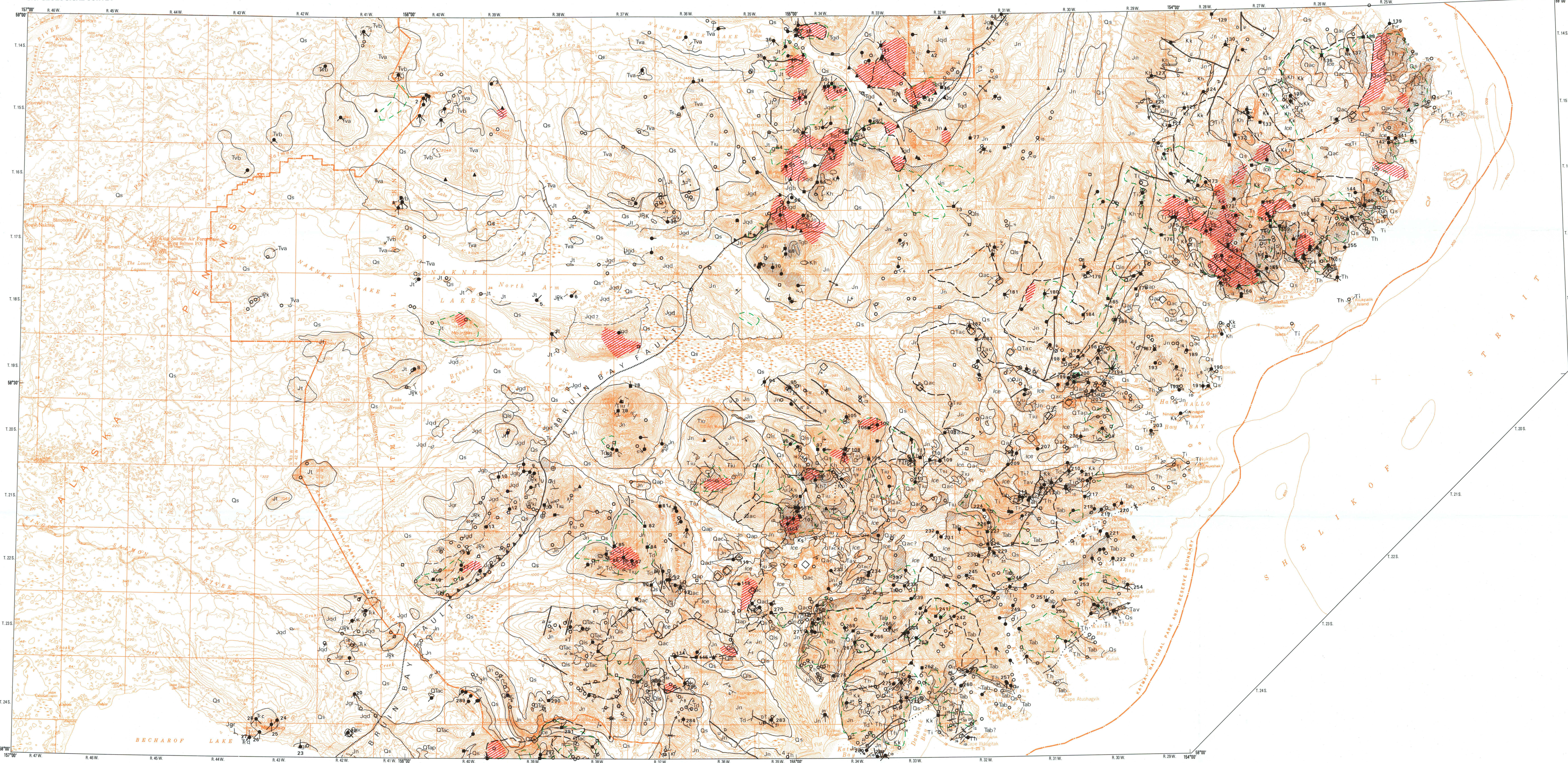
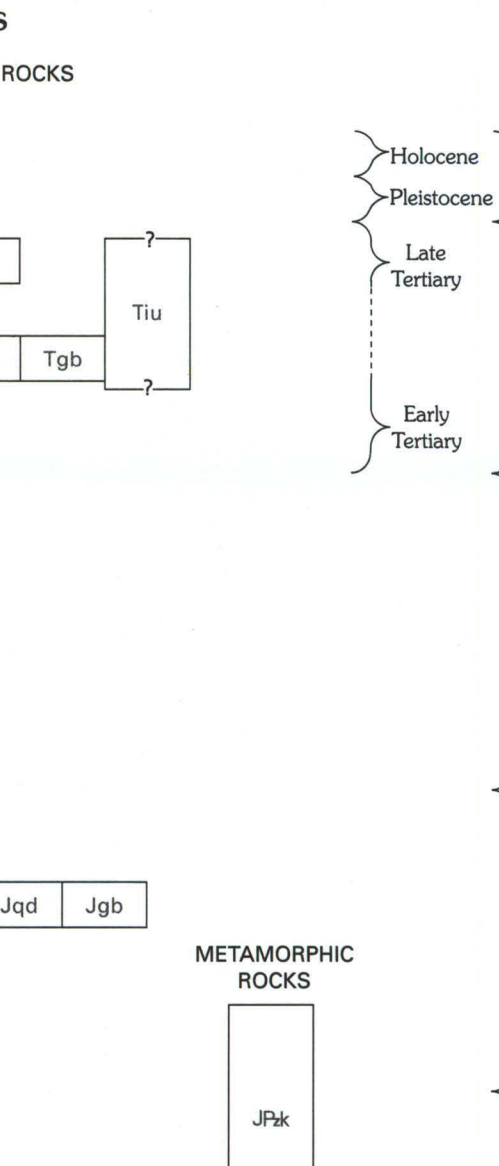
