baird Mountains quadrangle, Alaska

[Data are for the Alaska Mineral Resource Assessment Program and NURE (National Uranium Resource Evaluation) surveys; hyphenated elements are commonly observed at anomalous levels; elements in parentheses were less consistently observed at anomalous levels within the defined area; leaders (--), no anomalous elements]

| Area No. and name | Stream-sediment samples | Nonmagnetic heavy-mineral-concentrate samples | NURE stream-sediment samples |
|---|---|---|---|
| 1. Headwaters of Aklumayuak Creek | (Ag, Ba)-------------- | Ag-Pb-Sn (Ba)--------- | (Pb, Sb, Zn). |
| 2. Nanielik Creek---- | Co-Cu-Mo-Ni-Pb-Zn (Ba, Mn). | Pb (Ag)--------------- | (Co, Cu, Fe, Mn, V, Zn). |
| 3. Tutuksuk River---- | Co-Cu-Fe-Ni-Zn (Mo)--- | Pb (Ag, Bi, Co, Fe)--- | Co-Cu (Pb). |
| 4. Upper Salmon River. | Co-Cu-Mo (Mn, Ag, Ba, Cr, Ni, Zn). | Ag-Ba-Pb (Bi, Co, Cu, Fe, Ni, Sn, Zn). | Co-Cu (U). |
| 5. Lower Aklumayuak Creek. | Co (Ag, Cr, Mn, V)---- | Ag-Pb (Bi, Co, Cr, Cu, Sn, Zn). | (Co, Cu, Cr, Ni, V, W). |
| 6. Tukpahlearik Creek. | Ag-Mo-Ni-Zn (B, Cu)--- | Ag-Co-Cu-Fe-Mo-Ni (B, Ba, Mn, V). | Sb (Ba, Cu, Ni, U, V, Zn). |
| 7. Headwaters of Nikok River----- | Co-Cu-Ni (Ag, Mo, Zn). | W (Ag, Co, Pb, Sn)---- | --- |
| 8. Kallarichuk Hills. | Cu-Fe-Mn-Mo-Ni (Ag, (Ba, Co, Cr, Pb, Zn) | Sn-W (Ag, Au, Ba, Bi, Pb). | --- |
| 9. Headwaters of Omar River------ | Ag-Ba-Cu-Mo-Ni-Pb-Zn (B, Co, Cr). | Ag-Ba-Pb-Zn (Co, Cu, Mo, Ni, Sn, V). | (Co, Cr, Cu, Fe, Ni, V, Zn). |
| 10. Nakolikurok Creek. | Co-Cr-Fe-Ni-V (Cu). | Ag-Ba-Co-Cu-Fe-Ni-Pb-Zn (Mo). | (Co, Cr, Cu, Fe, Ni, V). |
| 11. Upper Nakolik River. | Cr-Fe (Ni, V)--------- | Ba-Cu (Ag, Co, Fe, Pb, Ni, Zn). | --- |
| 12. West fork of North Fork Squirrel River. | --- | Pb-Zn (Ag, B, Ba, Co, Cu, Fe, Mo, Ni, V). | --- |
| 13. West fork of Squirrel River. | (Cu, Pb, Zn)---------- | Ag-Ba-Co-Cu-Fe-Ni-Pb-Zn. | (Pb, U). |
| 14. Eli River--------- | Cu-Pb-Zn (Ag, Ba, Cr, Ni). | Ag-Ba-Cu-Pb-Zn (Cr, Ni). | (Ba, Pb, U, Zn). |
| 15. Porgo Creek------- | --- | Ba-Pb-Zn (Ag, Fe, Mn) | (Ni). |
| 16. Maiyumerak Mountains. | Ag-Cr-Cu-Mo-Zn (Ni, Pb). | Bi-Cr-Zn (Ag, Mn)---- | Co, Cu, Fe, Pb, U. |
| 17. Hotham Inlet------ | Cu-Fe (Mo)------------ | --- | U. |

The barium-zinc correlation within factor 4 may indicate samples with sphalerite and barite derived from sedimentary rocks. Samples with highest scores onto this factor are from sites scattered throughout the northwestern quarter of the quadrangle (areas 14, 15, and 16). The iron-cobalt-copper-nickel association within factor 2 probably indicates samples enriched with pyrite and lesser amounts of chalcopyrite. The silver-lead-zinc correlation within factor 5 is characteristic of many samples with abundant galena and (or) cerrussite and sphalerite. Samples with high scores onto factors 2 and 5 commonly overlap in the following four areas (discussed in detail below):

1. Agashashok River (northern part of area 13, southern part of area 14).

**Table 7.** Statistical summary for 913 stream-sediment samples and 916 water samples from the National Uranium Resource Evaluation survey, Baird Mountains quadrangle, Alaska

[All values in parts per million except Al, Ca, Fe, K, and Mg, in percent, and U in water, in parts per billion; B, number of samples with no data reported; L, number of samples having concentrations below the analytical determination limit. Concentrations followed by L, specific concentration was below the determination limit]

| Element | B | L | Minimum value | Median value | 85th percentile value | 90th percentile value | 95th percentile value | Maximum value |
|---|---|---|---|---|---|---|---|---|
| U.......... | 0 | 0 | 0.7 | 2.9 | 3.8 | 4.1 | 4.5 | 75 |
| Ag......... | 43 | 868 | 5L | 5L | 5L | 5L | 5L | 9 |
| Bi......... | 43 | 839 | 5L | 5L | 5L | 5L | 5L | 10 |
| Cd......... | 43 | 862 | 5L | 5L | 5L | 5L | 5L | 11 |
| Cu......... | 43 | 9 | 10L | 33 | 46 | 50 | 60 | 1,111 |
| Nb......... | 43 | 857 | 20L | 20L | 20L | 20L | 20L | 42 |
| Ni......... | 43 | 63 | 15L | 43 | 63 | 69 | 79 | 170 |
| Pb......... | 43 | 405 | 5L | 5 | 11 | 13 | 17 | 69 |
| Sn......... | 43 | 852 | 10L | 10L | 10L | 10L | 10L | 13 |
| W.......... | 43 | 838 | 15L | 15L | 15L | 15L | 15 | 60 |
| Be......... | 43 | 71 | 1L | 2 | 3 | 3 | 3 | 8 |
| Li......... | 43 | 0 | 1.0 | 41 | 63 | 73 | 90 | 258 |
| Al......... | 0 | 0 | .34 | 6.0 | 7.8 | 8.3 | 8.8 | 11.6 |
| Au......... | 0 | 909 | .05L | .09L | .11L | .12L | .13L | .51 |
| Ba......... | 0 | 97 | 82L | 573 | 869 | 970 | 1,148 | 2,425 |
| Ca......... | 0 | 140 | .05L | .9 | 9.1 | 14 | 18 | 35 |
| Ce......... | 0 | 5 | 3L | 85 | 119 | 130 | 149 | 413 |
| Cl......... | 15 | 821 | 45L | 96L | 122L | 139L | 192 | 9,284 |
| Co......... | 0 | 2 | 2L | 18 | 25 | 27 | 31 | 45 |
| Cr......... | 0 | 6 | 5L | 93 | 134 | 141 | 161 | 1,367 |
| Cs......... | 0 | 146 | .6L | 4.5 | 6.6 | 7.4 | 8.3 | 15 |
| Dy......... | 0 | 5 | 1L | 6 | 9 | 10 | 10 | 28 |
| Eu......... | 0 | 15 | .1L | 1.7 | 2.2 | 2.3 | 2.5 | 7.2 |
| Fe......... | 0 | 0 | .32 | 4.1 | 5.3 | 5.7 | 6.2 | 22.8 |
| Hf......... | 0 | 27 | .5L | 7.2 | 11 | 13 | 16 | 42 |
| K.......... | 0 | 32 | .1L | 1.5 | 2.1 | 2.3 | 2.5 | 3.2 |
| La......... | 0 | 25 | 2L | 38 | 53 | 60 | 68 | 175 |
| Cu......... | 0 | 27 | .1L | .5 | .6 | .7 | .7 | 1.3 |
| Mg......... | 0 | 15 | .2L | 1.1 | 2.1 | 3.4 | 6.2 | 10.1 |
| Mn......... | 0 | 0 | 98 | 682 | 1,075 | 1,227 | 1,496 | 3,902 |
| Na......... | 0 | 0 | 297 | 7,100 | 10,400 | 11,700 | 13,600 | 23,740 |
| Rb......... | 0 | 433 | 15L | 69 | 122 | 136 | 149 | 223 |
| Sb......... | 0 | 876 | 1L | 2L | 3L | 3L | 4L | 7 |
| Sc......... | 0 | 0 | 1 | 15 | 20 | 21 | 23 | 35 |
| Sm......... | 0 | 31 | .3L | 6.8 | 9.4 | 10 | 12 | 41 |
| Sr......... | 0 | 886 | 136L | 298L | 389L | 424L | 467L | 644 |
| Ta......... | 0 | 892 | 1L | 1L | 2L | 2L | 2L | 8 |
| Tb......... | 0 | 808 | 1L | 1L | 2L | 2L | 2 | 7 |
| Th......... | 0 | 8 | .5L | 10 | 14 | 15 | 16 | 81 |
| Ti......... | 0 | 16 | 353L | 4,700 | 6,100 | 6,500 | 7,000 | 20,600 |
| V.......... | 0 | 2 | 9L | 122 | 159 | 168 | 188 | 280 |
| Yb......... | 0 | 115 | .6L | 4.7 | 6.2 | 6.7 | 7.4 | 11 |
| Zn......... | 0 | 605 | 12L | 66L | 139 | 159 | 195 | 3,531 |
| U (water).. | 0 | 0 | .01 | .32 | 1.06 | 1.39 | 2.01 | 38.4 |

**Table 8.** Geochemical threshold values for selected elements within the data from the National Uranium Resource Evaluation survey, Baird Mountains quadrangle, Alaska

[Values are in parts per million except Fe, in percent, and U in water, in parts per billion. >, greater than]

| Element | Threshold values | Lower percentile of anomalous values |
|---|---|---|
| Ag......... | 6 | >99 |
| Au......... | .14 | >99 |
| Ba......... | 1,400 | 97 |
| Bi......... | 5 | 97 |
| Cd......... | 5 | 99 |
| Co......... | 27 | 90 |
| Cr......... | 142 | 90 |
| Cu......... | 50 | 90 |
| Fe......... | 6.0 | 93 |
| Mn......... | 2,900 | 99 |
| Ni......... | 66 | 88 |
| Pb......... | 15 | 93 |
| Sb......... | 2 | 96 |
| Sn......... | 10 | 98 |
| W.......... | 15 | 95 |
| U.......... | 4.3 | 93 |
| V.......... | 200 | 98 |
| Zn......... | 164 | 90 |
| U (water).. | 1.62 | 93 |

2. Headwaters of the Omar River (western part of area 9).
3. Headwaters of the Nakolik River (area 11).
4. Nakolikurok Creek (area 10).

## Spatial Analysis of Geochemically Anomalous Areas

Maps showing factor score values and individual element concentrations were used to delineate geochemically anomalous areas that may reflect the presence of metallic mineral occurrences. These anomalous areas are more than 50 percent of the Baird Mountains quadrangle. We have attempted to define each area based on consistent multielement geochemical signatures. In most areas, these geochemical signatures probably reflect either widespread disseminated mineralization or more concentrated metal accumulations of economic interest. Distinguishing between disseminated and more concentrated metal sources within marine sedimentary rocks is not possible solely from reconnaissance-level geochemical exploration surveys. Follow-up investigations of the reported anomalies are required, therefore, to positively identify the metal sources. Some of the anomalies were followed up during the field work for this AMRAP study. Schmidt and Allegro (1988) documented the mineral occurrences found during this follow-up work.

Areas from which samples were collected that have anomalous geochemical values and thus have a geochemical favorability for base- or precious-metal mineralization are shown on plate 1 and listed in table 6. A total of 17 areas (figs. 3–19) contain distinct geochemical signatures in stream-sediment and (or) heavy-mineral-concentrate samples. The geology shown for each of these 17 areas (figs. 3–19) has been generalized from Karl and others (1989). Samples with suites of element values above the selected geochemical thresholds or clusters of samples with metal values above the thresholds are judged more likely to reflect upstream mineralization than are isolated anomalous samples. Some samples outside the delineated areas are also anomalous in one or more elements. However, this study was not comprehensive enough to explain every anomalous sample, and we discuss only areas identified by clusters of anomalous samples.

## Statistical Summary of the NURE data

A statistical summary of the NURE survey is given in table 7. Geochemical threshold values for the NURE data (table 8) were selected by methods similar to those used for determining threshold values within the AMRAP data. Although NURE data were from the entire Baird Mountains quadrangle, they provided much less information than the AMRAP survey. The AMRAP survey sample density was greater (by about 100 percent) within the more highly dissected uplands of the quadrangle. Also, the concentrate samples collected during the AMRAP survey provide very significant information that is not available from the stream-sediment samples of the NURE survey.

Interpretation of the NURE data alone would have led to identification of base-metal-rich areas 2 and 5, the western half of area 4, perhaps the eastern half of area 7, the southeastern part of area 10, the northwestern part of area 12, the eastern half of area 15, and the southern half of area 17 (pl. 1). Pathfinder elements for each of these areas are listed in table 6 and are discussed below for each area. The remaining parts of these areas, as well as the other nine areas, could not have been identified from the NURE data. The western half of area 7, which contains three significant mineral occurrences (Frost, Powdermilk, and Omar prospects) and which was identified by multielement anomalies from the AMRAP survey, had only one sample anomalous in copper and one sample anomalous in zinc in the NURE data. These

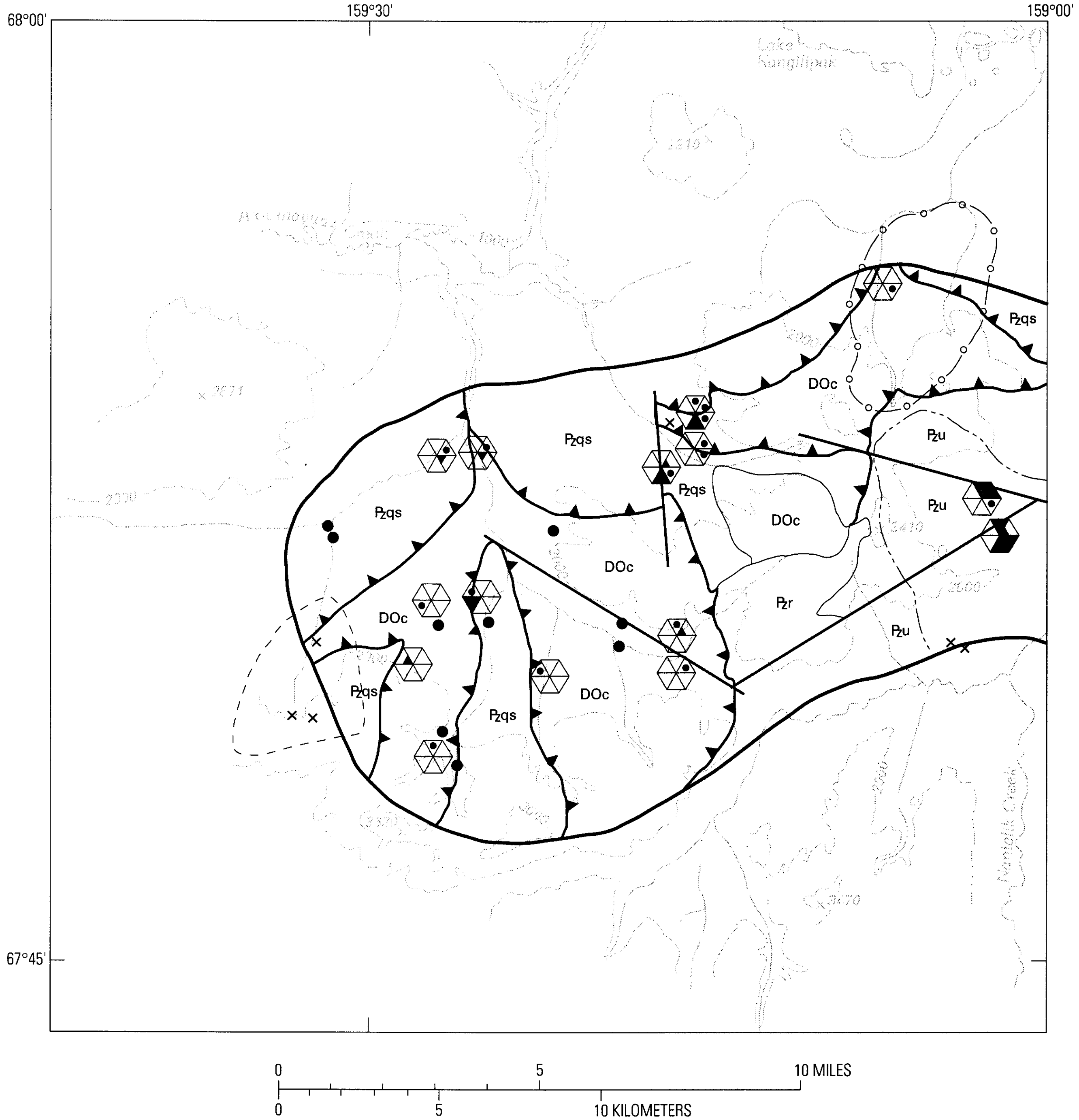
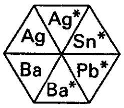



**Figure 3 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the headwaters of Aklumayuak Creek (geochemically anomalous area 1). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

two single-element point anomalies identify the Omar occurrence; the other two mineral occurrences are not identifiable from the NURE survey. The NURE data generally do not identify any significant anomalies outside the 17 areas of interest defined by the AMRAP data. One possible exception is just south and west of area 17, where NURE sediments with anomalous cobalt, copper, and iron concentrations extend to the western border of the Baird Mountains quadrangle. This additional anomalous area is discussed below in the description of area 17.

## EXPLANATION




**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below. In the diagram, an asterisk indicates a heavy-mineral-concentrate sample**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; >, greater than; leaders (– –) no value for that category]

| Category | Map symbol | Stream-sediment samples | | Heavy-mineral-concentrate samples | | | |
|---|---|---|---|---|---|---|---|
| | | Ag | Ba | Ag | Ba | Pb | Sn |
| Slightly anomalous. | ▽ (with dot) | 0.5 | 2,000 | 1.5 | -- | 500–1,000 | 30–70 |
| Moderately anomalous. | ▽ (partly filled) | 0.7 | -- | -- | -- | 3,000–5,000 | 150–500 |
| Highly anomalous. | ▼ | -- | 5,000 | 15–20 | >10,000 | 10,000 | 1,000 |

**Geochemical data from the National Uranium Resource Evaluation (NURE) studies**

- - - - - - - **Boundary of area of localities of stream-sediment samples containing 21–38 ppm Pb**

o——o——o **Boundary of area of localities of stream-sediment samples containing 16–19 ppm Pb**

- - - —— - - - **Boundary of area of localities of water samples containing 1.8–2.3 ppb U**

× **Locality of stream-sediment sample containing 200–241 ppm Zn**

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

Pzr **Rhyolite (Paleozoic)**

Pzu **Undifferentiated marble, black quartzite, siliceous phyllite, sandstone, and quartz conglomerate (Paleozoic)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

# DESCRIPTION OF GEOCHEMICALLY ANOMALOUS AREAS

## Area 1—Headwaters of Aklumayuak Creek

Paleozoic sandstone units and lesser quartz conglomerate and phyllite underlie the north part of area 1. The uppermost parts of Aklumayuak Creek, however, drain Ordovician to Devonian carbonate rocks and lesser siliceous phyllite and rhyolite (fig. 3). Copper-bearing quartz veins, fluorite disseminated in rhyolite, and metal-enriched black shale occur within this area (Degenhart and others, 1978; Schmidt and Allegro, 1988).

Concentrate samples in area 1 are enriched in lead and tin, containing as much as 10,000 ppm (parts per million)

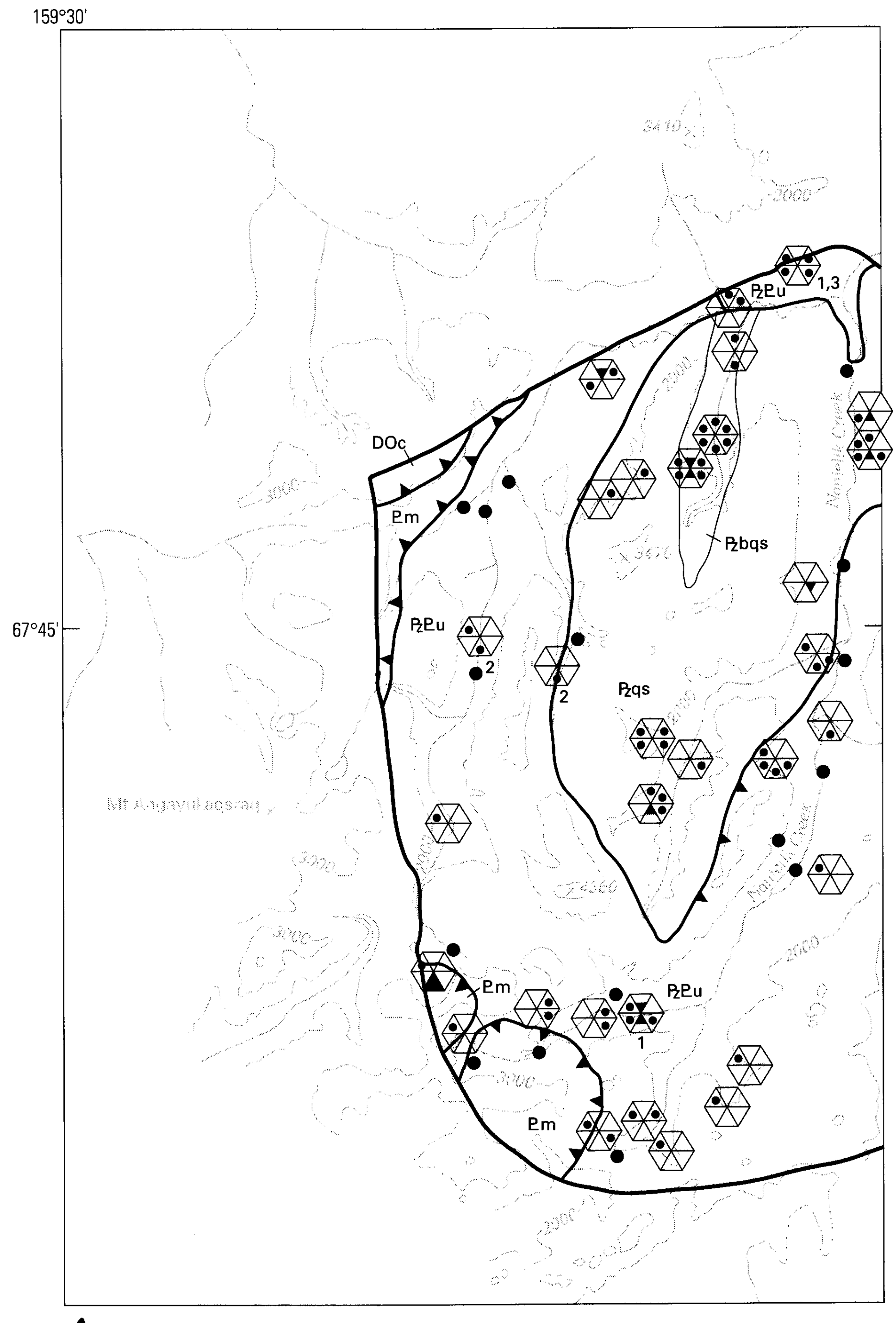
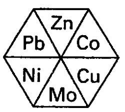



**Figure 4 (above and following pages).** Sample-locality maps for the Nanielik Creek area (geochemically anomalous area 2), showing sample data. Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, stream-sediment samples; *B*, heavy-mineral-concentrate samples; *C*, stream-sediment samples from the National Uranium Resource Evaluation survey.

## EXPLANATION




**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; >, greater than; leaders (- -), no value for that category]

| Category | Map symbol | Co | Cu | Mo | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. |  | 50 | 70–100 | 5–7 | 100–150 | 50–70 | 200 |
| Moderately anomalous. |  | -- | 150 | 10 | -- | -- | 300 |
| Highly anomalous. |  | -- | -- | >10 | -- | -- | -- |

SAMPLE DESCRIPTIONS: 1, 5,000 ppm Mn; 2, 1–2 ppm Ag; 3, 3,000 ppm Ba.

