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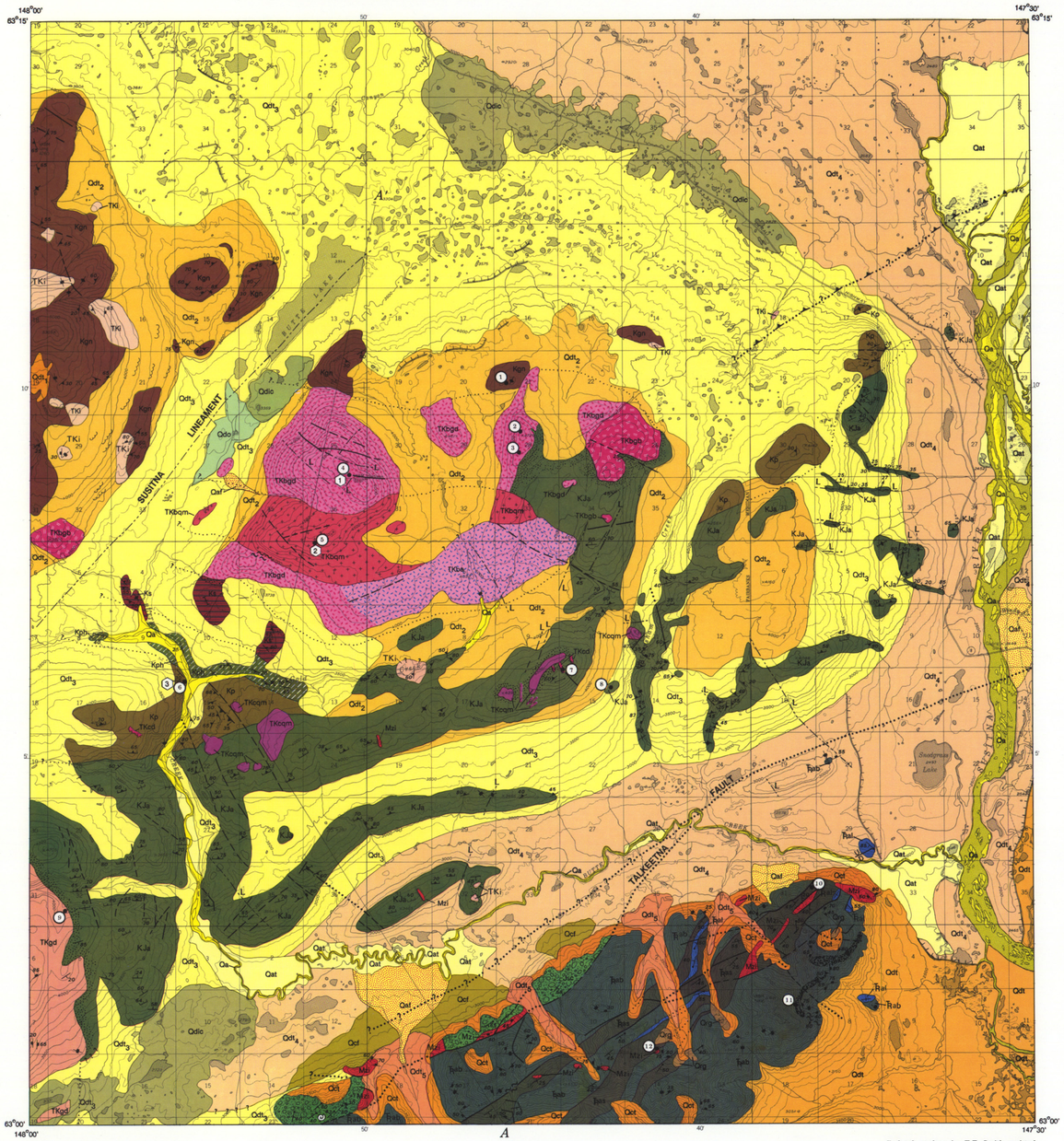

