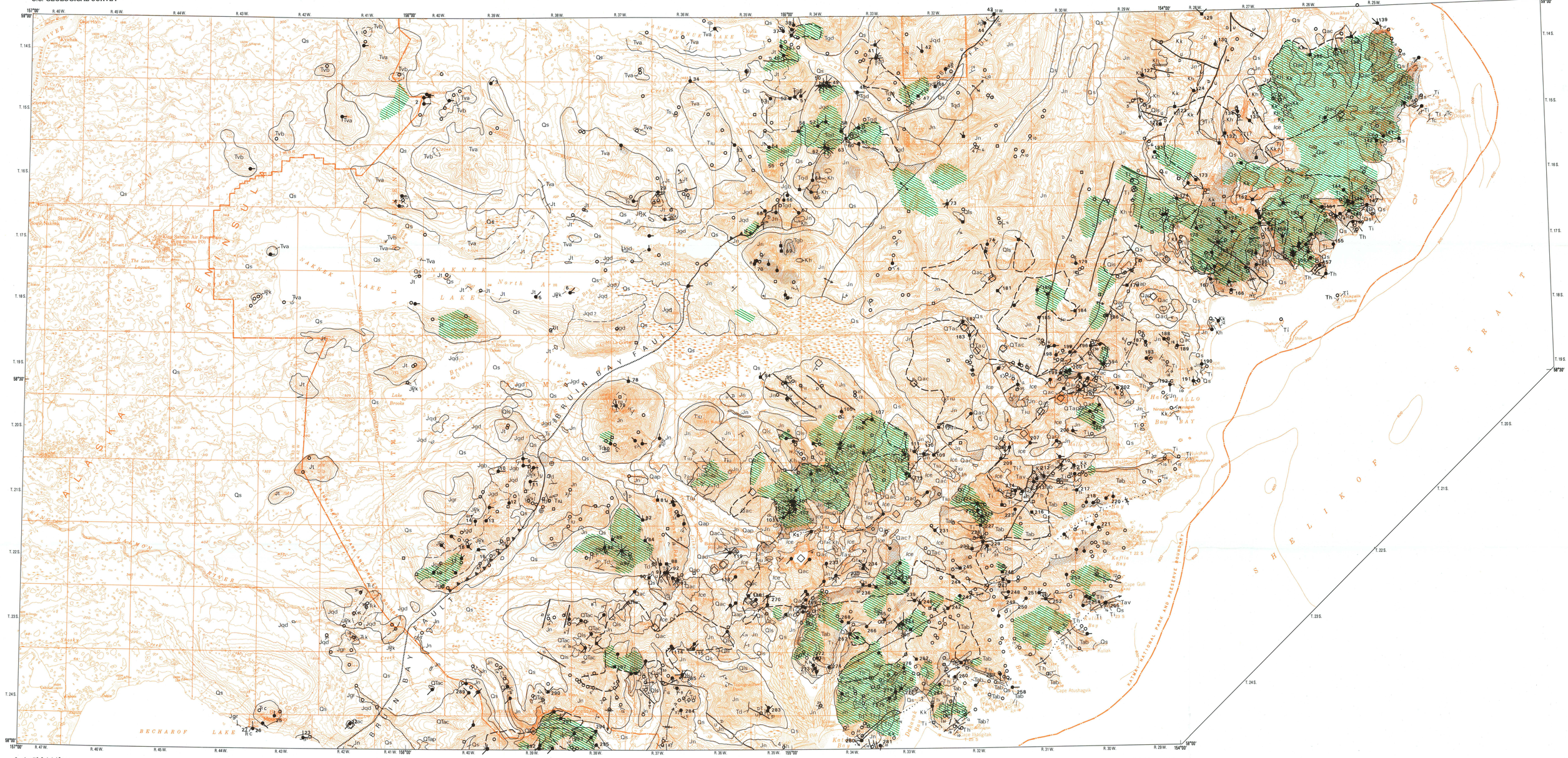
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

BULLETIN 2020
PLATE 2



Base from U.S. Geological Survey
Mt. Katmai, 1952 (revised 1975);
Afognak, 1952 (revised 1982);
Naknek, 1952 (revised 1988)
Universal Transverse Mercator Projection

Geologic base simplified from Riehle and others (in press)

SCALE 1:250 000

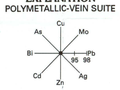
5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS

EXPLANATION

POLYMETALLIC-VEIN SUITE



Rock sample locality

Sample contained anomalous concentrations of elements in the base-metal polymetallic-vein suite at the 95th or 98th percentile (see star diagram above)—Numbered localities correspond to entries in tables 11–18

Sample from outcrop

209
76

Sample from stream float

Sample did not contain anomalous concentrations of elements in the base-metal polymetallic-vein suite

Sample from outcrop

Sample from stream float

Drainage basin containing anomalous concentrations of Cu, Mo, Pb, Ag, Zn, Cd, Bi, and (or) As as determined in both stream sediments and nonmagnetic-heavy-mineral concentrates

Drainage basin containing more than 25 percent sulfide minerals in the nonmagnetic-heavy-mineral separate from panned concentrates

DESCRIPTION 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 **Kaguyak 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 **Pedmar 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

Ks **Staniukovich 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 to massive sandstone member; thinly bedded, dark-gray marine siltstone member containing limestone concretions; thinly bedded marine sandstone and siltstone member; massive conglomerate member. Conglomerate in both the oldest and youngest members are metamorphic, volcanic, and sedimentary rocks with subordinate plutonic rocks

Jt **Talkeetna Formation (Early Jurassic)**—Lava flows, breccias, and lahars locally interbedded with volcaniclastic sandstone, conglomerate, and shale. Includes sills of uncertain ages. Locally metamorphosed to nonschistose epidote-albite-calcite assemblages suggestive of lower greenschist facies