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

Pzbqs **Black quartzite, siliceous semischist, black shale, and carbonate rocks (Paleozoic)**

Pm **Polymetamorphic mafic rocks (Proterozoic)**

PzPu **Undifferentiated quartz conglomerate, sandstone, siliceous phyllite, carbonate rocks, Kogruk Formation, black quartzite, and metabasite (Paleozoic and Proterozoic)**

**Contact**

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

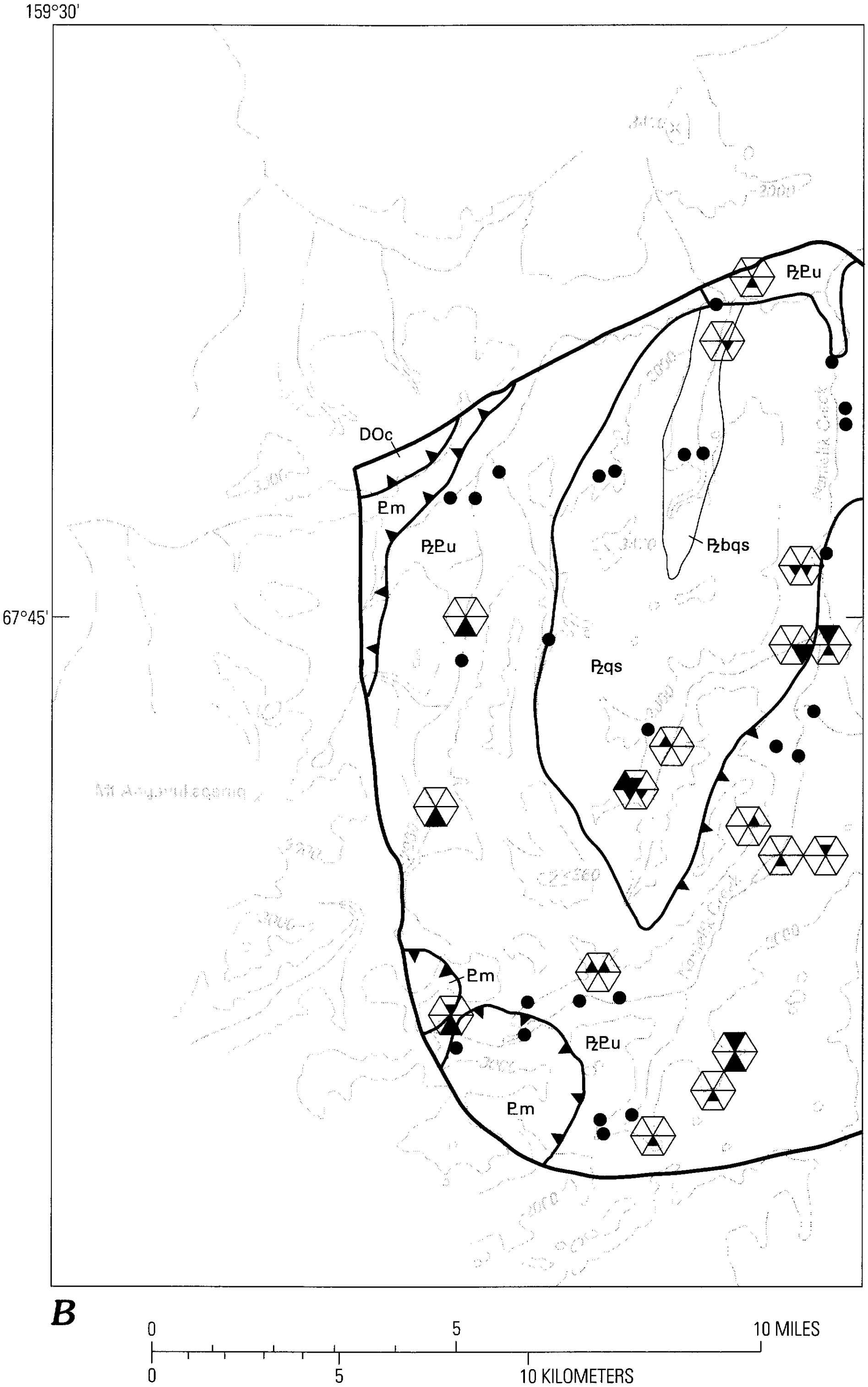
and 1,000 ppm, respectively, to the east of peak 3410. Less commonly, concentrates are also anomalous in silver or barium, and some contain microscopically visible sphalerite or galena. Many NURE sediment samples from the area contain 16–38 ppm Pb, 200–241 ppm Zn, and 2–4 ppm Sb, all exceeding geochemical thresholds (table 8). Stream water from the NURE survey had uranium concentrations of 1.8–2.3 ppb (parts per billion) at five sites in the area.

The silver, lead, antimony, and(or) zinc anomalies probably resulted from weathering of sulfide-bearing quartz veins and disseminated sulfides in sedimentary rocks. The anomalous uranium concentrations may reflect a higher geochemical background of these elements within the rhyolitic rocks. The source for the anomalous tin is uncertain. Although cassiterite was not observed within any of the concentrate samples from the area, rhyolitic outcrops in the Aklumayuak Creek area might contain disseminated cassiterite.

## Area 2—Nanielik Creek

The Nanielik Creek (fig. 4) watershed is underlain by complexly thrust faulted (Karl and others, 1989) Proterozoic to Paleozoic quartz conglomerate, sandstone, siliceous phyllite, carbonate rocks, and black siliceous shale. Lesser amounts of igneous rocks include undivided Proterozoic or Paleozoic metabasites. Area 2 is one of the most geochemically anomalous regions within the Baird Mountains quadrangle.

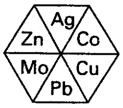
Area 2 contains several red-stained sections of creek bottom (draining black shale) and outcrops of red-stained, locally pyritic black shale. In addition, quartz, commonly iron-stained, occurs as stream cobbles and as veins cutting phyllite, conglomerate, and black shale. Chalcopyrite, bornite, malachite, azurite, hematite, and (or) pyrite occur in some quartz veins as well as within or adjacent to Paleozoic mafic rocks. Chemical analyses of numerous samples of




phyllite and schist (Zayatz and others, 1988) show consistently high concentrations for Ag, As, B, Ba, Cd, Co, Cr, Cu, Fe, Mo, Mn, Ni, Sb, Ti, V, and Zn. Both synsedimentary sulfide occurrences, in shale and phyllite, and sulfide-bearing quartz veins of probable metamorphic origin are possible sources for the geochemical anomalies described below.

Stream-sediment samples from both the AMRAP survey and the earlier NURE survey are anomalous in many of the elements listed above in sedimentary rock samples. Many AMRAP survey sediment samples contain 50 ppm Co, 70–150 ppm Cu, 5 ppm Mo or more, 100–150 ppm Ni, 50–70 ppm Pb, and 200–300 ppm Zn (fig. 4). The anomalous

## EXPLANATION




**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy–mineral–concentrate sample having no anomalous concentrations of elements**

[Values are in parts per million; leaders (– –), no value for that category]

| Category | Map symbol | Ag | Co | Cu | Pb | Mo | Zn |
|---|---|---|---|---|---|---|---|
| Moderately anomalous. | ▽ | 1–2 | 100 | 200–300 | 500–700 | 10 | 1,500–2,000 |
| Highly anomalous. | ▼ | 5–15 | – – | 700 | 1,000–7,000 | – – | 5,000 |

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

Pzbqs **Black quartzite, siliceous semischist, black shale, and carbonate rocks (Paleozoic)**

Pm **Polymetamorphic mafic rocks (Proterozoic)**

PzPu **Undifferentiated quartz conglomerate, sandstone, siliceous phyllite, carbonate rocks, Kogruk Formation, black quartzite, and metabasite (Paleozoic and Proterozoic)**

**Contact**

**Thrust fault**—Saw teeth on upper plate

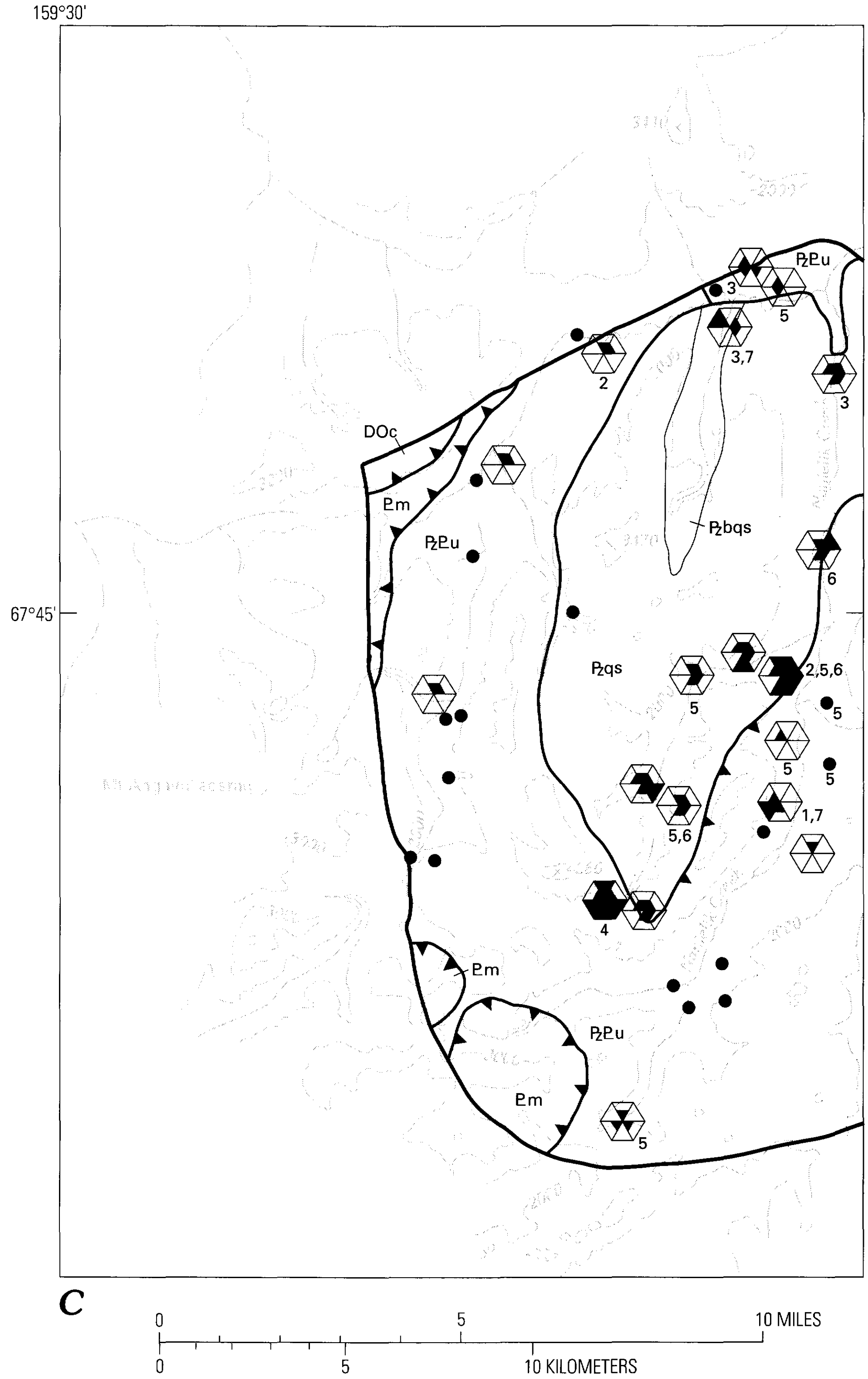
**Boundary of geochemically anomalous area**

samples also generally contain 5–7 percent Fe, a few samples also contain 5,000 ppm Mn, and two sediment samples from just east of Mt. Angayukaqsraq contain 1–2 ppm Ag. Many NURE survey samples contain anomalous barium (more than 1,600 ppm), cobalt (22–45 ppm), copper (51–188 ppm), iron (5.2–11.3 percent), nickel (50–106 ppm), vanadium (179–244 ppm), and zinc (207–352 ppm). Less consistently anomalous values were measured for silver, bismuth, cadmium, manganese, lead, antimony, uranium, and tungsten. One NURE sediment sample contained 31.5 ppm U, and NURE water samples from the eastern half of area 2 (fig. 4) contain at least 2 ppb U. A water-sample uranium value of 38.4 ppb (the highest value from the quadrangle) was measured at the site having the highest uranium value in sediments.

Less than half the sample sites with anomalous stream sediments also contain anomalous values in heavy-mineral-concentrate samples, suggesting that many metals were chemically rather than mechanically dispersed in the weathering environment. Additionally, many of the anomalous metals may be associated with iron or manganese hydroxide minerals and would therefore not be concentrated within the nonmagnetic heavy-mineral fractions. Silver and (or) lead are anomalous in 11 samples from area 2, and cobalt, copper, iron, molybdenum, and zinc are less consistently enriched. Sphalerite is commonly present within many of the concentrates collected from the headwaters of the eastern tributaries of Nanielik Creek.

## Area 3—Tutuksuk River

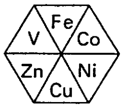
Area 3, which includes much of the Tutuksuk River watershed, is underlain by undifferentiated Proterozoic to Mesozoic schist and phyllite, mafic igneous rocks, and Paleozoic carbonate rocks. Pyrite, and less commonly hematite, copper sulfides, and copper oxides, are scattered through the schist and rarely occur in quartz veins. Cobalt, copper, iron, nickel, and zinc are consistently anomalous in stream-sediment samples throughout the Tutuksuk River watershed, especially east of the river (fig. 5). Many sediment samples contain 50–70 ppm Co, 70–300 ppm Cu, 7–10 percent Fe, 100 ppm Ni, and 200–500 ppm Zn. Pyrite is abundant within corresponding concentrate samples, and chalcopyrite is also common. Schmidt and Allegro (1988) reported the




occurrence of disseminated pyrite in schist to the east of area 3. Similar disseminated sulfides may also occur within area 3.

Heavy-mineral concentrates in the upper tributaries to the Tutuksuk River (fig. 5), immediately south of Mt. Angayukaqsraq, contain 500–10,000 ppm Pb, indicating the presence of galena and (or) cerrusite. Less consistently, samples are also anomalous in silver, bismuth, cobalt, and iron. Silver and bismuth are likely to be enriched in the galena, whereas the cobalt and iron may be concentrated in pyrite. Corresponding sediment samples are generally not anomalous, although one sample did contain 200 ppm Pb.

## EXPLANATION




Locality of geochemically anomalous stream-sediment sample collected in the National Uranium Resource Evaluation (NURE) studies. Symbols and anomaly categories are described below

● **Locality of NURE stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except for Fe, which is in percent; leaders (– –), no value for that category]

| Category | Map symbol | Fe | Co | Ni | Cu | Zn | V |
|---|---|---|---|---|---|---|---|
| Moderately anomalous. | ▽ | 5.2–8.0 | 22–33 | 50–99 | 51–70 | 207–226 | 179–205 |
| Highly anomalous. | ▼ | 8.0–11.3 | 37–45 | 100–106 | 71–188 | 294–352 | 244 |

SAMPLE DESCRIPTIONS: 1, 43 ppm Pb; 2, 16 ppm Pb; 3, 4–4.4 ppm U; 4, 31.5 ppm U; 38 ppb U in water; 5, 1.9–3.5 ppb U in water; 6, 2,321–3,754 ppm Mn; 7, 2,000–2,400 ppm Ba

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

Pzbqs **Black quartzite, siliceous semischist, black shale, and carbonate rocks (Paleozoic)**

Pm **Polymetamorphic mafic rocks (Proterozoic)**

PzPu **Undifferentiated quartz conglomerate, sandstone, siliceous phyllite, carbonate rocks, Kogruk Formation, black quartzite, and metabasite (Paleozoic and Proterozoic)**

**Contact**

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

Two concentrate samples with high lead values (7,000–10,000 ppm) were collected from creeks draining a ridge between Sheep Creek and the northernmost part of the Tutuksuk River (fig. 5). Galena, sphalerite, and (or) chalcopyrite were observed in these samples. One NURE sediment sample from the headwaters of Sheep Creek contained 30 ppm Pb, a strongly anomalous concentration.

Another part of area 3 with base-metal sulfide occurrence potential lies east of the Salmon River and south of hill 2878 (fig. 5). Concentrate samples are anomalous in lead and to a lesser extent in silver and bismuth. One of the samples, collected directly west of the hill 2878, contains 15,000 ppm Pb.

NURE sediment samples with anomalous amounts of copper (as much as 109 ppm), were taken from the headwaters of Kanaktok Creek, as well as from the headwaters of the Tutuksuk River (fig. 5). In addition, sediment samples collected during the AMRAP survey from upper Kanaktok Creek contained 70–100 ppm Cu and 5–7 ppm Mo. Only one concentrate sample from this area showed an anomalous copper value. The anomalies may reflect high background concentrations of copper from metabasites that underlie some parts of upper Kanaktok Creek, or mafic rock-related occurrences of malachite and azurite similar to those reported by Schmidt and Allegro (1988).

A single NURE stream-sediment sample collected to the south of hill 2336 on the southern edge of area 3 contains 0.33 ppm Au, 81 ppm Th, 34 ppm U, and anomalous concentrations of most rare-earth elements. These extremely anomalous concentrations clearly represent a geochemical signature distinct from all others in area 3. More detailed follow-up investigations are required to identify any possible source for the anomaly.

## Area 4—Upper Salmon River

Area 4 includes much of the headwaters of the Salmon River, including most of the Kanaktok Creek watershed, and the lower reaches of the Anaktok Creek and Sheep Creek basins (fig. 6). Much of the area is underlain by phyllite,

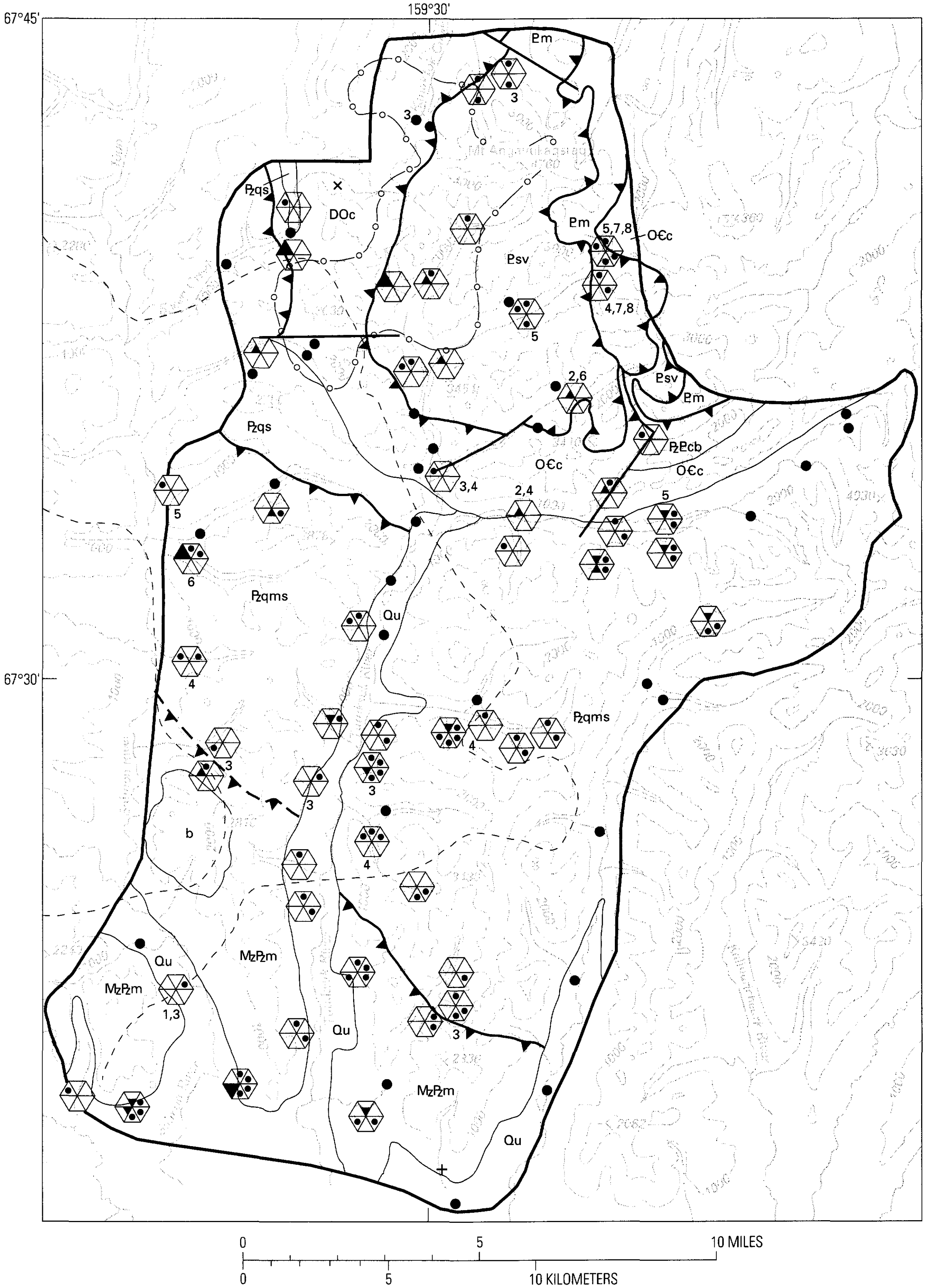
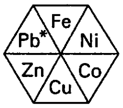



**Figure 5 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the Tutuksuk River area (geochemically anomalous area 3). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

# EXPLANATION




**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below. In the diagram, an asterisk indicates a heavy-mineral-concentrate sample**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except for Fe, in percent; S, stream-sediment sample; H, heavy-mineral-concentrate sample; >, greater than; leaders (– –), no value for that category]

| | | Stream-sediment sample | | | | | Heavy-mineral-concentrate samples |
|---|---|---|---|---|---|---|---|
| Category | Map symbol | Co | Cu | Fe | Ni | Zn | Pb |
| Slightly anomalous. | ▽ | 50–100 | 50–100 | 7 | 100 | 200 | 500–1,000 |
| Moderately anomalous. | ▽ | -- | 200–300 | 10 | -- | 300 | 1,500–3,000 |
| Highly anomalous. | ▼ | -- | -- | -- | -- | 500 | 7,000–15,000 |

SAMPLE DESCRIPTIONS: 1, 5,000 ppm Ba (S); 2, 100–200 ppm Pb (S); 3, 50–70 ppm Pb (S); 4, 1 ppm Ag (H); 5, 3–7 ppm Ag (H); 6, 20–30 ppm Ag (H); 7, 10–15 percent Fe (H); 8, 300–500 ppm Co (H).

**Geochemical data from the National Uranium Resource Evaluation (NURE) studies**

o——o——o **Boundary of area of localities of stream-sediment samples containing 50 ppm Cu or more**

- - - - - - - **Boundary of area of localities of stream-sediment samples containing 27 ppm Co or more**

× **Locality of stream-sediment sample containing 30 ppm Pb**

\+ **Locality of stream-sediment sample containing 34 ppm U**

Qu **Undifferentiated surficial deposits (Quaternary)**

MzPzm **Melange and phyllite (Mesozoic and Paleozoic)**

DOc **Carbonate rocks (Devonian to Ordovician)**

O€c **Carbonate rocks (Ordovician to Cambrian)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

Pzqms **Quartz-mica schists (Paleozoic)**

PzPcb **Carbonate rocks and metabasite (Paleozoic and(or) Proterozoic)**

Pm **Polymetamorphic mafic rocks (Proterozoic)**

Psv **Metasedimentary and metavolcanic rocks of Mount Angayukaqsraq (Proterozoic)**

b **Metabasalt**

**Contact**

**Fault**—Movement uncertain

▲—▲—▲ **Thrust fault**—Dashed where approximately located; saw teeth on upper plate

**Boundary of geochemically anomalous area**

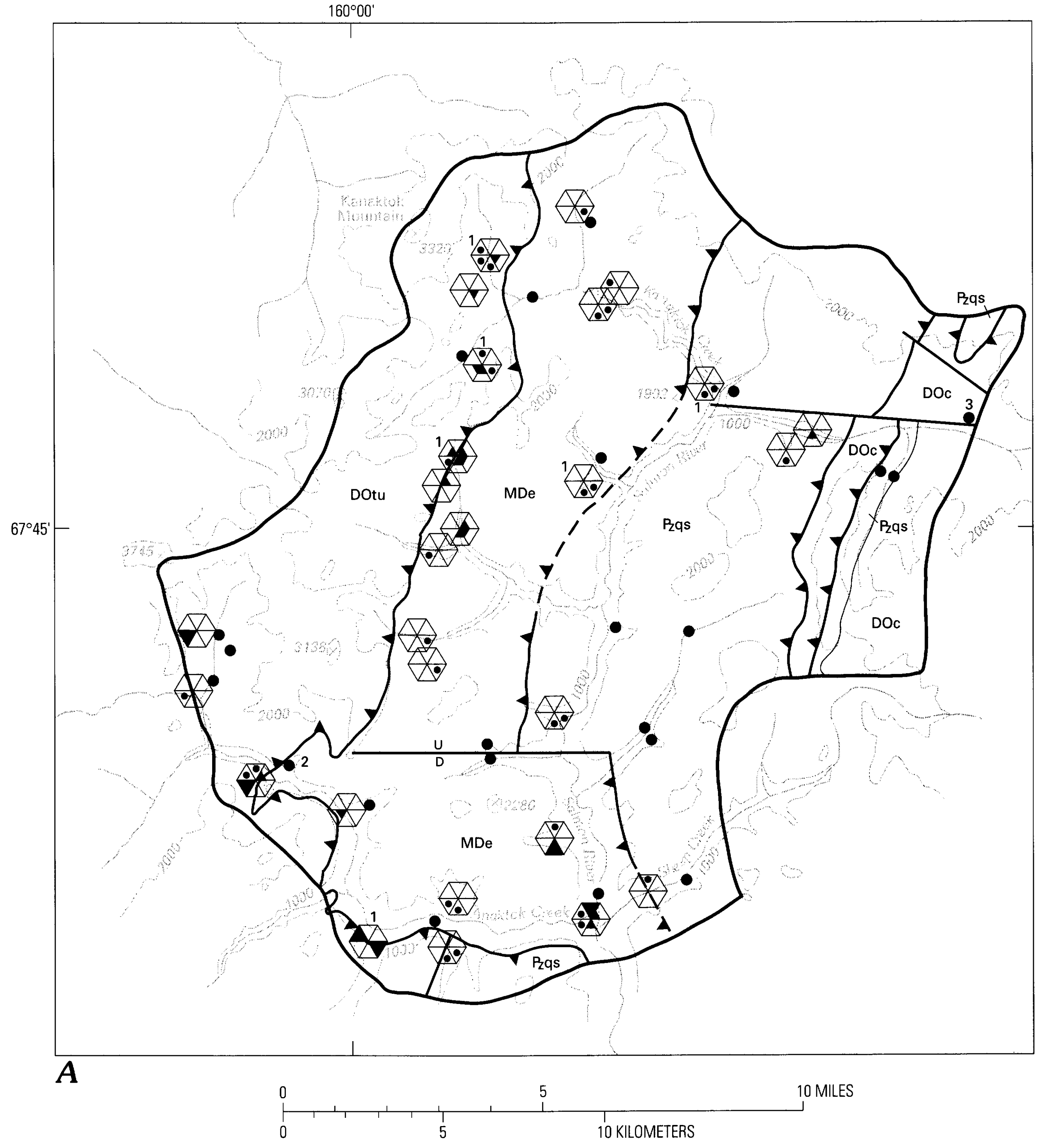
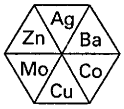



**Figure 6 (above and following pages).** Sample locality maps for the upper Salmon River basin (geochemically anomalous area 4). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, Stream-sediment samples; *B*, Heavy-mineral-concentrate samples; *C*, Stream-sediment samples from the National Uranium Resource Evaluation survey.

schist, and carbonaceous shale, with carbonate rocks predominating toward the eastern side.