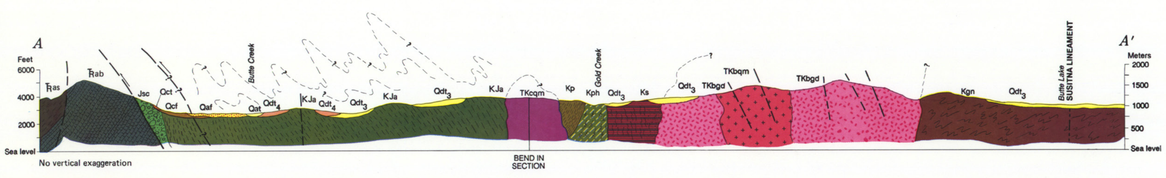

GEOLOGIC MAP OF THE HEALY A-2 QUADRANGLE, ALASKA

by

T.E. Smith, M.D. Albanese, and G.L. Kline

1988

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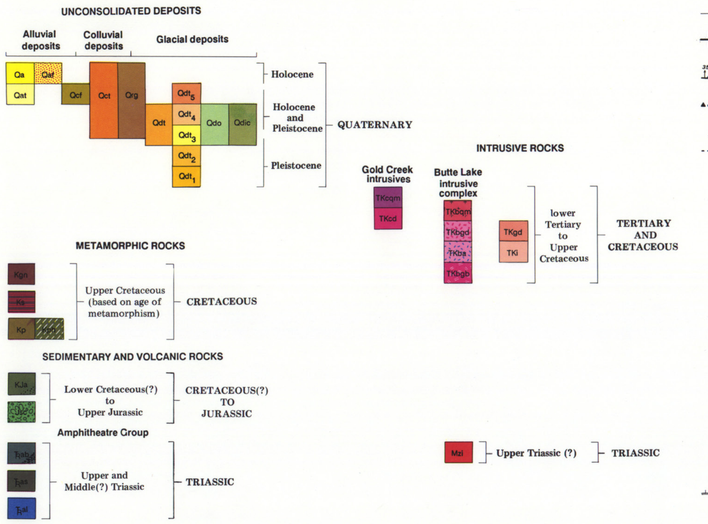
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Alluvial deposits

Qa FLOOD-PLAIN ALLUVIUM—Unconsolidated deposits in modern stream drainages. Material ranges from coarse, unsorted gravel in highland valleys to finely bedded silt in large river drainages.

Qat TERRACE ALLUVIUM—Deposits of locally vegetated terraces adjacent to modern streams. Mostly sand, silt, and gravel with some wood and peaty material.

Qaf ALLUVIAL-FAN DEPOSITS—Poorly consolidated sand and gravel; proximal material coarser than distal material.

Colluvial deposits

Qcf ALLUVIAL-COLLUVIAL-FAN DEPOSITS—Poorly consolidated sand and gravel, including considerable amount of fine-grained material deposited by mudflows and debris flows. More heavily vegetated than Qaf.

Qct COLLUVIUM AND TALUS—Unconsolidated, angular bedrock rubble and soil debris. Form cones or aprons that flank ridges of highland areas and form broad solifluction sheets on gentle slopes.

Qrg ROCK-GLACIER DEPOSITS—Lobate, tongue-shaped, and spatulate accumulations of shattered bedrock rubble with varying amounts of interstitial ice. Restricted to cirques and mountain valleys.

Glacial deposits

Drift sheets are preserved at different elevations and relative positions in the major valleys. They were mapped as undifferentiated drift, including terminal, medial, and ground moraines. The various till units (Qdt) are composed mostly of nonstratified sand and gravel with silt or clay matrix. Five ages of till are recognized in the map area, based on position and morphology of the deposits, 11 radiocarbon dates near the study area (Smith, 1981; Woodward-Clyde Consultants, 1982), and regional correlations with dated moraine sequences in southern Alaska (Péwé and Reger, 1983). The older glacial deposits generally occur at higher elevations and are more subdued, less well preserved, and more heavily vegetated.

Qdt TILL OF UNKNOWN AGE—May correlate with pre-Wisconsin till (Qdt_1) in Susitna River valley.

Qdt_5 TILL OF EARLY HOLOCENE(?) AGE—Confined to north-draining alpine valleys south of Butte Creek.

Qdt_4 TILL OF LATE WISCONSIN AGE—9,500 to 10,500 yr B.P.

Qdt_3 TILL OF LATE WISCONSIN AGE—11,800 to 25,000 yr B.P.

Qdt_2 TILL OF EARLY WISCONSIN AGE—40,000 to 75,000 yr B.P.

Qdt_1 PRE-WISCONSIN TILL—Older than 100,000 yr B.P.

Qdo OUTWASH DEPOSITS—Sorted, stratified sand and gravel deposited by streams that drain glacial termini and margins.