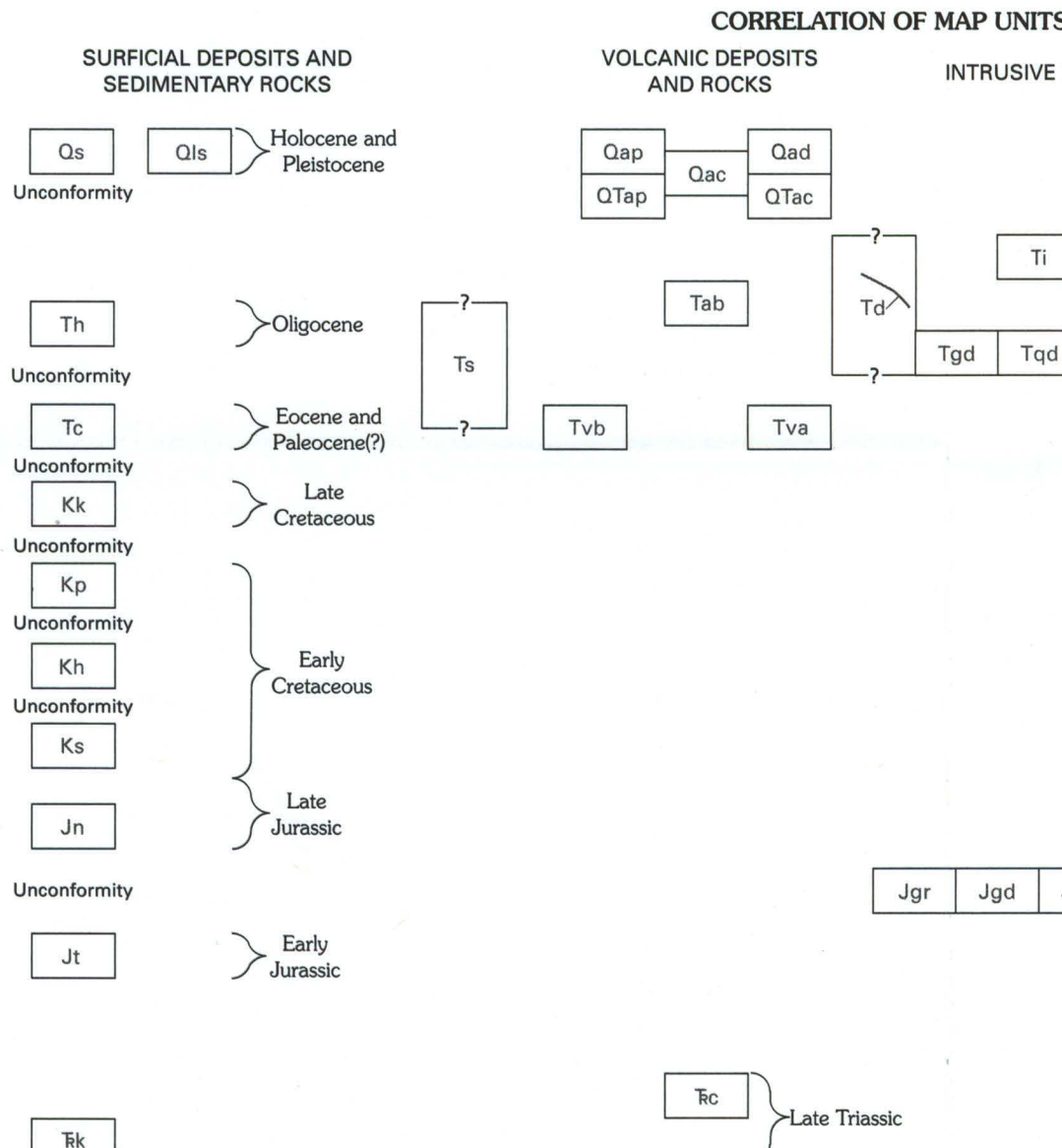