Copper is widely anomalous in sediments, and silver is commonly anomalous in concentrate samples within much of the area. The most anomalous part of the area lies at the higher elevations about 3–8 km south of Kanaktok Mountain, west and northwest of hill 1685. Barium, cobalt, and copper are anomalous in sediment samples collected from

# EXPLANATION




**Locality of geochemically anomalous stream-sediment sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; >, greater than; leaders (- -), no value for that category]

| Category | Map symbol | Ag | Ba | Co | Cu | Mo | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 0.5 | -- | 50 | 70 | 5 | 200 |
| Moderately anomalous. | | -- | 2,000 | 70–100 | 100 | 7 | 300 |
| Highly anomalous. | | 7 | -- | 150 | 150 | 10–20 | 500 |

SAMPLE DESCRIPTIONS: 1, 2,000–3,000 ppm Mn; 2, 300 ppm B; 3, 70 ppm Pb.

MDe **Endicott Group (Mississippian to Devonian)**

DOtu **Undifferentiated marble, quartz schist, pelitic schist, carbonaceous quartzite, and quartz conglomerate of Tukpahlearik Creek (Devonian to Ordovician)**

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

**Contact**

U / D **Fault**—Normal or reverse

**Thrust fault**—Saw teeth on upper plate; dashed where approximately located

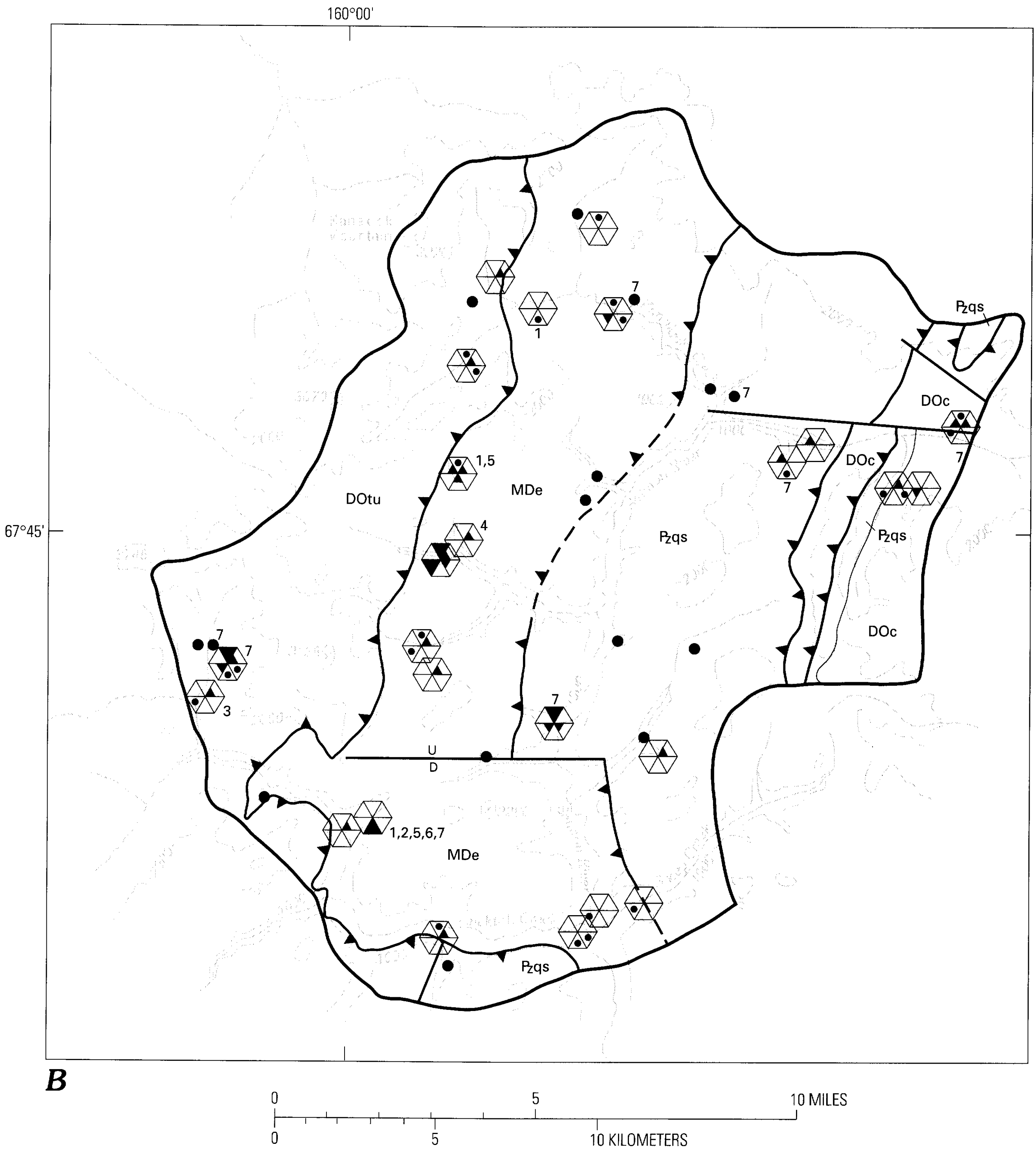
**Boundary of geochemically anomalous area**

this locality in both the AMRAP and NURE surveys. The most anomalous AMRAP sediments contain 100 ppm Co and 100 ppm Cu. Samples containing 50 ppm Co and 70 ppm Cu came from the north and south of these sample sites, across much of the northern part of area 4. Silver, barium, bismuth, copper, lead, or zinc are anomalous in some of the corresponding concentrate samples, especially west of hill 1685. Quartz float containing copper-bearing sulfides and oxides, and iron-oxide-rich marble with anomalous arsenic, iron, molybdenum, nickel, antimony, and zinc have been reported from this locality (Zayatz and others, 1988).

Further south in area 4, along Anaktok Creek, molybdenum is highly anomalous in many AMRAP sediment samples, and silver, boron, manganese, or zinc are also anomalous in at least one of these samples. Most of these anomalous values probably reflect high background concentrations within the sedimentary rocks. However, silver, lead, and tin are anomalous in corresponding concentrates from west of hill 3138, suggesting possible mineralization. Further down Anaktok Creek, west of hill 2280, a single concentrate sample with 200 ppm Co, as well as anomalous arsenic, copper, iron, nickel, and tin, may reflect additional metallic mineralization.

The sediment sample collected near the confluence of Anaktok Creek and the Salmon River contains 7 ppm Ag, plus anomalous barium, copper, molybdenum, and zinc. A second sediment sample collected from a small wash a few kilometers to the north contains 150 ppm Cu. Cobb and others (1981) reported that quartz float was found along the Salmon River, just north of the Anaktok Creek-Salmon River confluence, that contains as much as 2 percent Cu and 11 ppm Ag.

Many NURE sediment samples from within the central part of area 4, along lower Kanaktok Creek and other




***B***

tributaries of the Salmon River, contain 16–20 ppm Th and (or), less consistently, 4.9–6.6 ppm U. In addition, NURE stream-water samples from this area are anomalous in uranium, with concentrations as great as 9.3 ppb. Almost all of the anomalous samples are from sites that drain undifferentiated Endicott Group rocks, suggesting a background enrichment of uranium and thorium in this unit.

The AMRAP sediment sample collected furthest to the east within area 4 contains 70 ppm Pb. Anomalous amounts of silver, barium, bismuth, cobalt, lead, tin, and (or) zinc occur within the corresponding or nearby concentrate samples. A NURE sediment sample from just north of the AMRAP sediment-sample-site anomaly is also anomalous in cobalt, copper, lead, and thorium.

## EXPLANATION

Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below

Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements

[Values are in parts per million; >, greater than; <, less than; leaders (– –), no value for that category]

| Category | Map symbol | Ag | Ba | Bi | Co | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 1–2 | – – | <20 | 100 | 500–1,000 | – – |
| Moderately anomalous. | | – – | >5,000 | 30 | 150 | 2,000–3,000 | 1,000–2,000 |
| Highly anomalous. | | 7–10 | – – | 50 | 200 | 15,000 | – – |

SAMPLE DESCRIPTIONS: 1, 10–30 percent Fe; 2, 700 ppm As; 3, 300 ppm Au; 4, 200 ppm Cu; 5, 500–1,000 ppm Cu; 6, 700 ppm Ni; 7, 30–150 ppm Sn.

MDe **Endicott Group (Mississippian to Devonian)**

DOtu **Undifferentiated marble, quartz schist, pelitic schist, carbonaceous quartzite, and quartz conglomerate of Tukpahlearik Creek (Devonian to Ordovician)**

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

**Contact**

U D **Fault**—Normal or reverse

**Thrust fault**—Saw teeth on upper plate; dashed where approximately located

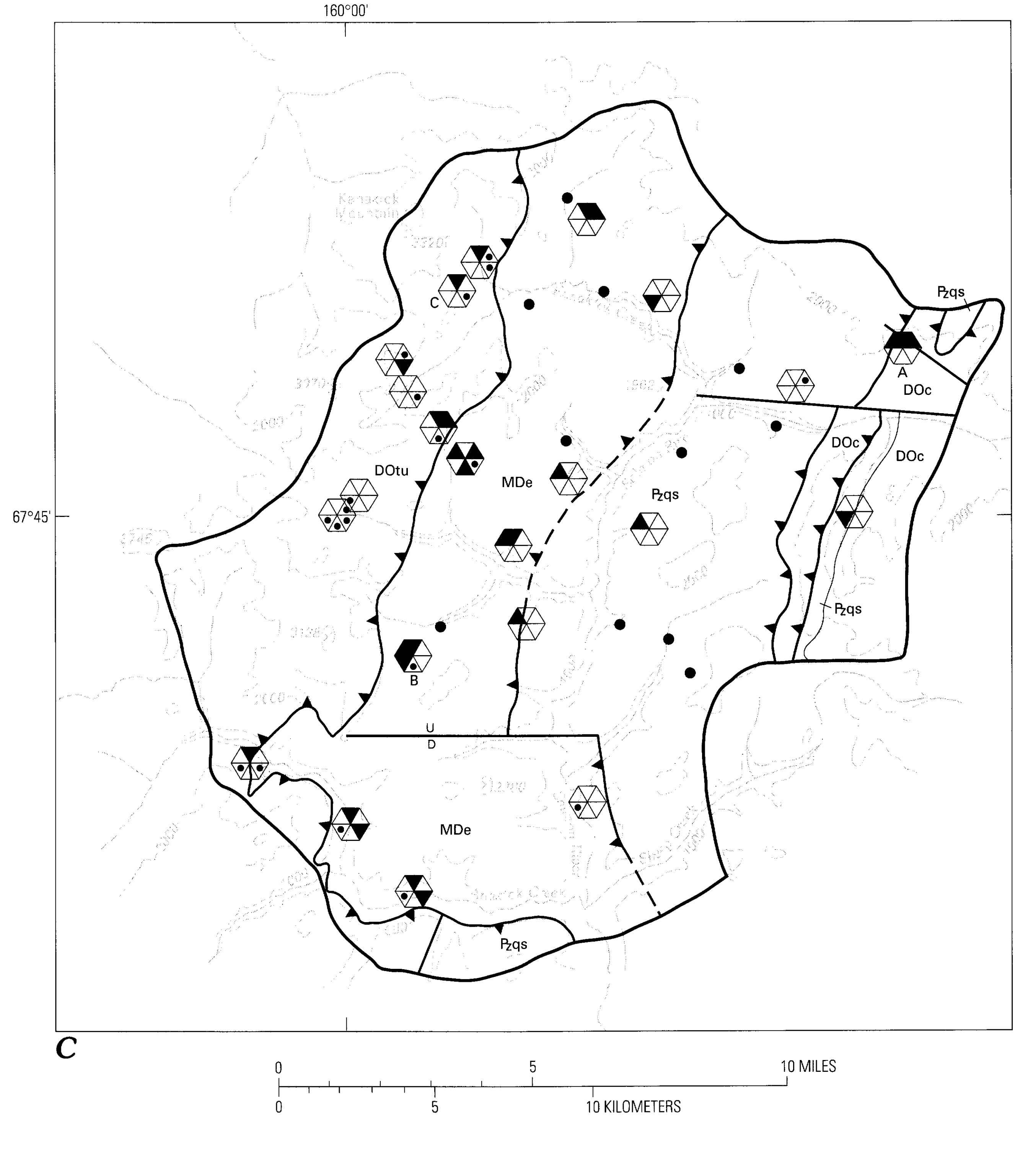
**Boundary of geochemically anomalous area**

NURE sediment-sample sites with anomalous lead also cluster just to the northeast of area 4 within area 1. Degenhart and others (1978) described copper- and silver-rich quartz-calcite veinlets occurring within dolostone in this part of area 4. These occurrences may be the source of some of the geochemical anomalies.

## Area 5—Lower Aklumayuak Creek

Area 5, in the northeastern part of the quadrangle, is underlain chiefly by Devonian and Mississippian sedimentary rocks (fig. 7). Concentrate samples with anomalous amounts of silver, lead, and less commonly tin were collected from tributaries on both sides of Aklumayuak Creek. A cluster of sample sites with anomalously high metal values is within the watershed draining the northwestern slopes of Kanaktok Mountain. Samples from the lower elevations of this drainage basin contain anomalous silver, bismuth, lead, and zinc. In the higher elevations of the basin a NURE sediment sample is anomalous in copper and a nearby concentrate from the AMRAP survey contains 700 ppm Cu, possibly reflecting the presence of chalcopyrite. Anomalous silver-lead signatures also characterize concentrates collected further east and along the south side of Aklumayuak Creek, as well as near hill 2760 on the north side of Aklumayuak Creek. In the latter area, a NURE sediment sample with one of the most anomalous lead concentrations (24 ppm) was collected just west of hill 2760.

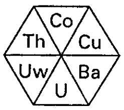
The U.S. Bureau of Mines staff (1978) described base-metal-bearing quartz veins west of hill 2871, in the southeastern part of area 5. Schmidt and Allegro (1988) noted several copper sulfide- and oxide-bearing quartz veins and




pods in the vicinity of Kanaktok Mountain. The described anomalies may reflect additional occurrences of such veins. The cause for the elevated tin values in many of the anomalous concentrates is uncertain.

Many of the stream-sediment samples collected along the lower elevations of Aklumayuak and Uluksian Creeks are slightly anomalous in iron, manganese, silver, chromium, nickel, and vanadium. Most of the anomalies are believed to represent adsorption by iron and manganese oxides in the more stagnant stream channels. Alternatively though, a large mafic sill crops out within lower Aklumayuak Creek (S.M. Karl, oral commun., 1989), and some of the anomalous values may reflect high lithogeochemical backgrounds associated with these igneous rocks.

## EXPLANATION




**Locality of geochemically anomalous stream-sediment sample collected in the National Uranium Resource Evaluation (NURE) studies. Symbols and anomaly categories are described below**

● **Locality of NURE stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except for uranium water samples (Uw), in ppb; leaders (– –), no value for that category]

| Category | Map symbol | Co | Cu | Ba | U | Uw | Th |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ | – – | 50–60 | 1,000–1,200 | 4.9–5.2 | 1.8–3.4 | – – |
| Highly anomalous. | ▼ | 27–41 | 61–74 | 1,201–1,400 | 6.6 | 7.6–9.3 | 16–20 |

SAMPLE DESCRIPTIONS: A, 17 ppm Pb; B, 97 ppm Ni; C, 243 ppm Zn.

MDe **Endicott Group (Mississippian to Devonian)**

DOtu **Undifferentiated marble, quartz schist, pelitic schist, carbonaceous quartzite, and quartz conglomerate of Tukpahlearik Creek (Devonian to Ordovician)**

DOc **Carbonate rocks (Devonian to Ordovician)**

Pzqs **Quartz conglomerate, sandstone, and siliceous phyllite (Paleozoic)**

**Contact**

**Fault**—Normal or reverse (U, D)

**Thrust fault**—Saw teeth on upper plate; dashed where approximately located

**Boundary of geochemically anomalous area**

## Area 6—Tukpahlearik Creek

Area 6 is underlain by undifferentiated Paleozoic metasedimentary rocks, predominately pelitic schist (fig. 8). Much of the exposed schist consists of black, presumably carbonaceous, siliceous material. The protolith for the schist was probably organic-rich shale that typically contains very high background concentrations for many metals.

Karl and others (1985), during the initial phases of this study, collected stream-sediment samples containing anomalous concentrations of silver, barium, copper, molybdenum, manganese, lead, and (or) zinc from throughout area 6. Zayatz and others (1988) reported as much as 40 ppm As, 300 ppm B, 5,000 ppm Ba, 3.4 ppm Cd, 70 ppm Mo, 200 ppm Ni, 6 ppm Sb, 2,000 ppm V, and 750 ppm Zn for selected samples of pelitic rocks within the Tukpahlearik Creek watershed. They also reported values of 230 ppm As, 200 ppm B, 1,500 ppm Ba, 12 ppm Cd, 150 ppm Co, 300 ppm Cu, 15 percent Fe, 20 ppm Mo, 700 ppm Ni, 20 ppm Sb, 300 ppm V, and 5,000 ppm Zn in an iron-oxide-bearing limestone lens within the metapelitic rocks.

The metal-rich metasedimentary rocks underlying much of area 6 probably contribute to the anomalous amounts of metals in most stream-sediment samples collected in the area. Almost 80 percent of the samples contain between 5 and 20 ppm Mo. Less consistently, many of the sediments are enriched in silver (0.5–1.5 ppm), boron (300 ppm), copper (70 ppm), nickel (100–150 ppm), and zinc (200–500 ppm). In addition, NURE stream-water samples from area 6 were extremely anomalous in uranium, and many samples contained 3.4–8.2 ppb U. The most uranium-rich sample sites are more common in the northern parts of area 6, within the headwaters of Anaktok Creek. This group of sites appears to be part of a trend extending into area 4, where widespread uranium anomalies characterized NURE sediment and water samples from areas underlain by rocks of the Endicott Group.

Concentrate samples collected within area 6 are commonly anomalous in silver, barium, cobalt, copper, iron,

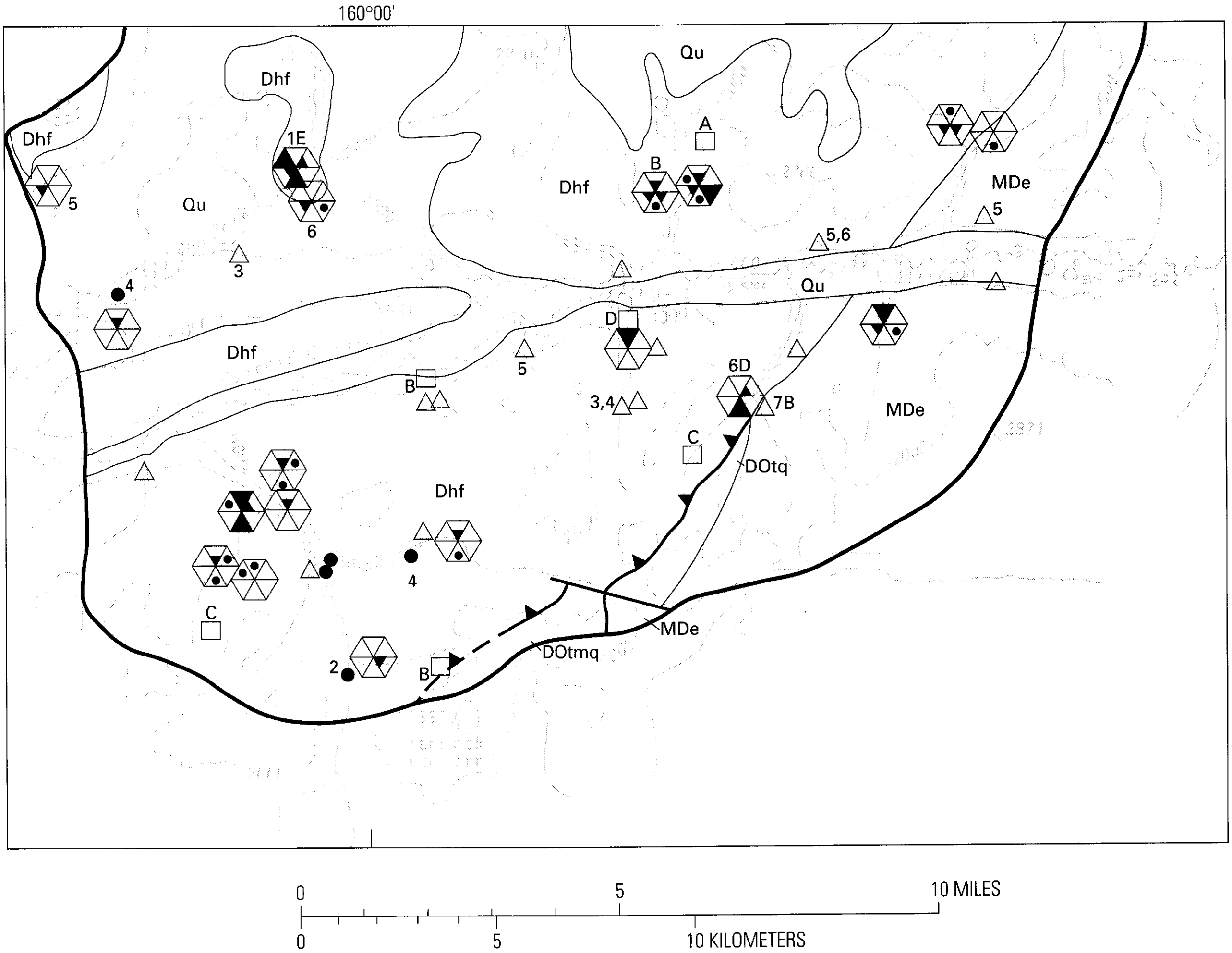



**Figure 7 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the lower Aklumayuak Creek area (geochemically anomalous area 5). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

molybdenum, and nickel. Some of these anomalous concentrations, for samples lacking microscopically visible sulfides, may reflect fine-grained, metalliferous lithic fragments. Conversely, the occurrence of pyrite and chalcopyrite in many of the samples indicates that some of the anomalous data indicate sulfide mineral phases. Sites of the most anomalous samples, containing very high silver, copper, iron, molybdenum, nickel, and zinc concentrations, cluster near the drainage divide between Tukpahlearik Creek and an unnamed tributary of the Salmon River, southwest of hill 2733. This area is the most geochemically favorable part of area 6 for the presence of metalliferous slate and shale and possibly sulfide mineral occurrences.

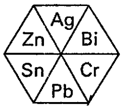
## Area 7—Headwaters of the Nikok River

The headwaters of the Nikok River are underlain largely by Proterozoic and Paleozoic schist (fig. 9). Disseminated pyrite cubes and distinctive iron staining are widespread throughout the schist in this area, but no base-metal occurrences have been identified. Base-metal values, however, are consistently anomalous in most stream-sediment samples collected from area 7.

The majority of the stream-sediment samples collected from area 7 contain 50–150 ppm Co, 70–100 ppm Cu, 100–200 ppm Ni, and 200–300 ppm Zn. Although corresponding concentrate samples were rarely anomalous with respect to the base metals, chalcopyrite, galena, or sphalerite were noted in a few samples. The lack of consistently anomalous concentrate samples, despite widespread anomalies in corresponding stream sediments, suggests that some of the sediment anomalies reflect either high lithogeochemical background levels for schist, or they are the result of hydromorphic dispersion of base-metal occurrences.

Two sediment samples and three concentrate samples from area 7 are also anomalous in silver and (or) lead. Galena is a likely source for these anomalies. The silver-lead

# EXPLANATION




**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

△ **Locality of AMRAP stream-sediment sample where no heavy-mineral-concentrate sample was collected**

[Values are in parts per million; S, stream-sediment; H, heavy-mineral-concentrate; <, less than; leaders (– –), no value for that category]

| Category | Map symbol | Ag | Bi | Cr | Pb | Sn | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽• | 1 | <20 | 300 | 500–1,000 | – – | 1,000–2,000 |
| Moderately anomalous. | ⧨ | 1.5–5 | 70 | 500 | – – | 30–70 | – – |
| Highly anomalous. | ▼ | 10–30 | – – | 700 | 7,000–15,000 | – – | 3,000 |

SAMPLE DESCRIPTIONS: 1, 200 ppm Cu (H); 2, 700 ppm Cu (H); 3, 0.5 ppm Ag (S); 4, 2,000–3,000 ppm Mn (S); 5, 200 ppm Cr (S); 6, 300 ppm V (S); 7, 300 ppm Zn (S).

□ **Locality of National Uranium Resource Evaluation (NURE) stream-sediment sample. Where AMRAP and NURE sample localities coincide, only the AMRAP symbol is shown**

SAMPLE DESCRIPTIONS: A, 24 ppm Pb; B, 17–24 ppm W; C, 60–85 Cu; D, 39-40 ppm Co; E, 2,435 ppm Mn.