Qdic ICE-CONTACT DEPOSITS—Material composing kames, kame terraces, and eskers. Includes ice-disintegration deposits with characteristic hummocky knob-and-kettle topography and deposits formed in narrow, glacier-confined channels. Well sorted and stratified to unsorted and nonstratified. Eskers consist of low, steep-sided, sinuous ridges of poorly sorted, irregularly stratified alluvium deposited in subglacial tunnels. Some deposits may be usable as road construction material.

METAMORPHIC ROCKS

Metamorphic rocks described below occur along the south flank of the Maclaren metamorphic belt (Turner and Smith, 1974; Smith, 1981). They grade from slaty argillite in the south to gneiss in the north and represent a transition from greenschist facies to upper amphibolite facies. Most rocks were recrystallized from pelitic protoliths, which are interbedded with a conglomerate interval (Jsc) south of Butte Creek that contains Late Jurassic megafossils (Smith, 1981).

Kgn GNEISS AND HIGH-GRADE SCHIST—Gray-brown to rust-weathering pelitic gneiss and silver-brown schist. Dominantly contain biotite, quartz, and plagioclase ± garnet with local sillimanite-bearing variants; accessory minerals include graphite, apatite, tourmaline, and zircon. Include local mafic and calc-magnesian horizons. Gneissic texture mainly layered with local folds. Form large tors up to 20-ft (6-m) high on some ridges. Unit is equivalent to pelitic gneiss in adjacent Healy A-1 Quadrangle, where a K-Ar age of 66.2 m.y. was obtained from hornblende in the gneiss (Smith, 1981).

Kgs SCHIST—Medium- to coarse-grained biotite-plagioclase-quartz schist with local garnet and feldspar porphyroblasts to 0.5 mm. Dominantly gray or brown weathering. Includes local horizons that contain randomly oriented hornblende on foliation surfaces. Stippled pattern near intrusive contacts indicates hornfelsed zone in schist. K-Ar age of 57.2 m.y. was obtained from biotite in this unit in the adjacent Healy A-1 Quadrangle (Smith, 1981).

Kp PHYLLITE—Silver-gray, biotite-bearing phyllite with biotite porphyroblasts to 2-mm long; locally calcareous. Minor compositional banding with more quartzose layers parallel to foliation. Biotite yielded K-Ar age of 53 ± 1.6 m.y. (loc. 3 on map; Turner and Smith, 1974). Grades into amphibole-bearing phyllite (Khp) unit.

Khp AMPHIBOLE-BEARING PHYLLITE—Medium-dark-gray spotted phyllite with planar laminations. Spotted with porphyroblastic biotite. Interlayered with beds that contain randomly oriented amphibole on foliation surfaces. Amphibole prisms commonly 0.5- to 3-mm long. K-Ar age of actinolitic hornblende from this unit in Healy A-1 Quadrangle is 64.1 m.y. (Smith, 1981).

SEDIMENTARY AND VOLCANIC ROCKS

KJa SLATY ARGILLITE, SILTSTONE, AND GRAYWACKE—Black to olive-gray argillite, siltstone, and graywacke with incipient to well-developed slaty cleavage. Commonly thin bedded with cyclic graded intervals to a few inches thick; festooned cross-bedding and load casts common. Slaty cleavage mainly parallel, but locally oblique, to bedding. Graywacke sandstone is fine to medium grained, gray or olive gray with varying amounts of chlorite, calcite, and epidote. Hornfelsed and hydrothermally altered zones are indicated by stippled pattern. Hornfels is typically light gray or tan weathering with white siliceous laminations. Limonitic (altered), metalliferous hornfels occurs near intrusive rocks south of Gold Creek.

KJcg CONGLOMERATIC SEDIMENTARY ROCKS—Interbedded shale, siltstone, sandstone, and polymictic conglomerate south of Butte Creek. Exhibit numerous graded, fining-upward sequences. Conglomerate contains subrounded cobbles to about 4-in. (10-cm) diam; most clasts are basalt, diabase, argillite, or graywacke in dark, calcareous graywacke matrix. Unit over 1,000-ft (300-m) thick. A Kimmeridgian (Late Jurassic) fossil assemblage, including pelecypods *Buchia rugosa*, *Oxytoma* sp., *Pleuromya?* sp. and the worm tube *Ditrupa?* sp., was collected from fossil site shown on map (D.L. Jones, written commun., 1973; Csejtey and others, 1978). Fossils and lithology are remarkably similar to that of Gravina-Nutzotin terrane of eastern Alaska Range (Berg and others, 1972).