U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEYBase from U.S. Geological Survey
Mt. Katmai, 1952 (revised 1975);
Afognak, 1952 (revised 1982);
Naknek, 1952 (revised 1988)
Universal Transverse Mercator ProjectionEXPLANATION
PORPHYRY-COPPER SUITESample did not contain anomalous
concentrations of elements in the porphyry-
copper suite
Sample from outcrop
Sample from stream flow
Drainage basin containing anomalous
concentrations of Cu and Mo; Sn or W as
determined in both stream sediments and
nonmagnetic-heavy-mineral concentrates
Drainage basin containing anomalous
concentrations of elements in the base-metal
polymetallo-cuivre suite as determined in
both stream sediments and nonmagnetic-
heavy-mineral concentrates
Drainage basin containing more than 25
percent sulfide minerals in the nonmag-
netic-heavy-mineral separate from panned
concentrates
Scheelite observed in panned concentratesRock sample locality
Sample contained anomalous concentrations
of elements in the porphyry-copper suite
at the 95th or 98th percentile (see star
diagram above)—Numbered localities cor-
respond to entries in tables 11-18
Sample from outcrop
Sample from stream flowDESCRIPTION OF MAP UNITS
SURFICIAL DEPOSITS AND SEDIMENTARY ROCKS

Qs Surficial deposits (Holocene and Pleistocene)—Unconsolidated to poorly consolidated alluvial, colluvial, glacial, marine, lacustrine, and eolian deposits. Locally includes extensive redeposited pumice and ash from the Novarupta eruption.

Qls Landslide deposits (Holocene and Pleistocene)—Nonsorted, nonstratified, coarse, angular rubble forming lobate masses.

Ts Sedimentary rocks (Tertiary)—Poorly to moderately well indurated fluvial sandstone, siltstone, tuff, and conglomerate; larger clasts consist of locally derived plutonic and volcanic rocks.

Th Hemlock Conglomerate (Oligocene)—Poorly indurated fluvial conglomerate, pale-brown tuffaceous sandstone, siltstone, shale, coal, and tuff. Age is late Oligocene.

Tc Copper Lake Formation (Eocene and Paleocene)—Well-indurated polymictic conglomerate, sandstone, and siltstone.