Qu **Undifferentiated surficial deposits (Quaternary)**

MDe **Endicott Group (Mississippian and Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

DOtq **Carbonaceous quartzite and quartz conglomerate of Tukpahlearik Creek (Devonian? to Ordovician)**

DOtmq **Marble and quartz schist of Tukpahlearik Creek (Devonian to Ordovician)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate; dashed where approximately located

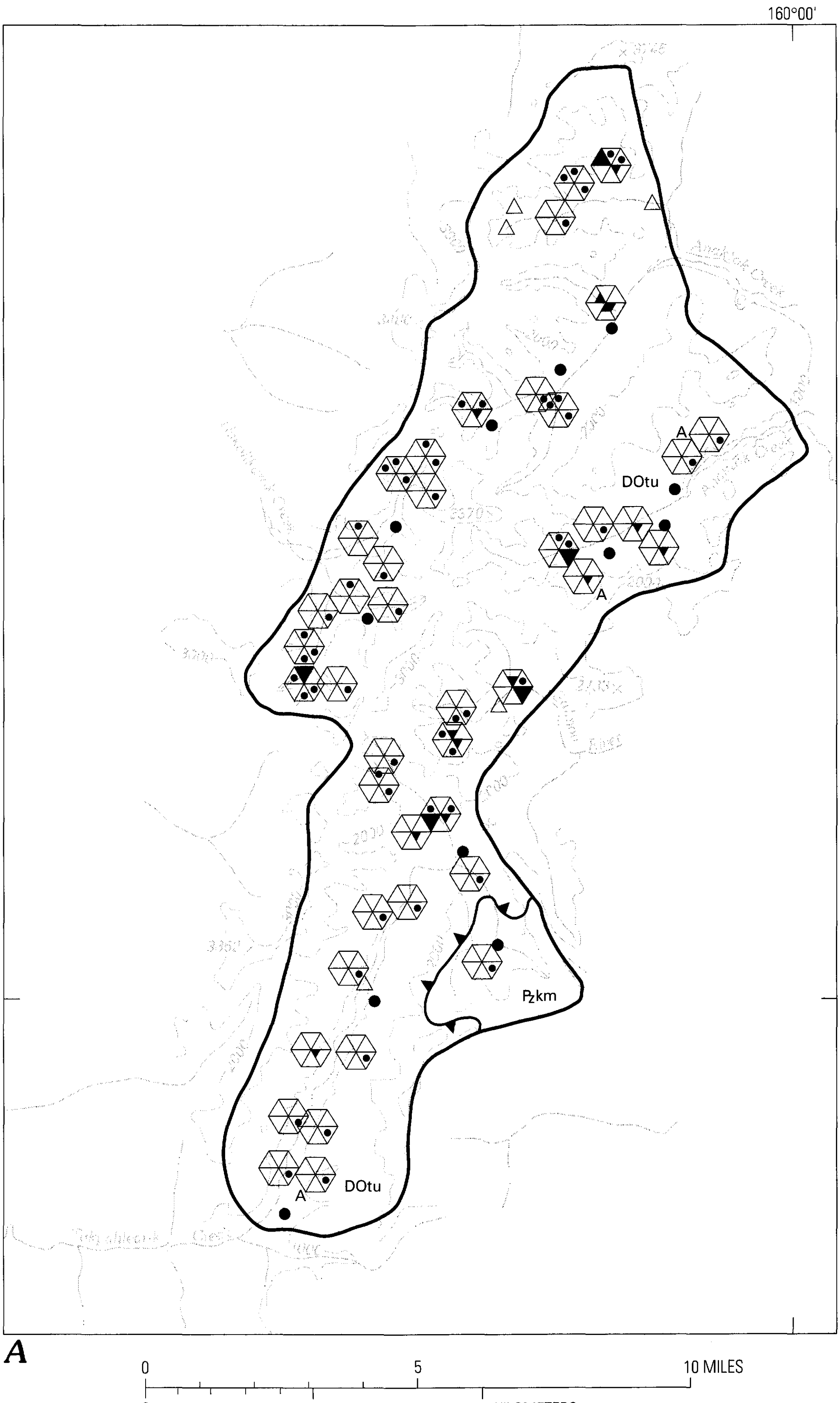
**Boundary of geochemically anomalous area**

anomalies indicate a locally high favorability for silver-rich base-metal mineral occurrences.

The majority of heavy-mineral-concentrate samples collected from the headwaters of the Nikok River contain anomalous amounts of tungsten, in the form of scheelite. The two samples with the highest tungsten concentrations (5,000 ppm) are derived from the southeastern side of hill 3270. Although gold anomalies are not associated with the anomalous tungsten in area 7, tungsten anomalies are widespread in the vicinity of placer-gold occurrences to the south in the Kallarichuk Hills (area 8). This relationship suggests that scheelite-bearing quartz veins that could be auriferous are a possible mineral-occurrence type within area 7.

## Area 8—Kallarichuk Hills

Area 8 (fig. 10) is underlain mainly by Paleozoic and Proterozoic quartz-mica schist, siliceous schist, and calcareous schist (Karl and others, 1989). Rare metabasite and chert have been noted in the southern part of the area. Minor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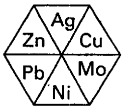
## EXPLANATION




Locality of geochemically anomalous stream-sediment sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below

● Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements

[Values are in parts per million; leaders (- -), no value for that category]

| Category | Map symbol | Ag | Cu | Mo | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 0.5 | 70 | 5–7 | 100 | -- | 200 |
| Moderately anomalous. | | .7 | -- | 10–15 | 150 | -- | 300 |
| Highly anomalous. | | 1.5 | -- | 20 | -- | 70 | 500 |

Geochemical data from the National Uranium Resource Evaluation (NURE) studies

△ Locality of water sample containing 3.4 to 8.2 ppb U—Where AMRAP and NURE sample localities coincide, the letter A designates the anomalous NURE water sample

DOtu Carbonaceous quartzite, quartz conglomerate, marble, quartz schist, and pelitic schist of Tukpahlearik Creek (Devonian to Ordovician)

Pzkm Marble of Klery Creek (Paleozoic)

Thrust fault—Saw teeth on upper plate

Boundary of geochemically anomalous area

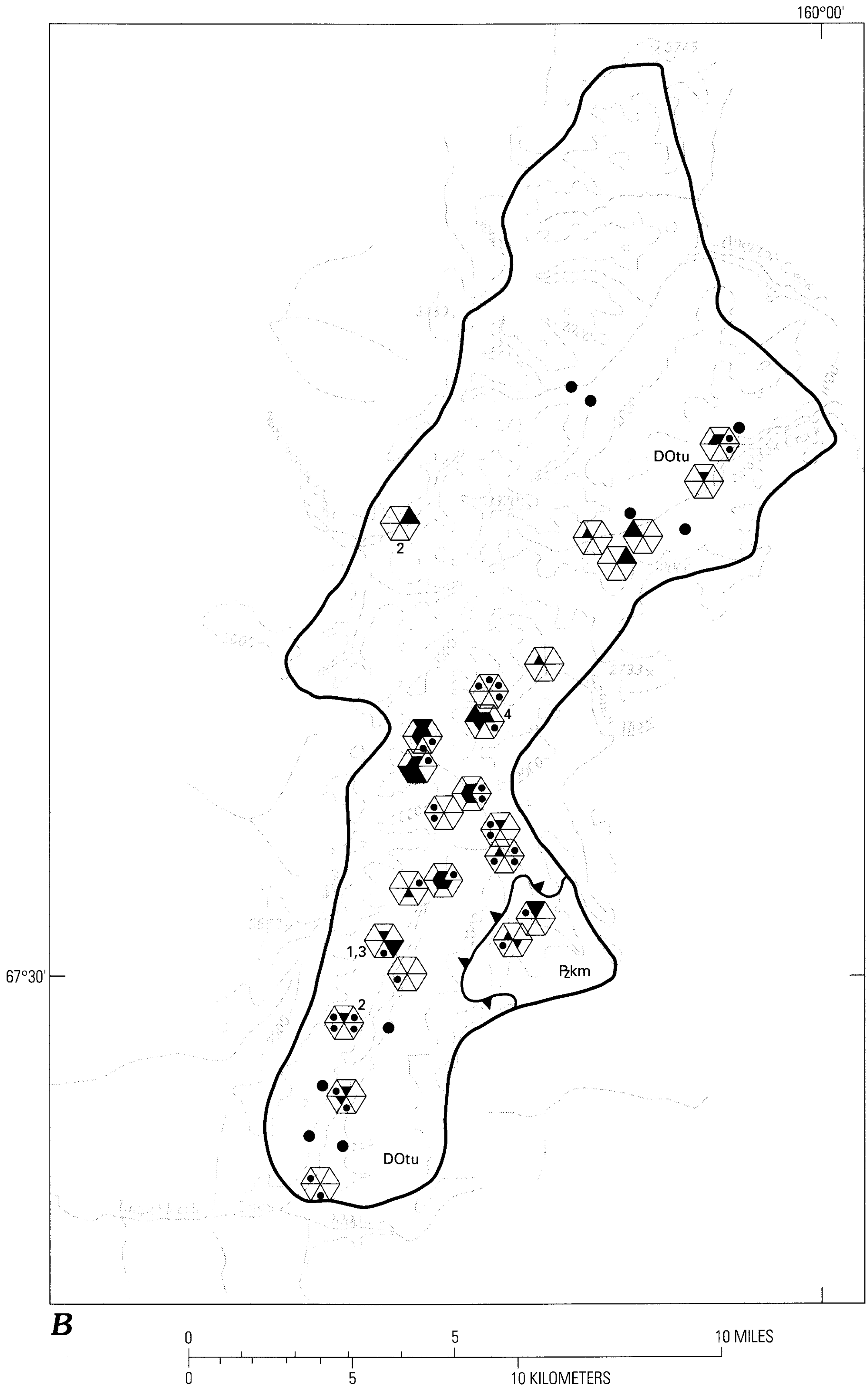
**Figure 8 (above, facing and following pages).** Sample-locality maps for the Tukpahlearik Creek area (geochemically anomalous area 6). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, Stream-sediment samples; *B*, Heavy-mineral-concentrate samples.

amounts of igneous rock (not shown on fig. 10) crop out in area 8. Schmidt and Allegro (1988) described fluorite-bearing granite gneiss in upper Timber Creek, fluorite-bearing diorite and rhyolite outcrops at the southern edge of area 8, and altered diorite along the Kallarichuk River.

Almost all of the concentrate samples collected from drainages within the Kallarichuk Hills contain anomalous amounts of tin, some with concentrations of 500 ppm or greater. Many of these anomalous samples contain microscopically visible cassiterite. The anomalous tin may have been derived from the scattered, minor outcrops of the more felsic igneous rocks within the Kallarichuk Hills.

Gold-placer mining was intermittent from the early 1900's through the present on Klery and Timber Creeks on the western side of the Kallarichuk Hills. Most of the concentrate samples collected from this area, especially from Timber, Klery, and Spruce Creeks, contain anomalous amounts of tungsten, with values ranging from 150 ppm to 5,000 ppm. Microscopic examination of the concentrate samples indicates that scheelite is the tungsten-bearing mineral phase. Some of these samples with anomalous tungsten also contain anomalous concentrations of silver and (or) gold. The samples enriched in these precious metals were collected near hill 2286 in upper Timber Creek and along Klery Creek, both areas of placer-gold production.

Although no lode production is reported from the area, the source of the placer gold is probably quartz veins within the metasedimentary rocks. Cobb (1975) reported gold occurring within quartz pebbles in some of the Klery Creek placers. A private company report indicates that a "several mile" long zone of quartz veins occurs along the east side of Klery Creek, probably near the unnamed creek north of Jack Creek on the 1:63,360-scale map of the area. The report suggests, based on the presence of placer gold, that both lode- and placer-gold potential occur in an 80-km by 56-km area between Klery Creek and the Salmon River (Anaconda Geological Document Collection, American Heritage Center—University of Wyoming, unpub. data). Most likely, the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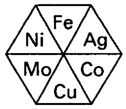
## EXPLANATION




Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below

● Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements

[Values are in parts per million except Fe, in percent; leaders (- -), no value for that category]

| Category | Map symbol | Fe | Ag | Co | Cu | Mo | Ni |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ | 7 | 1–2 | 100 | 200 | 10–15 | 150 |
| Moderately anomalous. | ▼ | 10 | 3 | 150 | 500 | 20 | 200–500 |
| Highly anomalous. | ▼ | 15 | 7 | 200 | 700 | -- | 500–700 |

SAMPLE DESCRIPTIONS: 1, 2,000 ppm Mn; 2, 700–2,000 ppm Pb; 3, 700 ppm V; 4, 1,000 ppm Zn.

DOtu Carbonaceous quartzite, quartz conglomerate, marble, quartz schist, and pelitic schist of Tukpahlearik Creek (Devonian to Ordovician)

Pzkm Marble of Klery Creek (Paleozoic)

Thrust fault—Saw teeth on upper plate

Boundary of geochemically anomalous area

scheelite in area 8 is coming from the same quartz veins that have released the gold. Scheelite is commonly found worldwide within auriferous quartz in metasedimentary rocks. The restriction of the anomalous tungsten to the western side of the Kallarichuk Hills, a much narrower distribution than that of the anomalous tin, tends to indicate a dissimilar source for both the scheelite and cassiterite. The distribution of concentrate samples with anomalous tungsten values (areas 7, 8) defines the one part of the Baird Mountains quadrangle with significant geochemical favorability for gold, in both placer and lode occurrences.

Several locations within area 8 show geochemical favorability for base-metal mineral occurrences. The most significant of these extends from the headwaters of Jack Creek to hill 2708, on the east side of the Kallarichuk Hills ridge crest (fig. 10, pl. 1). Concentrate samples from this area are anomalous in silver, cobalt, lead, antimony, and zinc and corresponding stream-sediment samples are enriched in barium, cobalt, copper, molybdenum, nickel, lead, and zinc. Zayatz and others (1988) and Schmidt and Allegro (1988) described several outcrops of iron-stained schist and vein quartz from this locality. Less extensive base-metal signatures in stream-sediment samples also occur within the headwaters of Crooked Creek, on the east side of hill 2286 within the upper Timber Creek watershed, and along the southern edge of area 8. The anomalies probably reflect small, disseminated sulfide occurrences within the metasedimentary rocks or false anomalies resulting from the scavenging of metals by iron and manganese oxides.

## Area 9—Headwaters of the Omar River

Area 9 is underlain by Paleozoic limestone and dolostone of the Baird Group on its western side, by undivided Paleozoic rocks on the east, and by the Devonian Hunt Fork Shale and undivided Devonian rocks on the north (fig. 11). Area 9 includes the Omar, Frost, and Powdermilk base-metal occurrences (fig. 11) described earlier.

Geochemical signatures from concentrate samples clearly identify the upstream mineralization at the Powdermilk and Frost occurrences but not at the Omar occurrence. Lead values in samples surrounding Powdermilk and Frost are typically more than 1,500 ppm; four samples from below these occurrences contain 10,000 to more than 50,000 ppm Pb. Silver and zinc are also strongly anomalous in many of

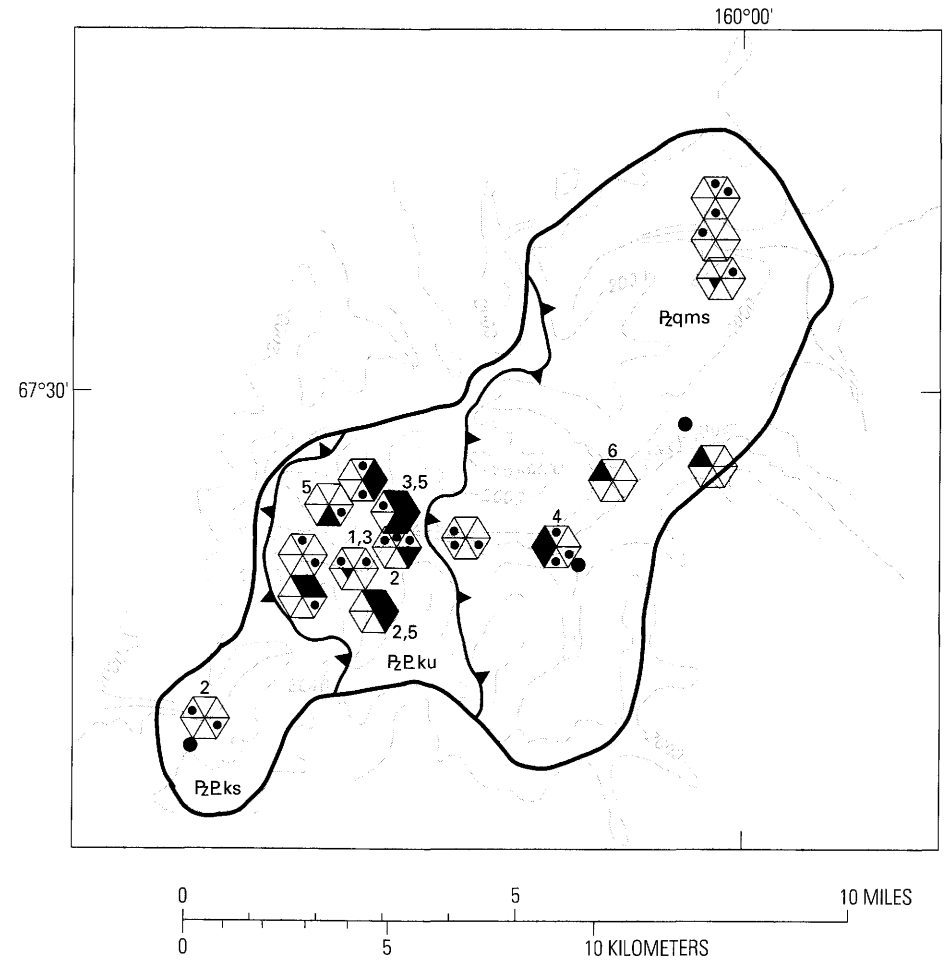
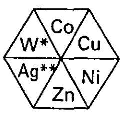



**Figure 9 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the headwaters of the Nikok River (geochemically anomalous area 7). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

the samples, and barium values are consistently more than 10,000 ppm. Stream-sediment samples from drainages below all three mineralized areas are anomalous. Copper values in sediment samples downstream from the Omar occurence range from 70 to 150 ppm, and from below Powdermilk and Frost lead in sediment samples is as high as 500 ppm. Also, NURE sediment samples contain elevated values of copper, nickel, and zinc downstream from the Omar prospect. However, they do not indicate the upstream mineralization at either Powdermilk or Frost.

Concentrate-sample sites with anomalous values for barium, lead, and zinc (±Ag, Cu, Mo, and Ni) are scattered in the western part of area 7. Concentrate samples from along the north-northwest-trending tributary of the Omar River, east of the Frost occurrence, contain anomalous barium and cobalt (±Ag, Mo, Ni, and Cu). However, only a few corresponding stream-sediment samples show slightly elevated values for silver, molybdenum, and lead from these two areas. This discrepancy likely indicates that metals are weathering mechanically as discrete grains, and they are at concentrations too low for detection in stream sediments. The anomalous concentrate samples indicate high geochemical favorability for carbonate-hosted base-metal occurrences in the western part of area 9.

A cluster of sediment samples from drainages underlain by undivided Paleozoic schist and phyllite in the east-central part of area 9 contains anomalous amounts of silver, molybdenum, lead, and zinc (±Ba and Cu). Only four corresponding concentrate samples also contain elevated values for these metals. NURE sediment samples from this area also contain anomalous chromium, copper, iron, and nickel (±Co, Pb, U, V, and Zn). Schmidt and Allegro (1988) reported numerous occurrences of hematite-stained gossans and local boxwork textures in bedrock and cobbles within the catchment basin. The general lack of anomalous metal values in concentrate samples relative to anomalies in corresponding




## EXPLANATION

**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below. In the diagram, an asterisk indicates a heavy-mineral-concentrate sample. A double asterisk indicates both stream-sediment and heavy-mineral-concentrate samples**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; S, stream sediment; H, heavy-mineral concentrate; leaders (- -), no value for that category]

| Category | Map symbol | Stream-sediment samples Co | Cu | Ni | Zn | Ag | Heavy-mineral-concentrate samples Ag | W |
|---|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ | 50–70 | 70 | 100 | 200 | 0.5–.7 | -- | 150–300 |
| Moderately anomalous. | ⧨ | -- | -- | -- | -- | -- | 2–5 | -- |
| Highly anomalous. | ▼ | 100–150 | 100 | 150–200 | 300 | -- | 30 | 2,000–5,000 |

SAMPLE DESCRIPTIONS: 1, 100 ppm Pb (S); 2, 100–150 ppm Co (H); 3, 500–1,500 ppm Pb (H); 4, 7,000 ppm Pb (H); 5, 30–50 ppm Sn (H); 6, 1,000 ppm Sn (H).

Pzqms **Quartz mica schists (Paleozoic)**

PzPku **Mixed schists of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

PzPks **Siliceous schist of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

▲▲▲ **Thrust fault**—Saw teeth on upper plate

——— **Boundary of geochemically anomalous area**

sediment samples suggests either high geochemical background for many elements in the metasedimentary rocks or hydromorphic dispersion from sulfide occurrences.

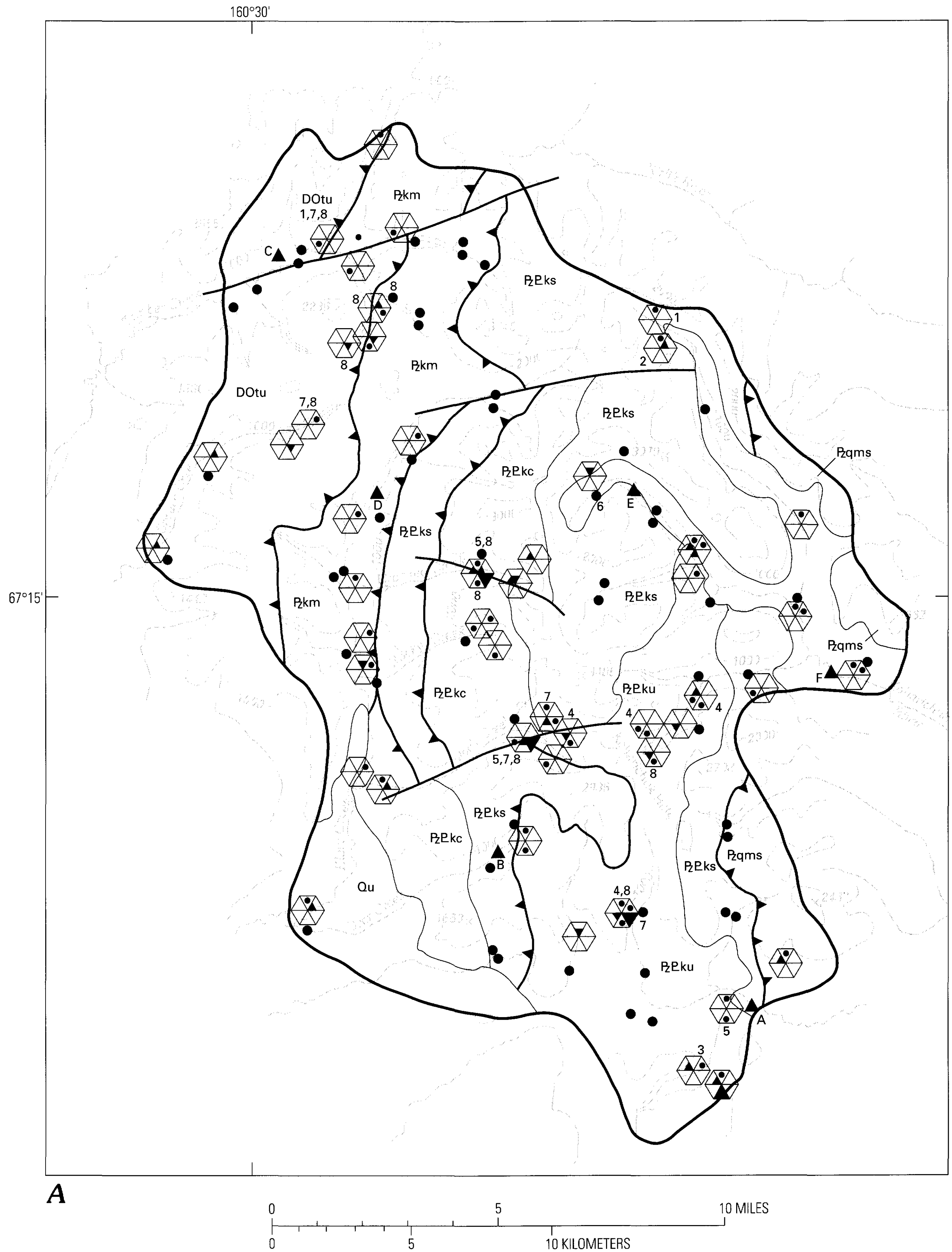
In the northern part of area 9 near peak 2730, concentrate samples with more than 5,000 ppm Ba, a few of which contain anomalous silver and lead (±Cu and Mo), occur within drainages underlain by schist, phyllite, and carbonate rocks. These anomalies may reflect isolated barite pods or lenses with associated sulfide minerals.

## Area 10—Nakolikurok Creek

Area 10 is underlain primarily by Devonian clastic rocks of the Hunt Fork Shale and Noatak Sandstone, and undivided Paleozoic schist, phyllite, greenstone, and carbonate and clastic rocks (fig. 12).

AMRAP stream-sediment samples from the southeastern part of area 10, underlain by undivided Paleozoic schist and Endicott Group clastic rocks, contain high amounts of cobalt, iron, and nickel (±Cr and Cu). Iron concentrations are commonly 10 percent and are accompanied by 50 ppm Co and 100 ppm Ni. NURE sediment samples from this region also show elevated cobalt, chromium, copper, iron, nickel, vanadium, and zinc values. Five of six AMRAP sediment samples from the headwaters of Sapun Creek do not have corresponding concentrate samples. However, the one concentrate sample collected from Sapun Creek contains 3,000 ppm As, 1 ppm Ag, and 20 percent Fe, suggesting the presence of detrital sulfide minerals.