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

VOLCANIC DEPOSITS AND ROCKS

Deposits and rocks of Aleutian volcanic arc

Qap **Pyroclastic-flow deposits (Holocene)**—Poorly sorted, variably indurated deposits of ash, vitrophyric blocks, and (or) pumiceous lapilli of the 1912 ash flow of Novarupta and the Holocene block-and-ash flows of Kaguyak 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, airfall 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, variable indurated deposits of ash, vitrophyric 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 Barrier Range (late Tertiary)**—Breccias, lava flows, sills, and local pyroclastic and epiclastic tuffs of late Tertiary volcanic field located southeast of the Aleutian Range crest and extending from the Katmai River to Kukak Bay. Predominantly of andesitic and dacitic composition. Propylitic alteration is extensive and argillic or potassic alteration is locally intensive, such as near contacts with hypabyssal intrusive rocks (Ti)

Volcanic rocks north of Naknek Lake

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 tuffs of rhyolitic(?) composition, now altered to quartz and sericite or kaolinite

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

INTRUSIVE ROCKS

Td **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

Ti **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 Fourpeaked 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

Tiu **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

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

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

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

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

Jgd **Granodiorite (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

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

Jgb **Diorite and gabbro (Jurassic)**—Dark, diabasic- and gabbroic-textured rocks

METAMORPHIC ROCKS

JPzk **Kakhonak Complex (Jurassic, Triassic, and Paleozoic?)**—Locally foliated or banded quartzite, schist, amphibolite, and garnet-bearing gneiss indicative of amphibolite-facies metamorphism. Protoliths presumably consist of Talkeetna Formation (Jt), Kamishak Formation (Trk), Cottonwood Bay Greenstone (Tkc), and unnamed sandstone and argillite

Contact—Dashed where inferred or approximately located; queried where uncertain

Fault—Dashed where inferred or approximately located; dotted where concealed; queried where uncertain. U, upthrown side; D, downthrown side; query next to U or D indicates direction of movement uncertain, arrows indicate direction of relative movement

37 **Thrust or reverse fault**—Showing dip of fault plane; sawteeth on upper plate

Anticlinal axis—Showing direction of plunge; dashed where approximately located; dotted where concealed; queried where existence uncertain

Synclinal axis—Showing direction of plunge; dashed where approximately located; dotted where concealed; queried where existence uncertain

22 **Measured strike and dip of beds**

Inclined

Horizontal

Approximate strike and dip of beds

Strike and dip of foliation

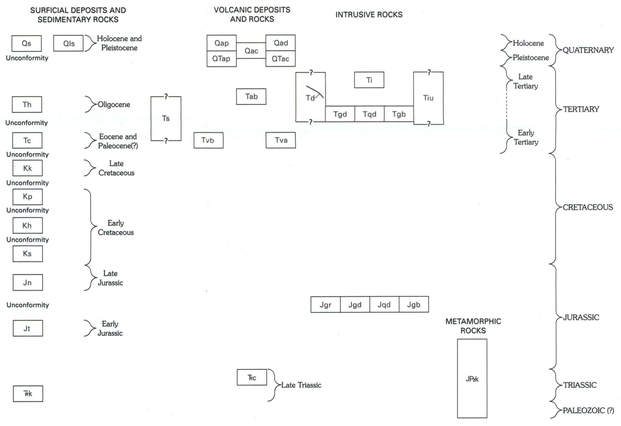
Quaternary volcanic vent

Area of altered rock

Area of hornfels

Ice **Area covered by glacier**

CORRELATION OF MAP UNITS



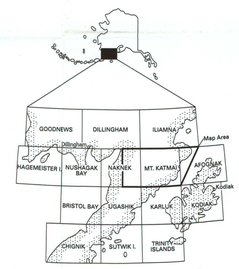


Table 9. Summary of threshold values (95th and 98th percentiles) used for rock and float samples plotted on plate 2, Katmai study area, Alaska.

[Analysis by semiquantitative emission spectrography except where noted by an asterisk (*), which indicates data determined by atomic absorption. Dashes (---), no data; all concentrations expressed as parts per million. Threshold values determined largely from the data in tables 1 and 4]

	Lithologic unit[1]													
	Unit 1		Unit 2		Unit 3		Unit 4		Unit 5		Unit 6		Unit 7		Unit 8	
Element	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th	95th	98th
Cu	150	200	100	200	100	200	150	500	100	150	150	700	100	150	100	200
Mo	.5	7	.5	7	.5	7	.5	7	10	15	7	25	.5	7	7	10
Pb	50	70	50	70	50	70	30	50	50	70	50	70	30	50	70	150
Ag	0.5	1	0.5	1	0.5	1	0.5	1	0.7	3	0.5	2	0.5	1	0.7	5
Zn*	100	210	130	160	190	340	60	140	90	150	90	170	60	180	140	265
Cd*	.5	1.5	.5	1.5	.5	1.5	.5	1.5	.5	1.5	.5	1.5	.5	1.5	.5	1.5
Bi*	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
As*	25	30	20	30	30	100	10	15	10	15	30	70	---	10	50	120

[1]Lithologic units:
1, Metamorphosed rocks northwest of Bruin Bay fault (Kakhonak Complex, Cottonwood Bay Greenstone, Kamishak Formation, Talkeetna Formation) and, locally, southwest of Bruin Bay fault, hornfelsedrocks adjacent to plutons; 94 samples were analyzed for most elements.
2, Mesozoic sedimentary rocks (Naknek, Staniukovich, Herendeen, Pedmar, and Kaguyak Formations); 357 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; 86 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 (informally named "volcanic rocks of Barrier 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 BASE-METAL-BEARING POLYMETALLIC VEINS

By
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