Kk Kagayak Formation (Late Cretaceous)—Upper part consists of interbedded siltstone and graded graywacke sandstone that represent the upper and middle regimes of a submarine fan. Lower part consists of thinly bedded siltstone and some thin limestone beds and includes abundant ammonites, pelecypods, and limestone concretions.

Kp Pednar Formation (Early Cretaceous)—Thick-bedded, gray sandstone and minor amounts of siltstone and shale that contain ammonites of Albian age.

Kh Herendeen Formation (Early Cretaceous)—Calcareous sandstone and interbedded siltstone, thinly bedded, light to dark olive gray.

Ka Stanikovich Formation (Early Cretaceous)—Siltstone, shale, and thinly bedded, fine-grained, brown feldspathic sandstone.

Jn Naknek Formation (Late Jurassic)—Main sedimentary rock unit of the map area, consisting of sandstone, conglomerate, siltstone, and dark shale. Divided into five members (not mapped separately here), from oldest to youngest: massive nonmarine conglomerate and thinly bedded sandstone member; thick-bedded massive sandstone member; thinly bedded, dark-gray marine siltstone member containing limestone concretions; thinly bedded marine sandstone and siltstone member; massive conglomerate, siltstone, and dark shale. Locally includes local conglomerate in both the oldest and youngest members are metamorphic, volcanic, and sedimentary rocks with subordinate plutonic rocks.

Jr Taltsetna Formation (Early Jurassic)—Lava flows, breccias, and siltstone locally interbedded with volcanoclastic sandstone, conglomerate, and shale. Includes sills of uncertain ages. Locally metamorphosed to nonchertaceous epidote-albite-calcite assemblages suggestive of lower greenschist facies.

Kk Kamishak Formation (Late Triassic)—Slightly recrystallized, nonfossiliferous limestone and interbedded basalt flows and breccia.

Ti Dikes (Tertiary)—Dikes from 1 to 20 m wide that occur mainly southeast of the Bruin Bay fault and have a northwest trend. Many are in rocks as young as the Hemlock Conglomerate (Th), suggesting that most dikes are middle to late Tertiary in age.

Volcanic Deposits and Rocks
Qap Pyroclastic-flow deposits (Holocene)—Poorly sorted, variably indurated deposits of ash, vitrophic blocks, and (or) pumiceous lapilli of the 1912 ash flow of Novarupta and the Holocene block-and-ash flows of Kagayak caldera.

Qad Domes (Holocene)—Domes of dacitic or rhyolitic composition.

Qac Younger central-vent deposits and rocks (Holocene and Pleistocene)—Lava flows, tuffs, and breccias predominantly of andesitic composition but locally including lava flows of low-silica dacitic composition, airtal deposits of andesitic to rhyolitic composition on Baked Mountain and Broken Mountain, and scoria cones of basaltic composition.

QTap Pyroclastic-flow deposits (Pleistocene and late Tertiary)—Poorly sorted, variably indurated deposits of ash, vitrophic blocks, and (or) pumiceous lapilli. Primary compositions are uncertain because of alteration but probably range from andesitic to dacitic.

QTac Older central-vent deposits and rocks (Pleistocene and late Tertiary)—Lava flows, breccias, and domes of andesitic and dacitic composition. Locally moderately to extensively altered where associated with fossil fumaroles (bleaching to light-red or yellow shades).

Tab Volcanic rocks of Barter Range (late Tertiary)—Breccias, lava flows, sills, and local pyroclastic and epiclastic tufts of late Tertiary volcanic field located southeast of the Aleutian Range crest and extending from the Katmai River to Kulak Bay. Predominantly of andesitic and dacitic composition. Porphyritic alteration is extensive and argillaceous or potassic alteration is locally intensive, such as near contacts with hypabyssal intrusive rocks (Ti).

Tvb Basaltic lava (early Tertiary)—Plugs, dikes, and flows of basaltic composition that intrude or overlie andesitic and dacitic lava flows and breccia (Tva).