Concentrate samples from many of the southern tributaries of Nakolikurok Creek contain anomalous amounts of cobalt, copper, and iron (±Ag, Pb, and Zn), strongly suggestive of sulfide mineralization. Concentrations range to as much as 150–500 ppm Co, 1,500 ppm Cu, 7–15 percent Fe, and 10,000 ppm Zn. Pyrite and (or) chalcopyrite were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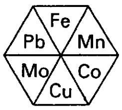
## EXPLANATION




**Locality of geochemically anomalous stream-sediment samples collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; leaders (– –), no value for that category]

| Category | Map symbol | Fe | Mn | Co | Cu | Mo | Pb |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ | 7 | 2,000 | 50 | 70 | 5–7 | – – |
| Moderately anomalous. | ▼ | 10 | 3,000 | 70 | 100 | 10 | 70 |
| Highly anomalous. | ▼ | – – | – – | 100 | 200 | – – | – – |

SAMPLE DESCRIPTIONS: 1, 0.5 ppm Ag; 2, 5 ppm Ag; 3, 300 ppm B; 4, 2,000 ppm Ba; 5, 200 ppm Cr; 6, 100 ppm Sn; 7, 200 ppm Zn; 8, 100 ppm Ni.

▲ **Locality of National Uranium Resource Evaluation (NURE) stream-sediment sample**

SAMPLE DESCRIPTIONS: A, 266 ppm Zn; B, 235 ppm Zn; C, 4.8 ppm U; D, 8.4 percent Fe; E, 6.0 ppm U; F, 5.7 ppm U.

Qu **Undifferentiated surficial deposits (Quaternary)**

DOtu **Undivided metasedimentary rocks of Tukpahlearik Creek (Devonian to Ordovician)**

Pzkm **Marble of Klery Creek (Paleozoic)**

Pzqms **Quartz mica schists (Paleozoic)**

PzPks **Siliceous schist of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

PzPkc **Calcareous schist and marble of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

PzPku **Mixed schists of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

**Contact**

**Fault**—Movement uncertain

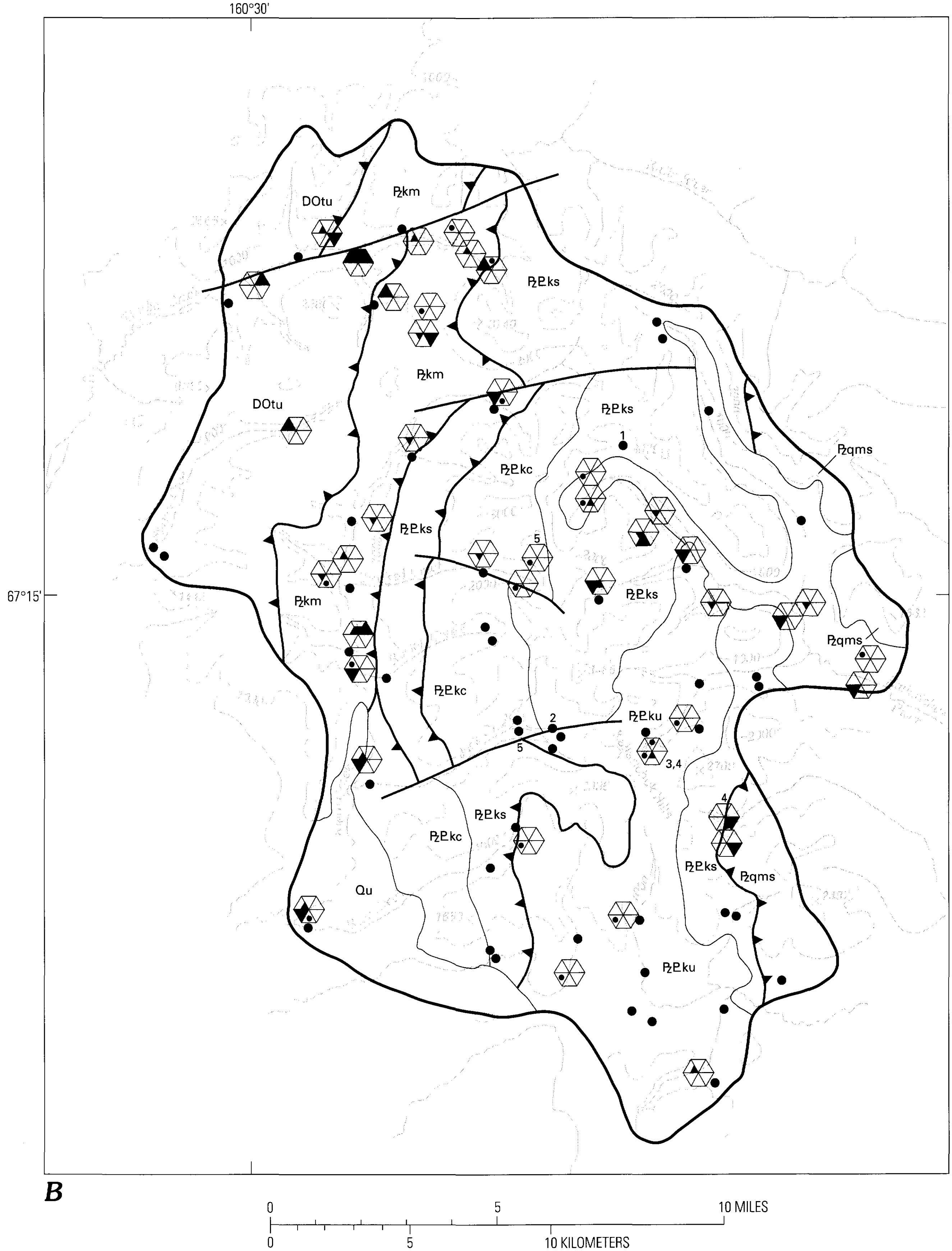
**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

**Figure 10 (above, facing and following pages).** Sample-locality maps for the Kallarichuk Hills (geochemically anomalous area 8). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, Stream-sediment samples; *B*, Heavy-mineral-concentrate samples.

observed microscopically in most samples. Schmidt and Allegro (1988) and Zayatz and others (1988) reported numerous occurrences of red-stained quartz cobbles, pyrite- or chalcopyrite-bearing quartz veins in shear zones and along foliation planes, and pyrite in black phyllite upstream from many of the anomalous samples.

Elevated amounts of chromium and iron (±Ni) are in sediment samples from the lower parts of Nakolikurok Creek. These concentrations probably reflect the black phyllite of the Endicott Group. However, four concentrate samples from south of the Angayukalik Hills contain as much as 30 ppm Ag, 10,000 ppm Ba, 3,000 ppm Pb, and (or) 5,000 ppm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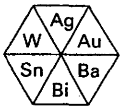
**B**

# EXPLANATION




**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

[Values are in parts per million; leaders (– –), no value for that category; <, less than; >, greater than; ≥, equal to or greater than]

| Category | Map symbol | Ag | Au | Ba | Bi | Sn | W |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 1 | -- | -- | <20 | 30–70 | 100 |
| Moderately anomalous. | | 7–15 | -- | -- | 20–30 | 100–300 | 150–200 |
| Highly anomalous. | | 15,000 | ≥20 | >10,000 | 1,000 | ≥500 | ≥300 |

SAMPLE DESCRIPTIONS: 1, 500 ppm B; 2, 500 ppm Co; 3, 700 ppm Sb; 4, 700–1,000 ppm Pb; 5, 3,000 ppm Zn.

Qu **Undifferentiated surficial deposits (Quaternary)**

DOtu **Undivided metasedimentary rocks of Tukpahlearik Creek (Devonian to Ordovician)**

Pzkm **Marble of Klery Creek (Paleozoic)**

Pzqms **Quartz mica schists (Paleozoic)**

PzPks **Siliceous schist of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

PzPkc **Calcareous schist and marble of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

PzPku **Mixed schists of the Kallarichuk Hills (Paleozoic and(or) Proterozoic)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

Zn. These concentrations indicate a high geochemical favorability for base-metal occurrences.

Concentrate samples from the east- and west-draining tributaries in the lower reaches of the Nakolik River, and to the west of Nakolik Mountain, contain variably anomalous amounts of silver, barium, and lead (±Cu and Zn). One of these samples, to the southeast of Nakolik Mountain, contains 10 ppm Ag, 200 ppm Cu, 5,000 ppm Pb, and 5,000 ppm Zn. NURE stream-sediment samples throughout the watershed west of Nakolik Mountain are anomalous in lead and tungsten. These anomalies in the northwestern part of area 10 may partly reflect scattered sulfide occurrences within quartz veins in the Hunt Fork Shale or Devonian carbonate rocks.

## Area 11—Upper Nakolik River

Area 11 is largely underlain by mixed Devonian sedimentary rocks (fig. 13). The southern and eastern parts of the area are underlain by mixed Devonian clastic and carbonate rocks, and the Devonian Hunt Fork Shale and Noatak Sandstone underlie the central and northern parts of the area. Zayatz and others (1988) reported minor

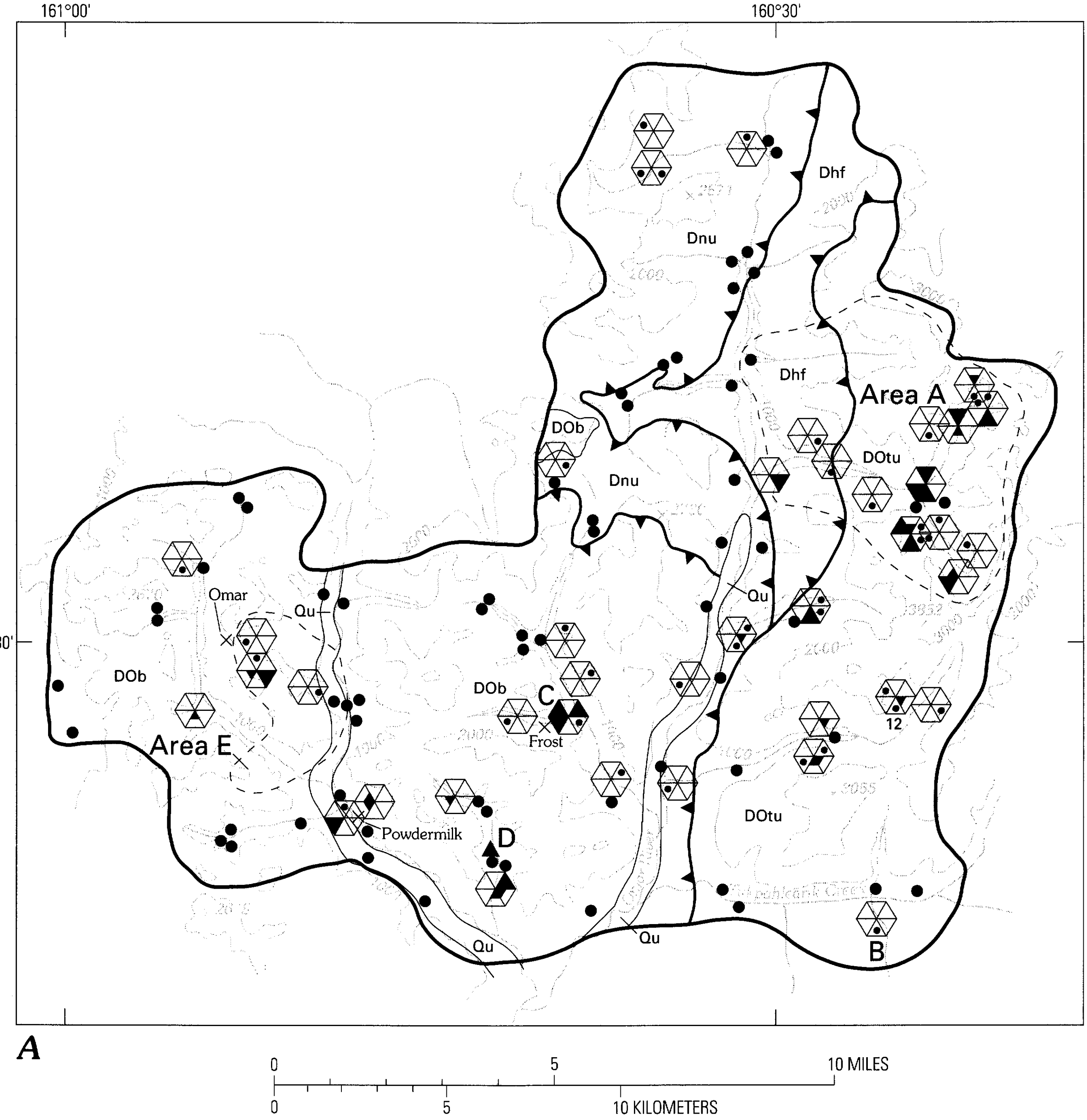



**Figure 11 (above and following pages).** Sample-locality maps for the headwaters of the Omar River (geochemically anomalous area 9). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, Stream-sediment samples; *B*, Heavy-mineral-concentrate samples.

occurrences of red-stained zones, and local pyrite and malachite within carbonate rocks in area 11.

Both stream-sediment and concentrate samples contain elevated amounts of many metals, and these values probably reflect both mineralization and background lithogeochemical concentrations. Scattered stream-sediment samples collected in area 11 contain 200 ppm Cr, 7–10 percent Fe, 100 ppm Ni, and 300 ppm V, possibly indicative of black shale interbedded with other Devonian sedimentary rocks. All 13 concentrate samples collected from the area (9 of the 22 sites in area 11 contained insufficient material for concentrate samples) contain 10,000 ppm or more Ba, suggesting the possibility of bedded barite in the sedimentary sequence. Additionally, some sulfide mineralization is suggested by

## EXPLANATION

**Locality of geochemically anomalous stream-sediment sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

**Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; leaders (– –), no value for that category]

| Category | Map symbol | Ag | Ba | Cu | Mo | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 0.5 | 2,000 | 70 | 5 | 70 | 200 |
| Moderately anomalous. | | 0.7–1 | – – | 100 | 10 | 100–150 | 300 |
| Highly anomalous. | | 3 | 5,000 | 200–300 | 15 | 200–500 | 500 |

SAMPLE DESCRIPTIONS: 1, 100 ppm Co; 2, 150 ppm Ni.

**Locality of National Uranium Resource Evaluation (NURE) stream-sediment sample**

SAMPLE DESCRIPTIONS: Area A, area of sediment samples containing 150–200 ppm Cr, 50–100 ppm Cu, 6.2–6.3 percent Fe, 67–110 ppm Ni, and anomalous Co, Pb, U, V, and Zn; B, 2,105 ppm Ba, 67 ppm Cu, 75 ppm Ni, 4 ppm Sb, 4.3 ppm U, 245 ppm V, and 200 ppm Zn; C, 131 ppm Ni, 181 ppm V, and 290 ppm Zn; D, 17 ppm Pb; Area E, area of sediment samples containing 120 ppm Cu, 136 ppm Ni, or 229 ppm Zn.

Area A — **Area of anomalous sediment sample**—Elements described above under SAMPLE DESCRIPTIONS

Qu — **Undifferentiated surficial deposits (Quaternary)**

Dhf — **Hunt Fork Shale (Devonian)**

Dnu — **Undivided phyllite, carbonate, and clastic rocks of Nakolik River (Devonian)**

DOtu — **Marble, pelitic schist, and greenstone, undivided, of Tukpahlearik Creek (Devonian to Ordovician)**

DOb — **Baird Group (Devonian to Ordovician)**

**Contact**

**Thrust fault**—Saw teeth on upper plate

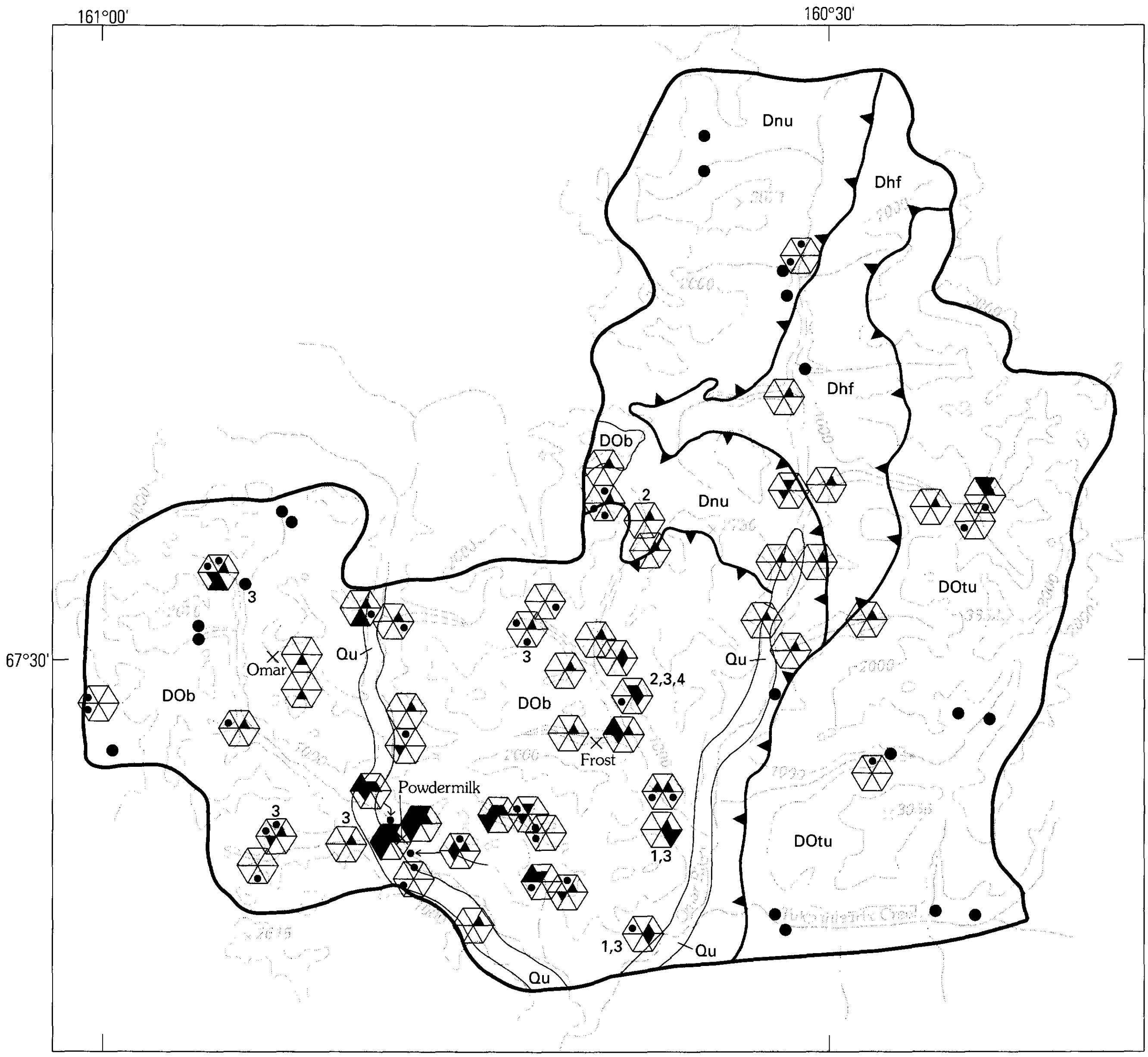
**Mineralized locality**—Showing name

**Boundary of geochemically anomalous area**

several concentrate samples from both north and south of hill 2630. These samples contain 200–1,500 ppm Cu and 10–15 percent Fe, and a single concentrate sample collected northeast of hill 3165 has 10,000 ppm Zn.

## Area 12—West Fork of the North Fork of the Squirrel River

Area 12 is underlain predominantly by Baird Group carbonate rocks (fig. 14). Only two AMRAP stream-sediment samples from the area contain anomalous base-metal values, and NURE sediment samples from this area did not contain anomalous values for any elements. Concentrate samples, however, indicate a strong lead-zinc (±Ag, Ba, Cu, Mo, and V) association, particularly in the northeastern and northwestern parts of area 12. Schmidt and Allegro (1988) reported pyrite and rusty-red stains on carbonate cobbles and outcrops in watersheds yielding some of the anomalous samples. In the southeastern part of area 12, concentrates are characterized by a boron-copper-iron (±Zn) association.

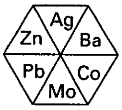



*B*

The strong base-metal association and tight clustering of anomalous concentrate samples derived from undifferentiated Devonian strata on the south side of hill 3280 suggest a high favorability for mineral occurrences in that area. Most of these samples contain 5,000 to 10,000 or more ppm Ba, 10–500 ppm Mo, 3,000–50,000 ppm Pb, 500–1,500 ppm V, and 1,500-5,000 ppm Zn. The furthest upstream sample also contains 30 ppm Ag, 1,500 ppm Cu, and 500 ppm Sb. Whereas anomalous values for molybdenum and vanadium likely indicate a high lithogeochemical background, many of the other anomalies are strong evidence for metallic mineralization in the vicinity of hill 3280.

Two concentrate samples collected in the northwestern part of area 12 show similar concentrations of these elements, also indicating the likely presence of base-metal mineral occurrences. Unlike the previously described locality further east in area 12, this locality southwest of hill 2745 is underlain solely by carbonate rocks of the Baird Group. The drainage basins containing the anomalous samples were briefly examined in 1985 for mineralized outcrops, but none were found.

# EXPLANATION




**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

[Values are in parts per million; >, greater than; ≥, equal to or greater than; leaders (- -), no value for that category]

| Category | Map symbol | Ag | Ba | Co | Mo | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ | 1–2 | -- | 100 | 10–15 | 500–1,000 | 1,000–3,000 |
| Moderately anomalous. | ▽ | 3–7 | >5,000 | 150 | 20 | 1,500–5,000 | 5,000 7,000 |
| Highly anomalous. | ▼ | 20–70 | -- | 200 | 70 | ≥10,000 | 10,000 |

SAMPLE DESCRIPTIONS: 1, 200 ppm Cu; 2, 500 ppm Cu; 3, 150–200 ppm Ni; 4, 500 ppm Sn.

Qu **Undifferentiated surficial deposits (Quaternary)**

Dhf **Hunt Fork Shale (Devonian)**

Dnu **Undivided phyllite, carbonate, and clastic rocks of Nakolik River (Devonian)**

DOtu **Marble, pelitic schist, and greenstone, undivided, of Tukpahlearik Creek (Devonian to Ordovician)**

DOb **Baird Group (Devonian to Ordovician)**

**Contact**

**Thrust fault**—Saw teeth on upper plate

× **Mineralized locality**—Showing name

**Boundary of geochemically anomalous area**

## Area 13—West Fork of the Squirrel River

Area 13 (fig. 15) is underlain in the southeast by Ordovician to Devonian carbonate rocks of the Baird Group. Devonian and Mississippian rocks of the Noaktak Sandstone, Hunt Fork Shale, and undivided carbonate and clastic rocks underlie the northwest part of the area. Many thrust faults separate rock units in the northwestern part of the area.

Concentrate samples collected from the southern part of area 13, in the headwaters of the westernmost fork of the Squirrel River, generally are slightly anomalous in cobalt and nickel, which might reflect weathering of disseminated pyrite. Schmidt and Allegro (1988) reported two occurrences of red-stained carbonate rocks and quartz with pyrite and copper sulfides and oxides in the southern part of area 13. Several isolated sample sites are especially noteworthy in this area. Concentrate samples collected east of hills 3160, 3137, and 1832 are strongly enriched in both silver and lead, with lead concentrations of at least 5,000 ppm indicating the presence of galena and (or) cerrussite. Values of 10 percent Fe and 500 ppm Ni for the sample from east of hill 1832 also suggests abundant pyrite near that locality. A single concentrate sample collected about 3 km south of hill 3160 contains 200 ppm Co, 700 ppm Cu, 10 percent Fe, 300 ppm Ni, and more than 2,000 ppm La. Although the cause of the anomalous lanthanum is uncertain, anomalous concentrations of the remaining elements undoubtedly reflect abundant iron and copper sulfides. Another sample, from about 1 km further southeast, contains 1,000 ppm Sb and 10,000 ppm W, the highest concentration of tungsten from the entire study area. Upstream areas should be care-

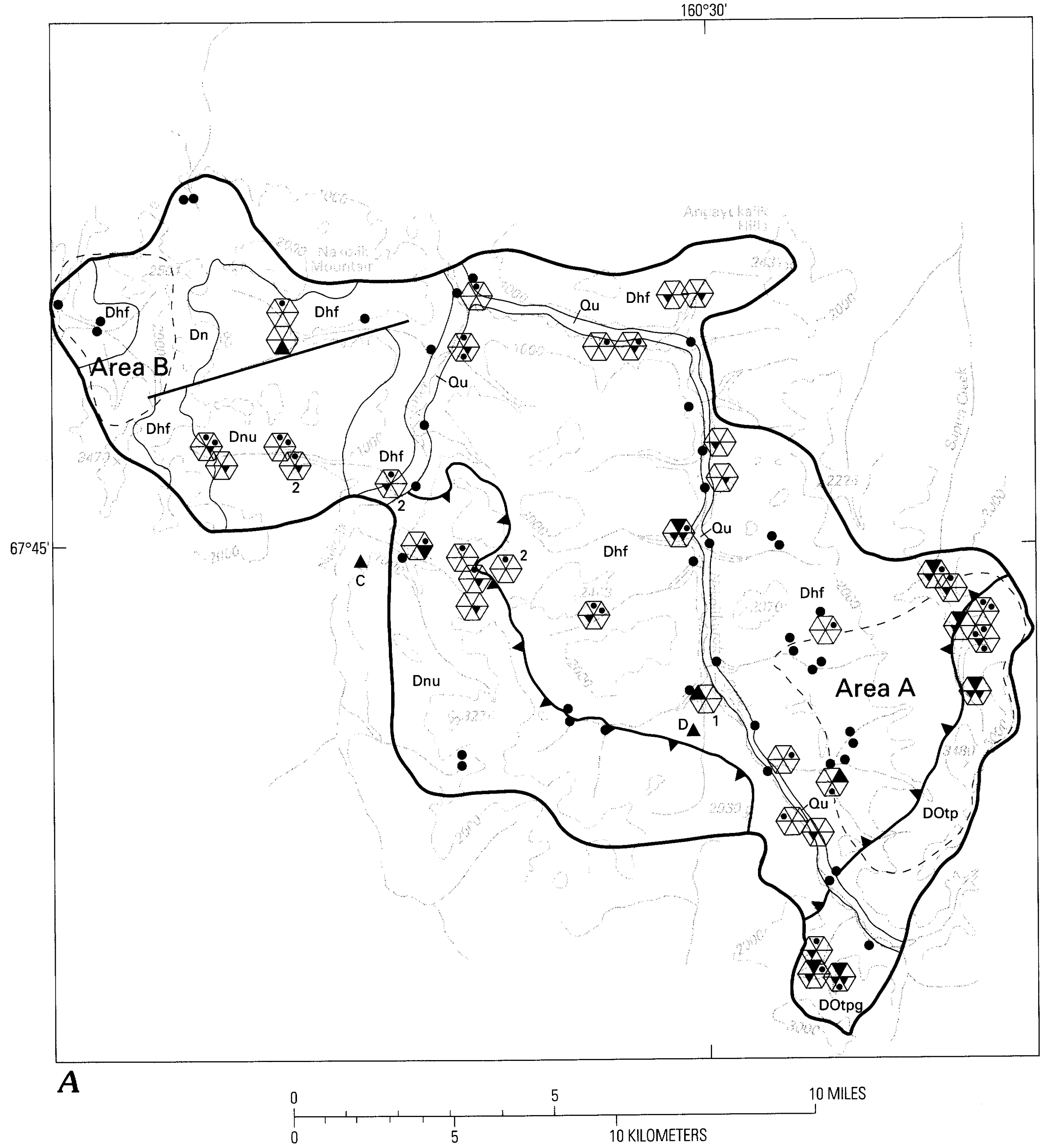
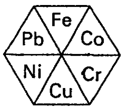



**Figure 12 (above and following pages).** Sample-locality maps for the Nakolikurok Creek area (geochemically anomalous area 10). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, Stream-sediment samples; *B*, Heavy-mineral concentrate samples.

fully examined for possible precious-metal-bearing quartz veins.