Tva Andesitic and dacitic lava flows and breccia (early Tertiary)—Unit also includes local domes or tufts of rhyolitic(?) composition, now altered to quartz and sericite or kaolinite.

Tc Cottonwood Bay Greenstone (Late Triassic)—Slightly metamorphosed basalt; locally includes fine to medium-grained diabase sills(?).

Jr Taltsetna Formation (Early Jurassic)—Lava flows, breccias, and siltstone locally interbedded with volcanoclastic sandstone, conglomerate, and shale. Includes sills of uncertain ages. Locally metamorphosed to nonchertaceous epidote-albite-calcite assemblages suggestive of lower greenschist facies.

in rocks as young as the Hemlock Conglomerate (Th), suggesting that most dikes are middle to late Tertiary in age.

Hypabyssal Intrusive Rocks near Shelikof Strait (late Tertiary)—Sill-like or cross-cutting subvolcanic intrusive bodies generally less than 10 km² in outcrop area, as well as larger plutonic bodies such as those beneath Four-peaked Volcano or along the Aleutian Range crest east of Serpent Tongue Glacier. Fine-grained, porphyritic to equigranular rocks that consist predominantly of granodiorite or tonalite and minor quartz diorite.

Hypabyssal Intrusive Rocks, undivided (Tertiary)—Intrusive bodies ranging from small plugs and sills to plutons exposed over as much as 30 km². Rocks are fine to medium grained, are commonly porphyritic, and consist chiefly of quartz diorite or tonalite.

Grandiorite (middle Tertiary)—Medium-grained equigranular rocks to marginally porphyritic rocks in which modal quartz rarely exceeds 25 percent; unit includes rocks that are mineralogically classified as quartz monodiorite or quartz diorite.

Quartz diorite (middle Tertiary)—Medium-grained equigranular rocks in which accessory hornblende exceeds biotite; also occurs as zones within intrusions of grandiorite (Tgd).

Gabbro and diorite (middle Tertiary)—Medium-grained rocks having gabbroic or diabasic textures.

Granite (Jurassic)—Medium-grained equigranular or fine-grained porphyritic rocks in which biotite exceeds hornblende.

Grandiorite (Jurassic)—Medium-grained equigranular or fine-grained porphyritic rocks. Also includes isolated outcrops of tonalite and quartz diorite. Modal quartz is 22–44 percent of rock.

Quartz diorite and tonalite (Jurassic)—Medium-grained equigranular rocks containing accessory biotite; unit includes some granodiorite.

Diorite and gabbro (Jurassic)—Dark, diabasic and gabbro-textured rocks.

Metamorphic Rocks
Jpk Kakhonak Complex (Jurassic, Triassic, and Paleozoic)—Locally foliated or banded quartzite, schist, amphibolite, and garnet-bearing gneiss indicative of amphibolite-facies metamorphism. Porphyritic presumably consist of Taltsetna Formation (Jt), Kamishak Formation (Kk), Cottonwood Bay Greenstone (Kc), and unnamed sandstone and argillite.

downthrown side; query next to U or D indicates direction of movement uncertain; arrows indicate direction of relative movement.

Thrust or reverse fault—Showing dip of fault plane; sawtooth on upper plate.

Anticline—Showing direction of plunge; dashed where approximately located; dotted where concealed; queried where existence uncertain.

Syncline—Showing direction of plunge; dashed where approximately located; dotted where concealed; queried where existence uncertain.

Measured strike and dip of beds
Inclined
Horizontal
Approximate strike and dip of beds
Strike and dip of foliation
Quaternary volcanic vent
Area of altered rock
Area of hornfels
Area covered by glacier

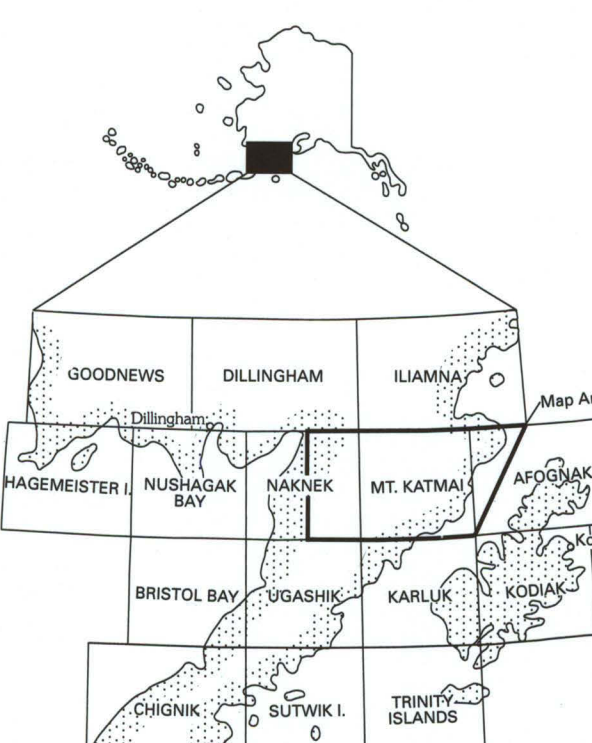


Table 8. Summary of threshold values (95th and 98th percentiles) used for rock and fluid samples plotted on plate 1, Katmai study area, Alaska.

[Analysis by x-ray fluorescence emission spectroscopy; all concentrations expressed in parts per million. Threshold values determined largely from the data in tables 1 and 4; < concentration is less than reported value.]

Element	Unit 1		Unit 2		Unit 3		Unit 4		Unit 5		Unit 6		Unit 7		Unit 8	
	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th
Co	150	200	100	200	100	150	150	150	100	150	700	100	150	100	200	200
Mo	5	7	5	7	5	7	5	7	10	15	7	25	5	7	7	10
B	100	100	100	150	100	100	100	100	100	100	150	50	70	100	150	150
Ca	70	100	50	70	50	70	70	100	50	70	70	50	70	70	100	100
Ni	70	100	70	100	70	100	70	100	70	100	70	100	70	100	70	100
Cr	300	500	200	300	200	300	150	200	200	200	300	200	300	150	200	300
Sn	10	20	10	20	10	20	10	20	10	20	10	20	10	20	10	20
W	<50	50	<50	50	<50	50	<50	50	<50	50	<50	50	<50	50	<50	50

1. Libolitic units.
2. Metamorphic rocks southwest of Bruin Bay fault (Kakhonak Complex, Cottonwood Bay Greenstone, Kamishak Formation, Taltsetna Formation) and, locally, southwest of Bruin Bay fault, hornfelsed rocks adjacent to plutons; 24 samples were analyzed for most elements.
3. Tertiary sedimentary rocks (Copper Lake Formation, Hemlock Conglomerate, and undivided Tertiary rocks); 90 samples were analyzed for most elements.
4. Jurassic and Tertiary plutonic rocks of the Alaska-Aleutian Range batholith (gabbro, diorite, quartz diorite, tonalite, granodiorite, and granite) and Tertiary hypabyssal plutons and sills occurring throughout the Katmai study area; 46 samples were analyzed for most elements.
5. Tertiary dikes (primarily middle to late Tertiary); 28 samples were analyzed for most elements.
6. Tertiary volcanic rocks (initially named "volcanic rocks of Barter Range" and "volcanic rocks north of Naknek Lake"); 474 samples were analyzed for most elements.
7. Quaternary volcanic rocks (chiefly lava flows and domes at or near the crest of the Aleutian Range); 73 samples were analyzed for most elements.
8. Altered rock samples from unspecified formation; threshold values taken from the stream-sediment data set (table 1).

MAP OF THE MOUNT KATMAI QUADRANGLE AND ADJACENT PARTS OF THE AFOGNAK AND NAKNEK QUADRANGLES, ALASKA,
SHOWING GEOCHEMICAL DATA INDICATING UNDISCOVERED PORPHYRY-COPPER DEPOSITSBy
S.E. Church, J.R. Riehle, and R.J. Goldfarb
1994