The Agashashok River drainage in the central and northwestern part of area 13 contains many phyllite-, shale-, and sandstone-hosted iron-stained quartz veins, pyrite and malachite lenses, and local chalcocite and azurite (Zayatz and others, 1988). Mineralization probably also included galena and sphalerite because concentrate samples from both

# EXPLANATION




**Locality of geochemically anomalous stream-sediment sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; leaders (– –), no value for that category]

| Category | Map symbol | Fe | Co | Cr | Cu | Ni | Pb |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ (with dot) | 7 | 50 | -- | 70 | -- | 70 |
| Moderately anomalous. | ▼ (partly filled) | -- | -- | 200 | -- | 100 | -- |
| Highly anomalous. | ▼ | 10 | 70 | -- | 100 | -- | 150 |

SAMPLE DESCRIPTIONS: 1, 1 ppm Ag; 2, 2,000 ppm Ba.

▲ **Locality of National Uranium Resource Evaluation (NURE) stream-sediment sample**

SAMPLE DESCRIPTIONS: Area A, area of stream-sediment samples containing as much as 41 ppm Co, 183 ppm Cr, 80 ppm Cu, 6.7 percent Fe, 83 ppm Ni, 193 ppm V, and 263 ppm Zn; Area B, area of samples containing as much as 30 ppm Pb and 19 ppm W; C, 21 ppm Pb; D, 58 ppm Cu and 11 ppm Sn.

( Area A ) **Area of anomalous sediment samples**—Elements described under SAMPLE DESCRIPTIONS

Qu **Undifferentiated surficial deposits (Quaternary)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dnu **Undivided phyllite, carbonate, and clastic rocks of Nakolik River (Devonian)**

DOtp **Pelitic schist of Tukpahlearik Creek (Devonian to Ordovician?)**

DOtpg **Pelitic schist and greenstone of Tukpahlearik Creek (Devonian to Ordovician?)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

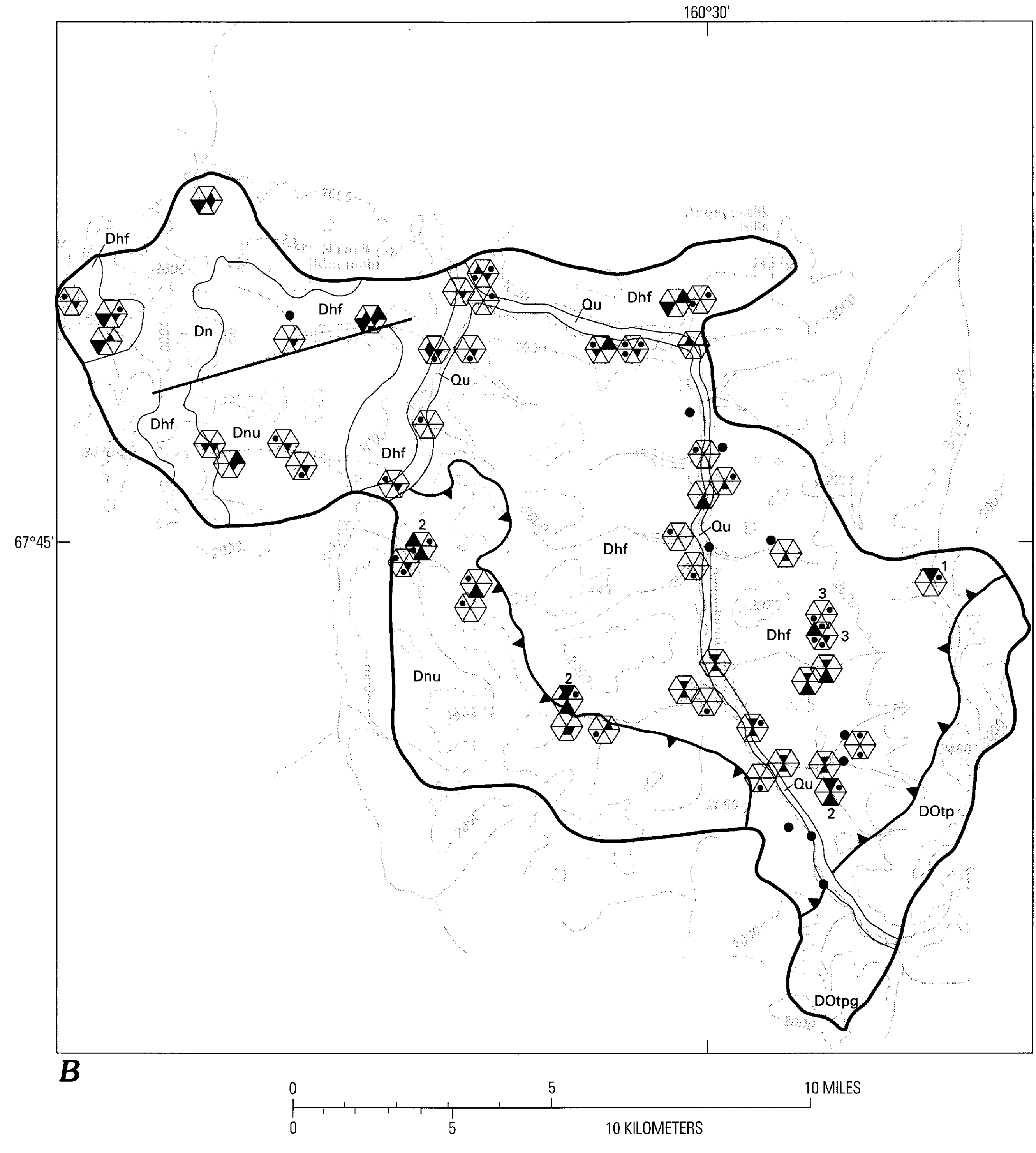
**Boundary of geochemically anomalous area**

these drainage basins contain these sulfide phases. The polymetallic suites in many concentrate samples suggest a high potential for base-metal mineralization throughout this area. Concentrate samples commonly have silver, lead, and zinc values of 3 ppm or more, 5,000 ppm or more, and 10,000 ppm or more, respectively. Many of these samples are also commonly enriched in barium, cobalt, copper, iron, and nickel.

Stream-sediment samples especially target the more northern branch of the Agashashok River, in the northwest corner of area 13, as favorable for base-metal occurrences. AMRAP sediment samples from this area contain as much as 200 ppm Cu, 200 ppm Pb, and 700 ppm Zn. Lead and zinc concentrations of 69 and 490 ppm, respectively, occur in one NURE sediment-sample site to the south of hill 3230; this lead concentration is the highest reported from the NURE survey.

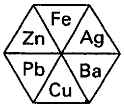
## Area 14—Eli River

Area 14 (fig. 16) is underlain by a variety of rock types and contains known mineral occurrences and previously




reported anomalous metal values in both stream-sediment and concentrate samples (Karl and others, 1985). The area encompasses most of the upper Eli River tributaries and parts of the upper Agashashok River (fig. 16). Rock types mainly consist of complexly interbedded Paleozoic shale, phyllite, sandstone, and limestone. Northeast-trending thrust faults commonly separate rock types.

Concentrate samples from the headwaters of the Agashashok River consistently contain at least 7,000 ppm Ba, and less commonly 500-700 ppm Pb and 1,000–2,000 ppm Zn. Corresponding sediment samples generally are not anomalous. Schmidt and Allegro (1988) reported several occurrences of pyrite-bearing phyllitic and carbonate rocks upstream from the most lead- and zinc-enriched concentrate




## EXPLANATION

**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; ≥, equal to or greater than; leaders (– –), no value for that category]

| Category | Map symbol | Fe | Ag | Ba | Cu | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | ▽ | 7 | 1–2 | – – | 200–300 | 500–700 | 1,000–2,000 |
| Moderately anomalous. | ▼ | 10 | 3–7 | ≥7,000 | 500–700 | 1,000 | 3,000–5,000 |
| Highly anomalous. | ▼ | 15–20 | 10–30 | – – | 1,000–1,500 | 2,000–5,000 | 10,000 |

SAMPLE DESCRIPTIONS: 1, 3,000 ppm As; 2, 150–200 ppm Co; 3, 300–500 ppm Co.

Qu **Undifferentiated surficial deposits (Quaternary)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dnu **Undivided phyllite, carbonate, and clastic rocks of Nakolik River (Devonian)**

DOtp **Pelitic schist of Tukpahlearik Creek (Devonian to Ordovician?)**

DOtpg **Pelitic schist and greenstone of Tukpahlearik Creek (Devonian to Ordovician?)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

samples. However, base-metal-bearing occurrences have not been recognized in this part of area 14.

Concentrates from the headwater tributaries of the Eli River in the northeastern part of area 14 contain anomalous barium and zinc with less consistent enrichments of copper and lead. Minor amounts of sphalerite and barite and less commonly galena and cerussite were observed in the anomalous samples. Two of the NURE sediment samples with very anomalous barium contents and an AMRAP sediment sample with 3,000 ppm Ba are from sites clustered in the headwaters of the most southeastern branch of the Eli River. Zayatz and others (1988) reported a few red-stained cobbles and iron-stained zones in carbonate and phyllite, with pyrite and minor chalcopyrite or bornite upstream from these anomalous samples.

At one site in the northeast part of area 14, below hill 3106, a sediment sample contains 0.5 ppm Ag, 70 ppm Co, 70 ppm Cu, 300 ppm Ni, and 1,000 ppm Zn, and the corresponding concentrate contains more than 10,000 ppm Ba, 700 ppm Cr, 150 ppm Ni, and 500 ppm V. The nickel and zinc concentrations in the AMRAP stream-sediment sample are the highest from the entire study area. Most likely these data reflect high background values in black shale or a small mafic intrusion. However, Zayatz and others (1988) reported an orange-weathering siliceous shale with pyrite, quartz veins, and anomalous silver and barium in the vicinity of the anomalous stream site.

The cluster of sites of anomalous samples along the south fork of the upper Eli River reflects mineralization mostly in Hunt Fork Shale and Noatak Sandstone. Zayatz and others (1988) reported numerous iron- and (or) copper-stained, commonly pyritic, silicified boulders and cobbles, and red-stained quartz veins in phyllite along the Eli River drainage. These occurrences are possible sources for anomalous silver,

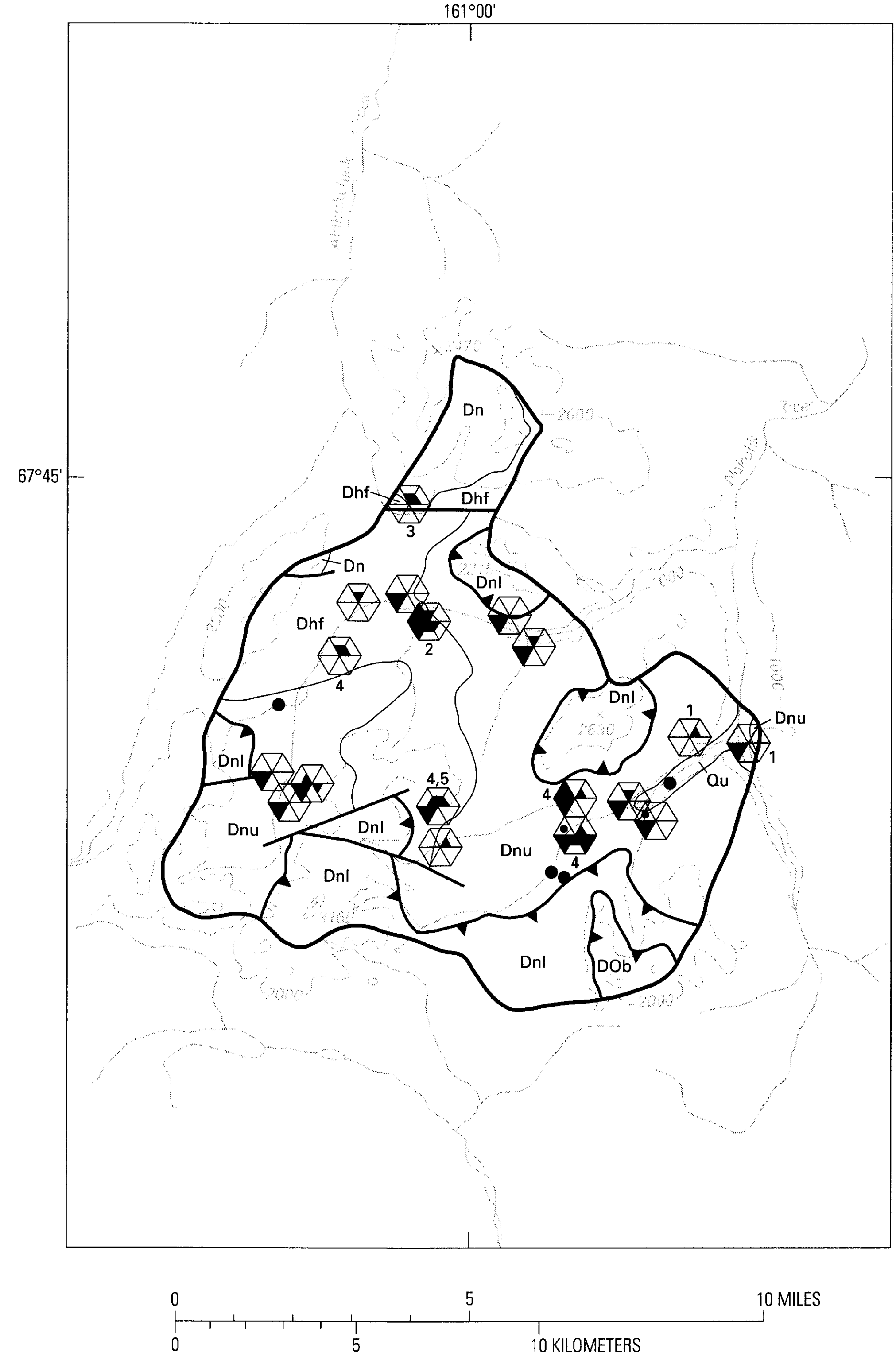
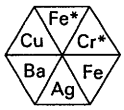



**Figure 13 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the upper Nakolik River area (geochemically anomalous area 11). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

# EXPLANATION




**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below. In the diagram, an asterisk indicates a stream-sediment sample; all others are heavy-mineral-concentrate samples**

● **Locality of AMRAP samples having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; S, stream sediment; H, heavy-mineral concentrate; ≥, equal to or greater than; leaders (- -), no value for that category]

| | | Stream-sediment samples | | Heavy-mineral-concentrate samples | | | |
|---|---|---|---|---|---|---|---|
| Category | Map symbol | Fe | Cr | Fe | Ag | Ba | Cu |
| Slightly anomalous. | | -- | -- | -- | -- | -- | 200–300 |
| Moderately anomalous. | | 7–10 | 200 | 10 | 2–3 | -- | 500–700 |
| Highly anomalous. | | -- | -- | 15 | -- | ≥10,000 | 1,000–1,500 |

SAMPLE DESCRIPTIONS: 1, 2,000 ppm Ba (S); 2, 0.5 ppm Ag (S); 3, 200 ppm Cu (S); 4, 300 ppm V (S); 5, 10,000 ppm Zn (H).

Qu **Undifferentiated surficial deposits (Quaternary)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dnu **Undivided phyllite, carbonate, and clastic rocks of Nakolik River (Devonian)**

Dnl **Limestone of Nakolik River (Devonian)**

DOb **Baird Group (Devonian to Ordovician)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

copper, lead, and zinc concentrations detected in concentrate samples from along the Eli River. Concentrates contain mostly sphalerite with lesser amounts of galena and (or) cerussite.

Copper, lead, and zinc are commonly anomalous in corresponding stream-sediment samples in the southern fork of the Eli River. Commonly observed iron oxide coatings on stream cobbles and pebbles may have adsorbed anomalous amounts of metals that are detected in the stream sediments, indicating chemical as well as mechanical dispersion of metals downstream from mineralized rock. Much of the iron may have been derived from pyrite-bearing quartz veins along foliation in the Hunt Fork Shale. These veins may locally host copper, lead, or zinc-bearing sulfides. Duttweiler (1987) reported similar mineralized veins in the Hunt Fork Shale in the Chandler Lake quadrangle east of the Baird Mountains.

Base-metal anomalies in concentrate samples from the northwestern part of area 14 may reflect mineralization of undivided Paleozoic rocks and the Kanayut Conglomerate.

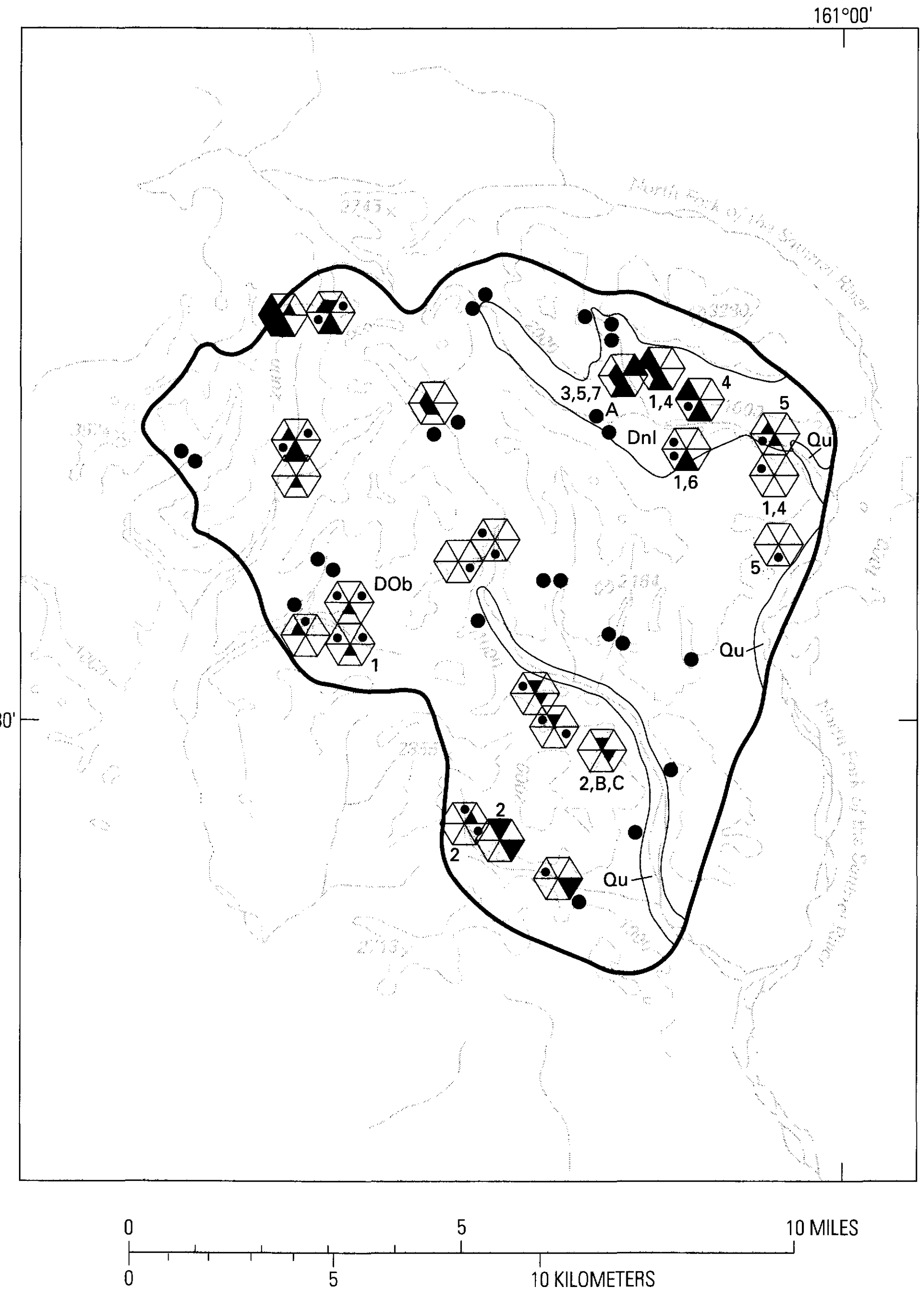
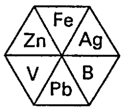



**Figure 14 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the area of the west fork of the North Fork of the Squirrel River (geochemically anomalous area 12). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

The most anomalous concentrate sample collected along Ahua Creek during the present survey contained 20 ppm Ag and 10,000 ppm Pb. Ellersieck and others (1984) and Karl and others (1985) first described stream sediments and rocks with anomalous silver, arsenic, barium, copper, lead, and (or) zinc values along Ahua Creek. One noteworthy occurrence, termed the "Ahua occurrence," consists of hydrothermally altered black shale with pyrite-marcasite lenses and concentrations of as much as 5 ppm Ag. Geochemically anomalous, syngenetic pyrite in black shale, as at the Ahua occurrence, may be a source for some of the stream-sediment and concentrate anomalies in this part of

## EXPLANATION




Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below

● Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements

[Values are in parts per million except Fe, in percent; >, greater than; S, stream sediment; H, heavy-mineral concentrate

| Category | Map symbol | Fe | Ag | B | Pb | V | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 7 | 1–3 | 500–700 | 500–700 | 500–700 | 1,000–1,500 |
| Moderately anomalous. | | 10 | 5 | 1,000 | 1,000–5,000 | 1,000–1,500 | 2,000–3,000 |
| Highly anomalous. | | 15 | 30 | 1,500 | 10,000–>50,000 | 5,000 | 5,000 |

SAMPLE DESCRIPTIONS: 1, >10,000 ppm Ba (H); 2, 200–500 ppm Cu (H); 3, 1,500 ppm Cu (H); 4, 10–20 ppm Mo (H); 5, 50–100 ppm Mo (H); 6, 500 ppm Mo; 7, 500 ppm Sb (H); A, 15 percent Fe (S); B, 70 ppm Cu (S); C, 70 ppm Pb (S).

Qu Undifferentiated surficial deposits (Quaternary)

Dnl Limestone of Nakolik River (Devonian)

DOb Baird Group (Devonian to Ordovician)

Contact

Boundary of geochemically anomalous area

area 14. However, consistently anomalous values for barium, lead, and zinc are just as likely to reflect high background concentrations for these metals in the black shale and phyllite in this region.

## Area 15—Porgo Creek

Late Devonian and Early Mississippian rocks of the Noatak Sandstone underlie the southern part, and Hunt Fork Shale underlies the northern part of area 15 (fig. 17). Although stream-sediment samples generally lack anomalous metal values throughout area 15, almost every concentrate sample is anomalous in one or more of the base metals. Some concentrate samples contain 50,000 ppm Pb, 10,000 ppm Zn, or more than 10,000 ppm Ba; a single sample from Okiotak Creek also contains 1,000 ppm Cu. Sphalerite and less commonly galena were present in many of these samples from area 15. Zayatz and others (1988) described pyrite- and iron-oxide-bearing chert, phyllite, and quartz veins from the headwaters of Okiotak Creek, but samples of these rocks did not contain anomalous concentrations of barium, lead, or zinc.

Although samples from the headwaters of Porgo Creek are the only concentrates from area 15 lacking base-metal anomalies, they contain elevated iron (10–15 percent) and manganese concentrations (1,500–3,000 ppm). Values of 76–84 ppm Ni in four NURE sediment samples collected in the same area most likely reflect adsorbtion of nickel by iron and manganese oxides. Zayatz and others (1988) described ironstone nodules with 15 percent Fe and 1,500 ppm Mn in upper Porgo Creek. These are the most likely source of the iron-manganese signature in the concentrate samples.

## Area 16—Maiyumerak Mountains

Area 16 includes the Maiyumerak Mountains and is underlain predominantly by northeast-trending Paleozoic and Mesozoic sedimentary rocks (fig. 18). Mesozoic basaltic flows underlie the western edge of the area. Karl and others (1985) identified disseminated and massive sulfide

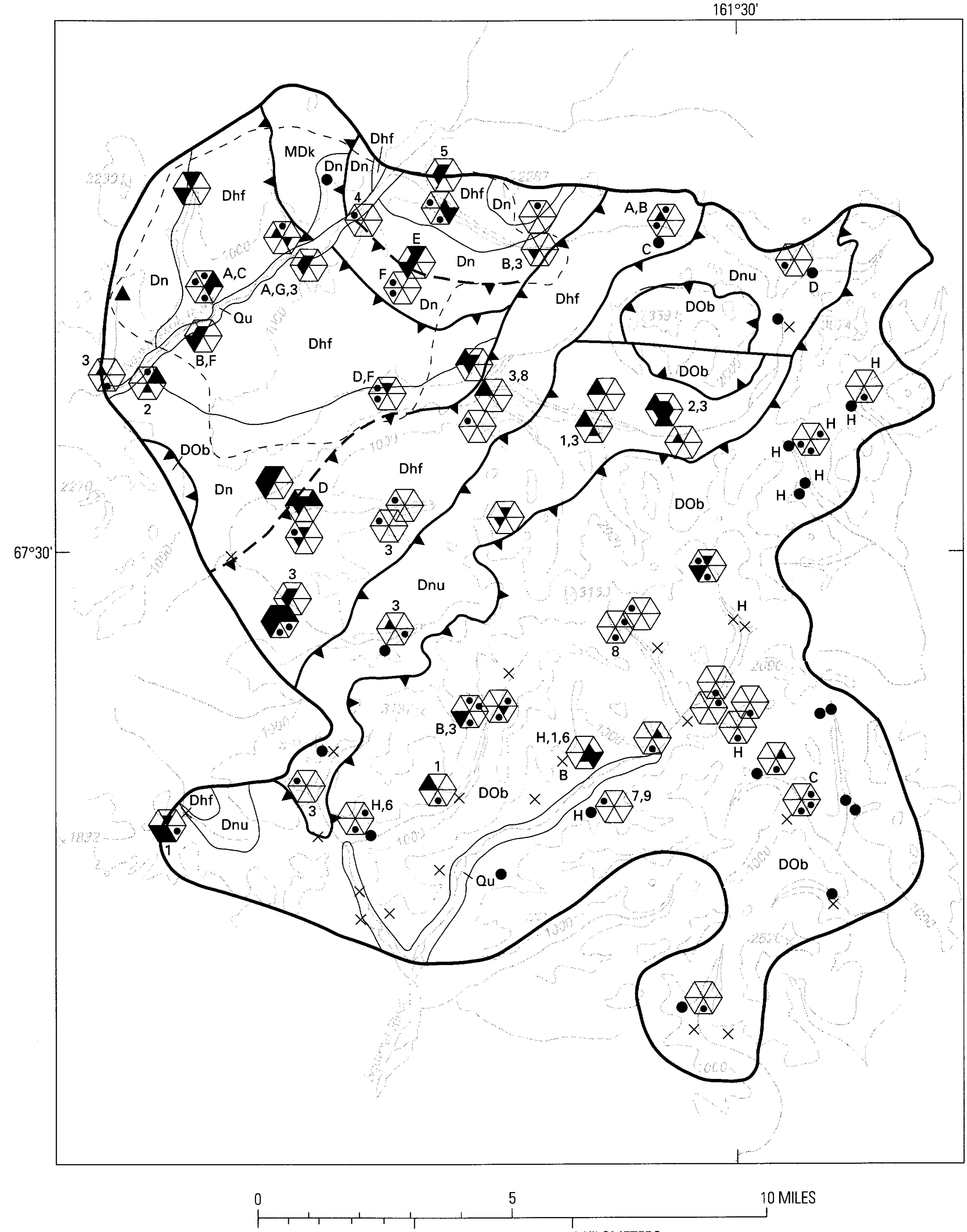
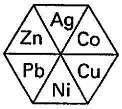



**Figure 15 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the West Fork of the Squirrel River area (geochemically anomalous area 13). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

# EXPLANATION




**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

× **Locality of AMRAP stream-sediment sample with no heavy-mineral-concentrate sample**

[Values are in parts per million; >, greater than; ≥, equal to or greater than]

Heavy-mineral-concentrate samples

| Category | Map symbol | Ag | Co | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 1–2 | 100 | 200–300 | 150–200 | 500–1,000 | 1,000–2,000 |
| Moderately anomalous. | | 3–7 | 150–200 | 500 | 300 | 1,500–3,000 | 3,000–7,000 |
| Highly anomalous. | | 15–50 | 300 | 700 | 500–1,000 | ≥5,000 | ≥10,000 |

SAMPLE DESCRIPTIONS (heavy-mineral concentrate): 1, 10 percent Fe; 2, 20–30 percent Fe; 3, >10,000 ppm Ba; 4, 30 ppm Be; 5, 200 ppm Be; 6, >2,000 ppm La; 7, 1,000 ppm Sb; 8, 150–200 ppm Sn; 9, 10,000 ppm W.

SAMPLE DESCRIPTIONS (stream sediment): A, 300 ppm B; B, 70–100 ppm Cu; C, 150–200 ppm Cu; D, 70–100 ppm Pb; E, 200 ppm Pb; F, 200–300 ppm Zn; G, 700 ppm Zn; H, 1,000–3,000 ppm Sr.

**Geochemical data from the National Uranium Resource Evaluation (NURE) studies**

**Area of stream-sediment sample localities containing 4.3–4.8 ppm U**

▲ **Locality of stream-sediment sample containing 69 ppm Pb and 490 ppm Zn**

Qu **Undifferentiated surficial deposits (Quaternary)**

MDk **Kanayut Conglomerate (Mississippian and Devonian)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dnu **Phyllite, carbonate, and clastic rocks of Nakolik River, undivided (Devonian)**

DOb **Baird Group (Devonian to Ordovician)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate; dashed where approximately located

**Boundary of geochemically anomalous area**

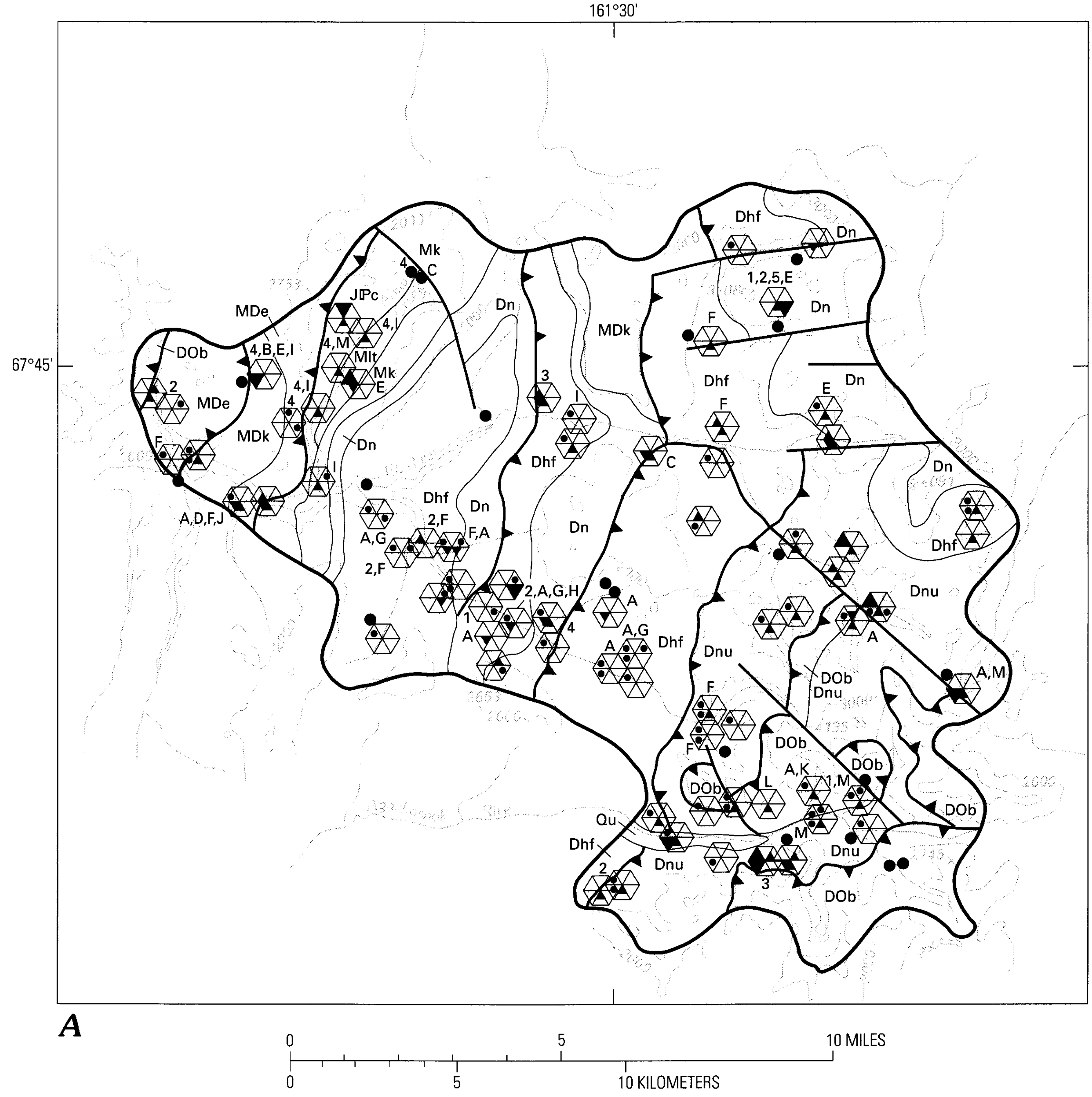
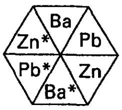



**Figure 16 (above and following pages).** Sample-locality maps of the Eli River area (geochemically anomalous area 14). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000. *A*, Stream-sediment and heavy-mineral-concentrate samples from the Alaska Mineral Resources Assessment Program; *B*, Stream-sediment samples from the National Uranium Resource Evaluation Survey.

occurrences and sulfide-bearing quartz veins within a variety of rock types throughout area 16.

Ellersieck and others (1984) reported that stream-sediment grab samples from some of the southern tributaries of Kivivik Creek contained as much as 20 ppm Ag, 320 ppm Cu, 360 ppm Pb, and 1,200 ppm Zn. They suggested that the underlying Kuna Formation or related black shale may host lead-zinc-silver mineral occurrences similar to the Red Dog deposit about 160 km to the west. Zayatz and others (1988) and Schmidt and Allegro (1988), in part investigating the anomalies discovered by Ellersieck and others (1984), described pyritic quartzite and black shale, barite blebs in black shale, and possible sphalerite in siliceous shale from this part of area 16.

# EXPLANATION




**Locality of geochemically anomalous sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below. In the diagram, an asterisk indicates a heavy-mineral-concentrate sample**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; ≥, equal to or greater than; leaders (– –), no value for that category]

| Category | Map symbol | Stream-sediment samples | | | Heavy-mineral-concentrate samples | | |
|---|---|---|---|---|---|---|---|
| | | Ba | Pb | Zn | Ba | Pb | Zn |
| Slightly anomalous. | | 2,000 | 70 | 200 | – – | 500–700 | 1,000–2,000 |
| Moderately anomalous. | | 3,000 | 100 | 300 | ≥7,000 | 1,000–2,000 | 3,000–5,000 |
| Highly anomalous. | | 5,000 | – – | 500–1,000 | – – | 5,000–10,000 | ≥10,000 |

SAMPLE DESCRIPTIONS (stream sediment): 1, 0.5 ppm Ag; 2, 70–100 ppm Cu; 3, 150–200 ppm Cu; 4, 30-50 ppm Nb; 5, 300 ppm Ni.

SAMPLE DESCRIPTIONS (heavy-mineral concentrate): A, 1–7 ppm Ag; B, 20 ppm Ag; C, 10–50 ppm Be; D, 150 ppm Co; E, 700 ppm Cr; F, 200–700 ppm Cu; G, 1,000 ppm Cu; H, 1,500 ppm La; I, 200–300 ppm Nb; J, 200 ppm Ni; K, 200 ppm Sb; L, 2,000 ppm Sb; M, ≥10,000 ppm Sr.

Qu **Undifferentiated surficial deposits (Quaternary)**

JIPc **Etivluk Group (Jurassic to Pennsylvanian)**

Mk **Kayak Shale (Mississippian)**

Mlt **Limestone and tuff (Mississippian)**

MDe **Endicott Group (Mississippian and Devonian)**

MDk **Kanayut Conglomerate (Mississippian and Devonian)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dnu **Phyllite, carbonate, and clastic rocks of Nakolik River, undivided (Devonian)**

DOb **Baird Group (Devonian to Ordovician)**

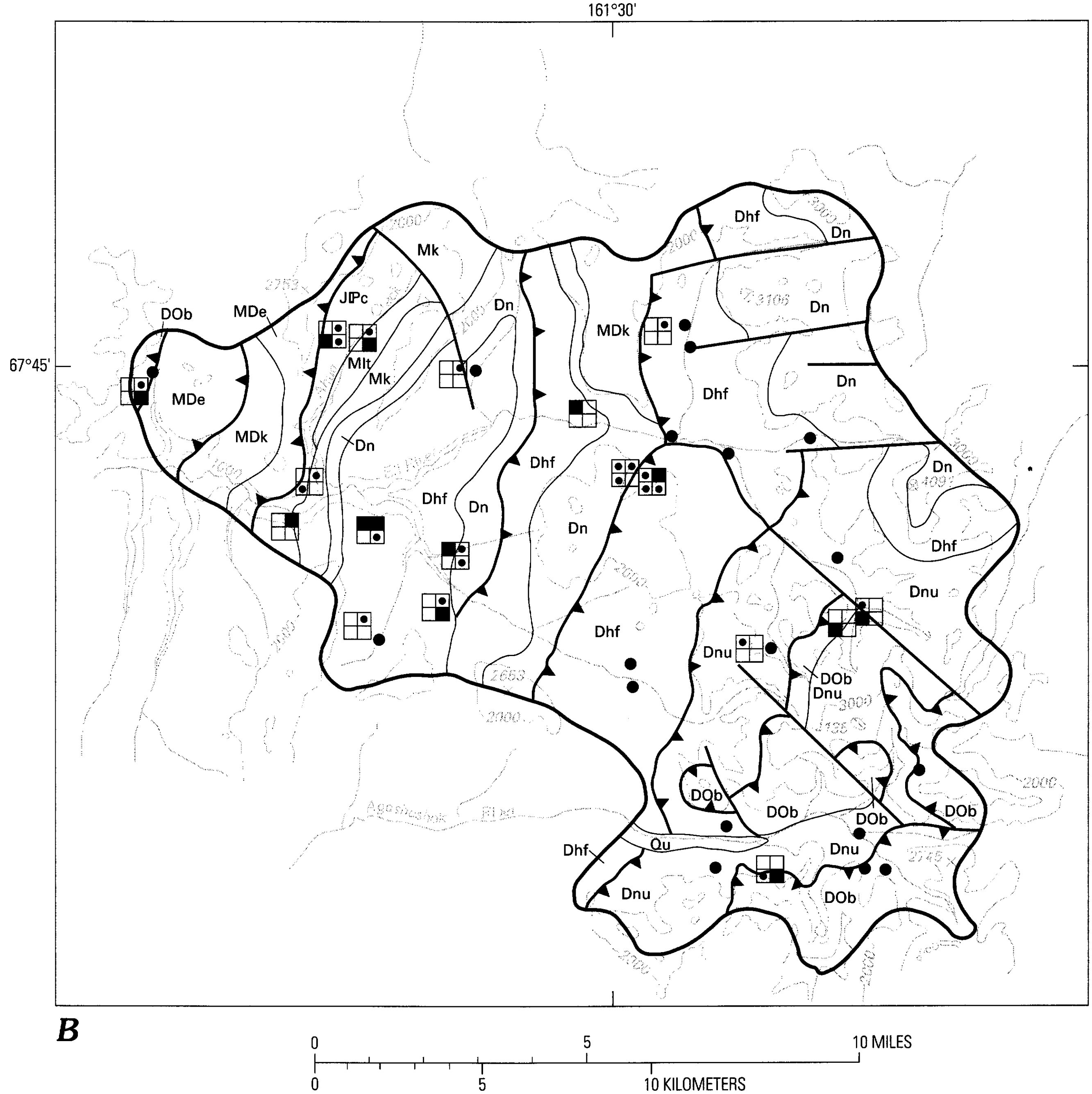
**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

Stream-sediment samples, from both the AMRAP and NURE studies, collected in Kivivik Creek just north of the Kilyaktalik Peaks are anomalous in silver, molybdenum, uranium, and zinc (±Ba, Cr, Cu, Fe, Ni, and Y). One NURE sediment sample contained 9 ppm Ag, 1,111 ppm Cu, 170 ppm Ni, 23 percent Fe, 41 ppm Sm, 75 ppm U, and 3,531 ppm Zn; the corresponding stream-water sample contained 7.0 ppb U. The sediment concentrations represent the highest values for the elements from the NURE survey of the Baird Mountains quadrangle. Similar anomalous sediment




***B***

signatures also occur to the west of Kilyaktalik Peaks, in the headwaters of Ahaliknak Creek. Concentrate samples from north and west of Kilyaktalik Peaks are enriched in barium, beryllium, chromium, niobium, and zinc (±La and Pb). Four of these concentrates contain fine-grained sphalerite probably derived from black shale. Many of the anomalous metal values in this part of area 16 indicate sulfide mineralization and (or) high lithogeochemical backgrounds in the more organic-rich black shale and phyllite of the Kuna Formation and related rocks. On the other hand, the anomalous values for beryllium, lanthanum, niobium, samarium, yttrium, and perhaps uranium certainly reflect weathering of refractory minerals from coarser clastic rocks within the undivided sedimentary units.

Two sediment samples, one from the NURE survey and one from the AMRAP survey, collected along the western edge of area 16 contain very high concentrations of chromium, copper, manganese, and zinc (±Co and Fe). Concentrate samples from this area lack significant anomalies. Therefore, these data are believed to reflect lithogeochemical background concentrations in basaltic rocks underlying this part of area 16.

## EXPLANATION

| Zn | U |
|---|---|
| Ba | Pb |

Locality of geochemically anomalous stream-sediment sample collected in the National Uranium Resource Evaluation (NURE) studies. Symbols and anomaly categories are described below

● Locality of NURE stream-sediment sample having no anomalous concentrations of elements

[Values are in parts per million]

| Category | Map symbol | U | Pb | Ba | Zn |
|---|---|---|---|---|---|
| Slightly anomalous. | ⊡ | 4.0–4.8 | 14–19 | 1,000–1,250 | 165–180 |
| Highly anomalous. | ■ | 4.9–5.8 | 20–40 | 1,750–2,200 | 180–200 |

| | |
|---|---|
| Qu | Undifferentiated surficial deposits (Quaternary) |
| JIPc | Etivluk Group (Jurassic to Pennsylvanian) |
| Mk | Kayak Shale (Mississippian) |
| Mlt | Limestone and tuff (Mississippian) |
| MDe | Endicott Group (Mississippian and Devonian) |
| MDk | Kanayut Conglomerate (Mississippian and Devonian) |
| Dn | Noatak Sandstone (Devonian) |
| Dhf | Hunt Fork Shale (Devonian) |
| Dnu | Phyllite, carbonate, and clastic rocks of Nakolik River, undivided (Devonian) |
| DOb | Baird Group (Devonian to Ordovician) |

**Contact**

**Fault**—Direction of movement unknown

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

The sediment sample collected furthest downstream along a Kivivik Creek tributary contains more than 5,000 ppm Cr and 200 ppm Ni; the corresponding concentrate sample contains 2,000 ppm Cr and 200 ppm Ni. These are the highest values for chromium in both sample media. An adjacent stream-sediment sample contains 15 percent Fe plus anomalous silver and copper; the corresponding concentrate contains 20 percent Fe and 5,000 ppm Cu, clearly reflecting the presence of iron- and copper-bearing sulfide minerals. NURE sediment samples collected in this area and about 5 km to the northeast are also anomalous in cobalt, chromium, manganese, and nickel (±Cu, Fe, and Zn). Zayatz and others (1988) described iron-stained and pyrite- and chalcopyrite-bearing pillow basalt and mafic rocks in this area. Most anomalies in this north-central part of area 16, between lower Kivivik Creek and the region north of hill 2553, reflect the presence of these mafic units. However, the site with the very anomalous silver and copper concentrations suggests upstream mineralization.

## Area 17—Hotham Inlet

Anomalous sediment samples were collected from channels draining the eastern half of the large ridge north of Hotham Inlet (fig. 19). Several samples contain 70–100 ppm Cu, 7–10 percent Fe, and 10–15 ppm Mo. In addition, one

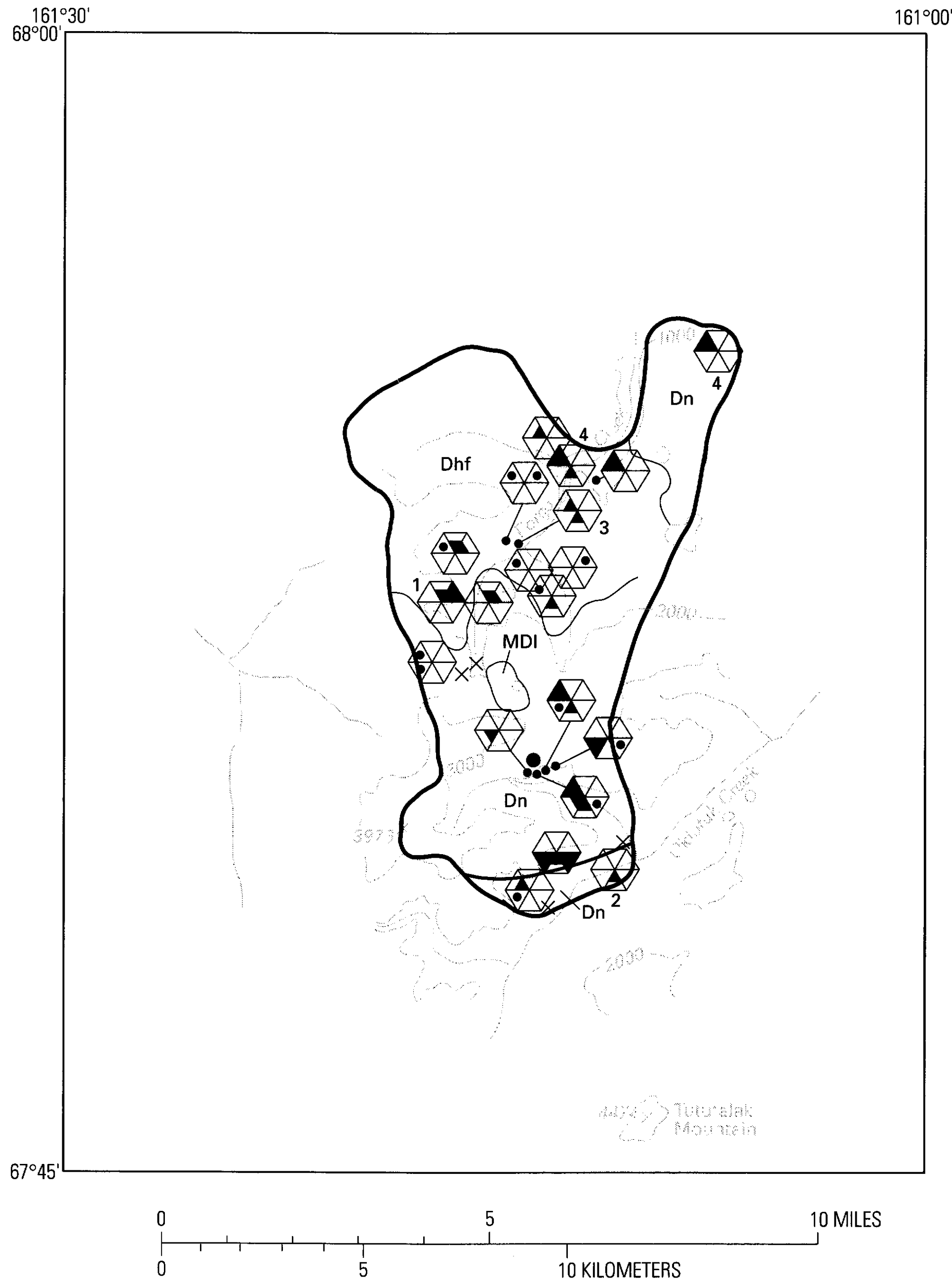


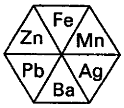

**Figure 17 (above and facing page).** Map showing geochemically anomalous stream-sediment and heavy-mineral-concentrate sample sites in the Porgo Creek area (geochemically anomalous area 15). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

sample contains 5,000 ppm Mn. Two of the NURE sediment samples from the area contained 5.2 and 6 ppm U. Much of this anomalous data is believed to represent high background levels for these elements in the underlying pelitic schist, especially because corresponding concentrate samples are not anomalous in these elements. However, Cobb and others (1981) described a few chalcopyrite-bearing quartz veins from near the ridge crest. Thus, the anomalous copper may, in part, reflect a wider distribution of these veins in area 17.

## CONCLUSIONS

Results from the reconnaissance geochemical survey of the Baird Mountains quadrangle indicate that much of the

## EXPLANATION




**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

× **Locality of AMRAP stream-sediment sample with no heavy-mineral-concentrate sample**

[Values are in parts per million, except Fe, in percent; >, greater than; ≥, equal to or greater than; leaders (- -), no value for that category]

| Category | Map symbol | Fe | Mn | Ag | Ba | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | -- | 1,000 | 1-3 | -- | 500–1,000 | 1,000 |
| Moderately anomalous. | | 10–15 | 1,500 | -- | >5,000 | 2,000–3,000 | 1,500 |
| Highly anomalous. | | -- | 3,000 | 15 | -- | ≥10,000 | 2,000–10,000 |

SAMPLE DESCRIPTIONS: 1, 150 ppm Co (H); 2, 1,000 ppm Cu (H); 3, 70 ppm Pb (S); 4, 500–700 ppm Cr (H).

MDl **Limestone (Mississippian and(or) Devonian)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

**Contact**

**Fault**—Movement uncertain

**Boundary of geochemically anomalous area**

northern two-thirds of the quadrangle is favorable for sediment-hosted base-metal mineral occurrences. Only the area north of the Noatak River and that underlain by the Endicott Group, largely along Sapun Creek, commonly lack anomalous sample sites. Because anomalies may occur in only the sediment samples or only in the concentrate samples, both media were necessary for a thorough geochemical evaluation of the quadrangle. Whether or not one or both of the media contain anomalous metal values is likely a function of the specific element and the predomination of chemical or physical weathering at a given locality.

The fact that a large part of the quadrangle is identified as being geochemically favorable for the discovery of new mineral deposits is not surprising. Devonian and Mississippian sedimentary rocks, correlative with those underlying much of the Baird Mountains quadrangle, host numerous, roughly syngenetic, base-metal-rich mineral deposits and occurrences throughout northern Alaska. These include the volcanogenic copper-zinc massive sulfide deposit at Arctic (Schmidt, 1986), the carbonate-hosted copper occurrence at the Omar prospect, the barium-lead-zinc-bearing veins and disseminated minerals at the Frost and Powdermilk prospects, and the shale-hosted zinc-lead-silver deposit at Red Dog (Moore and others, 1986). Although the complex geology and in places overlapping geochemical signatures prevent relating geochemical anomalies to specific mineral-deposit models, some areas may be identified as favorable for certain metallic element suites.

Silver-, barium-, lead-, and (or) zinc-rich metal deposits are suggested for Aklumayuak Creek (areas 1, 5), the upper reaches of the Tutuksuk River south of Mt. Angayukaqsraq (area 3), the area east of the Salmon River and south of hill 2878 (area 3), the north part of the west fork of the North Fork of the Squirrel River (area 12), the headwaters of the Nakolik River (area 11), the region just to the south of the Angayukalik Hills (area 10), the Agashashok and Eli River watersheds (areas 13, 14), upper Porgo Creek (area 15), and the Maiyumerak

Mountains region (area 16). Copper-dominant mineral systems are predicted in the central part of the Tutuksuk River watershed (area 3), the area south of Kanaktok Mountain (area 4), the upper part of the Tukpahlearik Creek drainage basin (area 6), and much of the Nakolikurok Creek basin (area 10). Both copper and silver-barium-lead-zinc mineral occurrences are likely within the western part of the upper reaches of the Omar River (area 9), the west fork of the Squirrel River (area 13), and along Nanielik Creek (area 2).

Seven concentrate samples with anomalous gold were collected near known placer deposits in the Kallarichuk Hills (area 8). Anomalous amounts of tungsten that are common in these samples and occur over a much broader part of the Kallarichuk Hills indicate scheelite weathering from quartz veins. The tungsten anomalies provide the best indication of the distribution of possible gold-bearing quartz veins (and related placers) within the Baird Mountains quadrangle.

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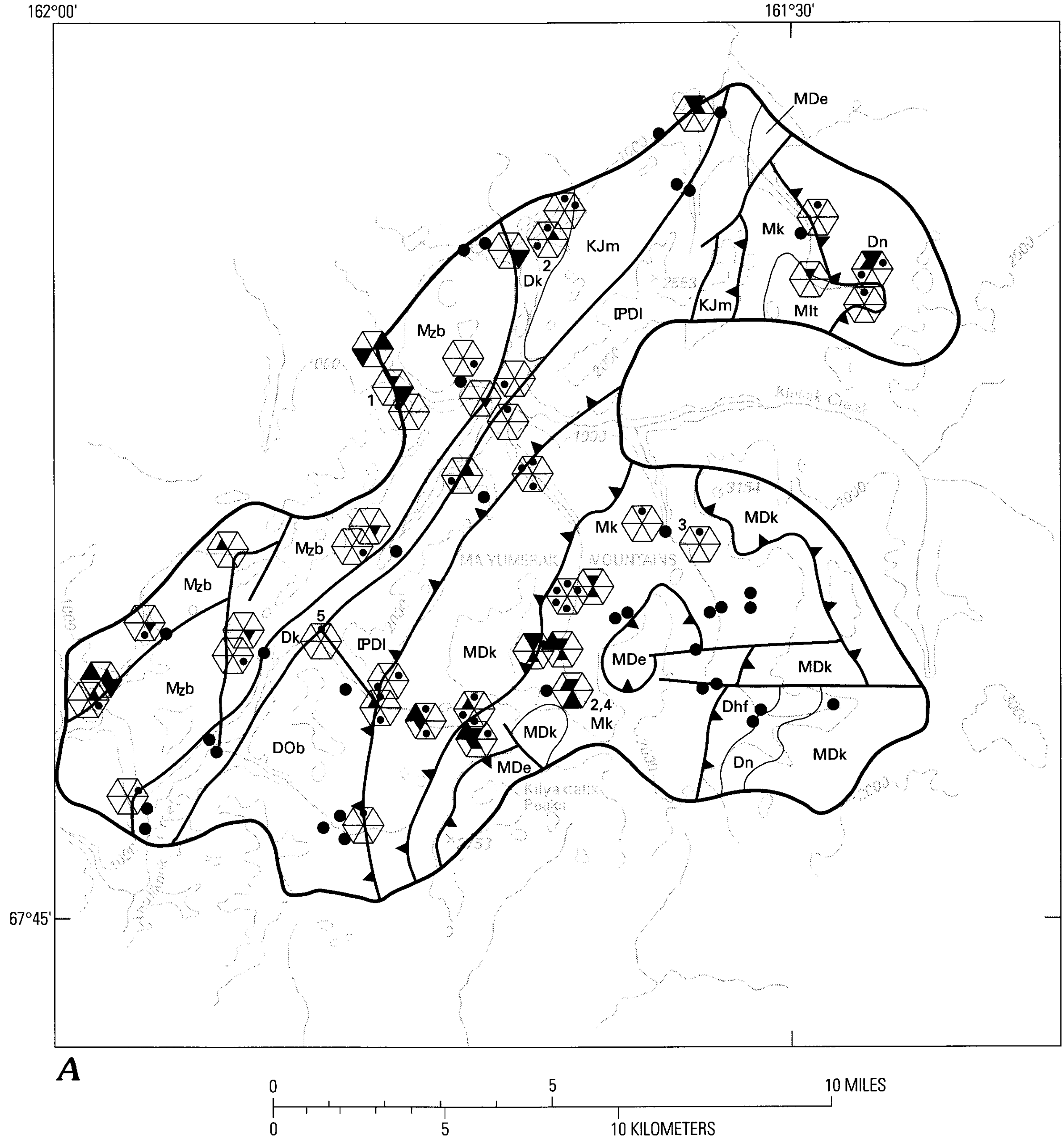
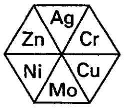



**Figure 18 (above and following pages).** Sample-locality maps of the Maiyumerak Mountains area (geochemically anomalous area 16). *A*, Stream-sediment samples from the Alaska Mineral Resources Assessment Program survey; *B*, Heavy-mineral-concentrate samples; *C*, Stream-sediment samples from the National Uranium Resource Evaluation Survey. Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

# EXPLANATION




**Locality of geochemically anomalous stream-sediment sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million; >, greater than]

| Category | Map symbol | Ag | Cr | Cu | Mo | Ni | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. |  | 0.5–0.7 | 200–300 | 70 | 5 | 100 | 200 |
| Moderately anomalous. |  | 1–1.5 | 700–2,000 | 100 | 7–10 | 150 | 300 |
| Highly anomalous. |  | 2–3 | >5,000 | 150–700 | 15 | 200 | 500–700 |

SAMPLE DESCRIPTIONS: 1, 15 percent Fe; 2, 2,000 ppm Ba; 3, 300 ppm Pb; 4, 200 ppm Y; 5, 700 ppm Zr.

KJm **Melange (Cretaceous and(or) Jurassic)**

Mzb **Basalt (Mesozoic)**

ℙDl **Limestone (Pennsylvanian, Mississippian, and Devonian)**

Mlt **Limestone and tuff (Mississippian)**

Mk **Kayak Shale (Mississippian)**

MDe **Endicott Group (Mississippian and Devonian)**

MDk **Kanayut Conglomerate (Mississippian and Devonian)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dk **Kugururok Limestone (Devonian)**

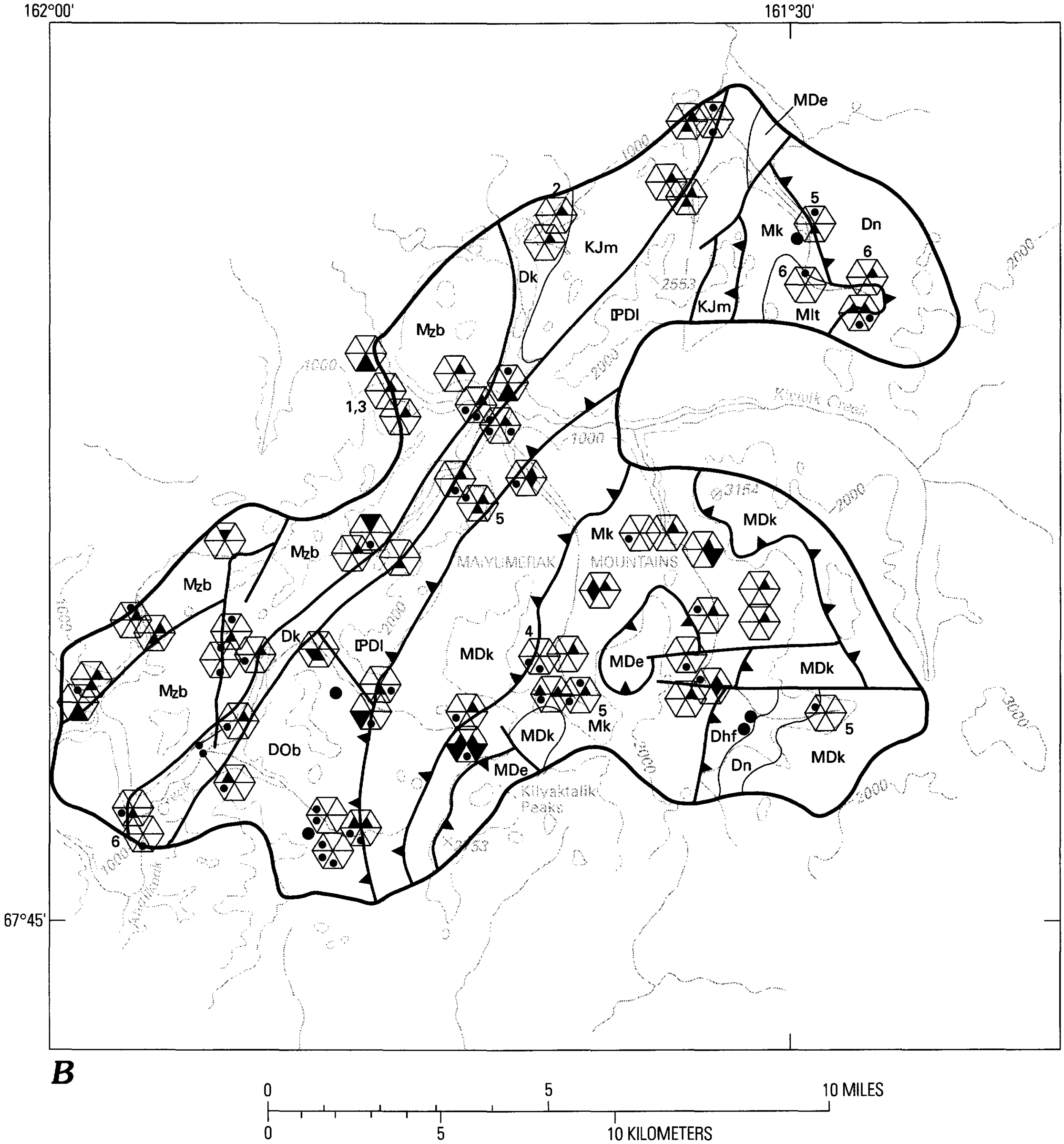
DOb **Baird Group (Devonian and Ordovician)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**


162°00'
161°30'
67°45'
MDe
Dn
Mk
5
6
6
Mlt
KJm
2
KJm
Dk
PDI
2553
Mzb
1,3
Kivivik Creek
3154
MDk
5
Mzb
Mzb
MAIYUMERAK
Mk
MOUNTAINS
Dk
PDI
MDk
4
MDe
MDk
Mzb
5
Mk
MDk
MDe
Dhf
Dn
5
MDk
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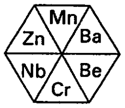
Kilyaktalik Peaks
6
1000
2000
3000
B
0
5
10 MILES
0
5
10 KILOMETERS

# EXPLANATION




**Locality of geochemically anomalous heavy-mineral-concentrate sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP heavy-mineral-concentrate sample having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; >, greater than; leaders (– –), no value for that category]

| Category | Map symbol | Mn | Ba | Be | Cr | Nb | Zn |
|---|---|---|---|---|---|---|---|
| Slightly anomalous. | | 1,000 | – – | 7–10 | 500–700 | 200–300 | 1,000–1,500 |
| Moderately anomalous. | | 1,500 | >10,000 | 20–50 | 1,000–1,500 | 500 | 2,000 |
| Highly anomalous. | | 2,000 | – – | 70–500 | 2,000 | 700 | 5,000 |

SAMPLE DESCRIPTIONS: 1, 20 percent Fe; 2, 1,000 ppm B; 3, 5,000 ppm Cu; 4, >2,000 ppm La; 5, 700–1,500 ppm Pb; 6, 700 ppm Y.

KJm **Melange (Cretaceous and(or) Jurassic)**

Mzb **Basalt (Mesozoic)**

PDl **Limestone (Pennsylvanian, Mississippian, and Devonian)**

Mlt **Limestone and tuff (Mississippian)**

Mk **Kayak Shale (Mississippian)**

MDe **Endicott Group (Mississippian and Devonian)**

MDk **Kanayut Conglomerate (Mississippian and Devonian)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dk **Kugururok Limestone (Devonian)**

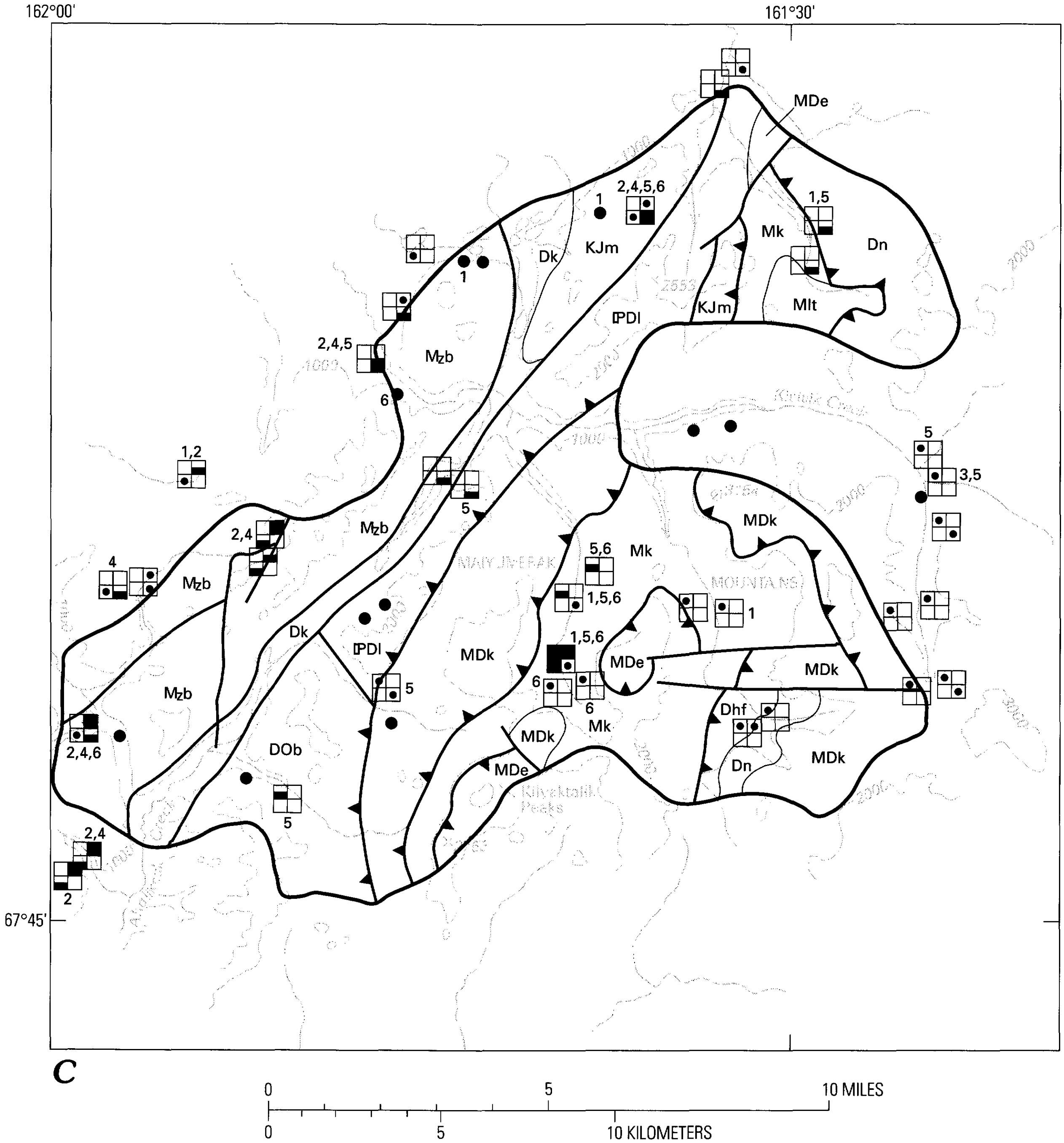
DOb **Baird Group (Devonian and Ordovician)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**


162°00'
161°30'
67°45'
MDe
Dn
Mk
Mlt
KJm
Dk
IPDI
Mzb
MDk
DOb
Dhf
MAIYUMERAK
MOUNTAINS
Kilyaktalik Peaks
C
0
5
10 MILES
0
5
10 KILOMETERS

# EXPLANATION

| U | Cu |
|---|---|
| Fe | Cr |

**Locality of geochemically anomalous stream-sediment sample collected in the National Uranium Resource Evaluation (NURE) studies. Symbols and anomaly categories are described below**

● **Locality of NURE stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; >, greater than; ≥, equal to or greater than]

| Category | Map symbol | Cu | Cr | Fe | U |
|---|---|---|---|---|---|
| Slightly anomalous. | | 50–70 | 140–200 | 6–7 | 4–5 |
| Moderately anomalous. | | 71–100 | 201–1,000 | 7.1–8 | 5.1–8 |
| Highly anomalous. | | >100 | >1,000 | 23 | 75 |

SAMPLE DESCRIPTIONS: 1, ≥1,200 ppm Ba; 2, ≥30 ppm Co; 3, ≥16 ppm Pb; 4, ≥1,400 ppm Mn; 5, ≥70 ppm Ni; 6, ≥199 ppm Zn.

KJm **Melange (Cretaceous and(or) Jurassic)**

Mzb **Basalt (Mesozoic)**

ℙDl **Limestone (Pennsylvanian, Mississippian, and Devonian)**

Mlt **Limestone and tuff (Mississippian)**

Mk **Kayak Shale (Mississippian)**

MDe **Endicott Group (Mississippian and Devonian)**

MDk **Kanayut Conglomerate (Mississippian and Devonian)**

Dn **Noatak Sandstone (Devonian)**

Dhf **Hunt Fork Shale (Devonian)**

Dk **Kugururok Limestone (Devonian)**

DOb **Baird Group (Devonian and Ordovician)**

**Contact**

**Fault**—Movement uncertain

**Thrust fault**—Saw teeth on upper plate

**Boundary of geochemically anomalous area**

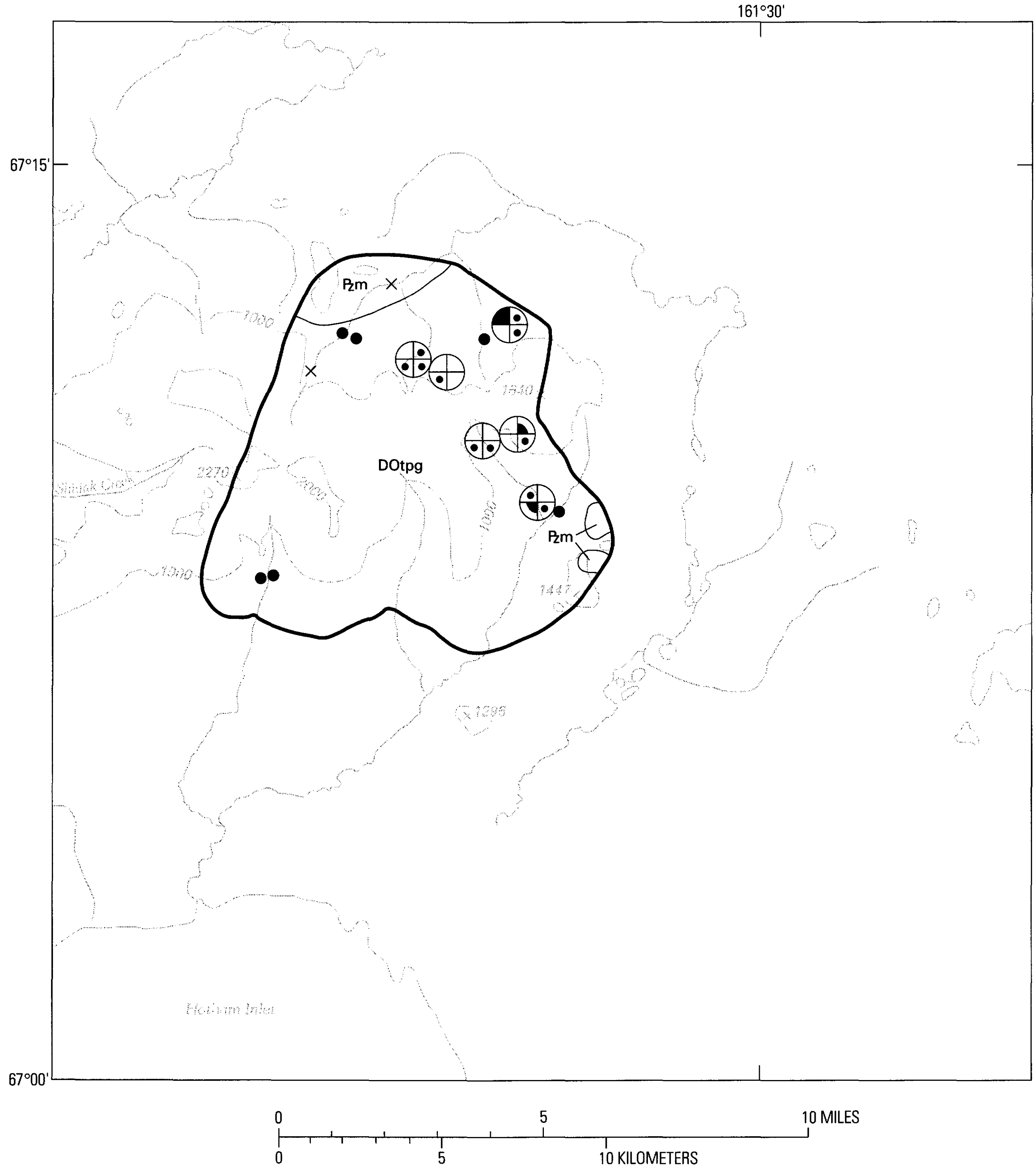
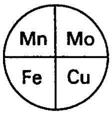



**Figure 19 (above and facing page).** Map showing geochemically anomalous stream-sediment sample sites in the Hotham Inlet area (geochemically anomalous area 17). Base map is from U.S. Geological Survey Baird Mountains, 1950, scale 1:250,000.

# EXPLANATION




**Locality of geochemically anomalous stream-sediment sample collected in the Alaska Mineral Resources Assessment Program (AMRAP) studies. Symbols and anomaly categories are described below**

● **Locality of AMRAP stream-sediment sample having no anomalous concentrations of elements**

[Values are in parts per million except Fe, in percent; leaders (– –), no value for that category]

| Category | Map symbol | Cu | Fe | Mo | Mn |
|---|---|---|---|---|---|
| Slightly anomalous. | | 70–100 | 7 | 10 | 2,000 |
| Moderately anomalous. | | -- | 10 | 15 | -- |
| Highly anomalous. | | -- | -- | -- | 5,000 |

× **Locality of National Uranium Resource Evaluation (NURE) sample with 5.2–6.0 ppm U.**

DOtpg **Pelitic schist and greenstone of Tukpahlearik Creek (Devonian to Ordovician?)**

Pzm **Marble (Paleozoic)**

———— **Contact**

━━━━ **Boundary of geochemically anomalous area**

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