Amphitheatre Group

Weakly metamorphosed tholeiitic lavas, agglomerates, and associated sedimentary rocks of the Amphitheatre Group are exposed in a broad belt across the southern part of the Mt. Hayes and Healy Quadrangles. These rocks are similar to the Nikolai Greenstone of the McCarthy area to the southeast; however, available faunal evidence from central Alaska suggests the Amphitheatre Group is slightly younger—late Karnian or Norian vs. pre-late Karnian for the Nikolai Greenstone (Csejtey and others, 1978).

TRab BASALTIC METAVOLCANIC ROCKS—Gray-olive to gray-green metabasalt and basaltic andesite. Aphanitic to porphyro-sphanitic with plagioclase clusters as large as several millimeters. Volcanic rocks consist mainly of plagioclase, clinopyroxene, and iron-titanium oxides with a subophitic or intergranular texture. Propylitic alteration common, especially along shear zones or fractures. Local flows and flow tops are amygdaloidal; typically, amygdules are filled with quartz, epidote, and calcite. Flow units vary in thickness from several inches to about 100 ft (30 m). Stippled pattern indicates thickly bedded massive flows with columnar jointing.

TRsc INTERBEDDED SEDIMENTARY AND VOLCANIC ROCKS—Dark-gray argillite and siltstone; tan, gray, white, pink, and light-green chert; gray, recrystallized limestone and calcarenite; and thin units of metamorphosed volcanic rock.

TRrl RECRYSTALLIZED LIMESTONE -Gray-weathering beds of fine-grained marble and calcarenite within interbedded sedimentary and volcanic rock unit (TRas); locally dark gray to black; contains numerous calcite veins. Similar limestone from Amphitheatre Group in adjacent Healy A-1 (Smith, 1981) and Talkeetna Mountains D-2 (Csejtey and others, 1978) Quadrangles yields late Karnian and Norian (Late Triassic) megafossils.

INTRUSIVE ROCKS

Gold Creek intrusives

The Gold Creek intrusives are exposed along the low ridge south of Gold Creek. They are predominantly of intermediate composition and, on the east end of the ridge, are hydrothermally altered and mineralized with local stockwork fractures, quartz veinlets, and minor fine-grained, disseminated pyrite, chalcopyrite, and molybdenite. The mineralized intrusives are surrounded by rust-weathering, green, pyritic hornfelsed siltstone (stippled zone in KJa unit) with minor limonitic breccia and quartz veins. The mineralized system is a probable source of placer gold in Wickersham and Gold Creeks.

TKgcm QUARTZ MONZONITE—Small intrusive bodies exposed south of Gold Creek. Predominantly medium-grained, equigranular or seriate, nonfoliated biotite-hornblende quartz monzonite with local pods of granodiorite and granite. Propylitic alteration common locally with chlorite replacing biotite and calcite replacing feldspar.

TKcd INTERMEDIATE DIKES—Small, dark-gray, aphanitic to porphyritic, nonfoliated dikes of intermediate composition in Gold Creek vicinity. Locally pyritic.

Butte Lake intrusive complex

The Butte Lake complex is an intrusive suite exposed over about 20 mi^2 (52 km^2) on an upland plateau in the central Healy A-2 Quadrangle. The complex is compositionally zoned with a quartz monzonite core surrounded by a granodiorite-diorite border phase. Satellite stocks of hornblende gabbro occur on the east and west ends of the complex.

TKbgm BIOTITE-HORNBLENDE QUARTZ MONZONITE AND GRANODIORITE—Light-gray, fine- to medium-grained, equigranular to seriate biotite-hornblende quartz monzonite and granodiorite. Locally porphyritic with pink poikilitic potassium feldspar phenocrysts to 1 cm. Contain biotite and hornblende in varying proportions, but generally mafics total 5 to 15 percent. Mafics and feldspars crudely foliated. Disseminated pyrite and limonitic alteration present locally. K-Ar age of hornblende from center of complex at locality 2 (see map) is 55.9 ± 1.7 m.y. (Turner and Smith, 1974).

TKbgd BIOTITE-HORNBLENDE GRANODIORITE—Gray, fine- to medium-grained, hypidiomorphic granular biotite-hornblende granodiorite. Contains up to 15 percent hornblende with minor biotite and accessory sphene, augite, and apatite with local chloritic alteration. Hornblende prisms to several millimeters parallel foliation, which occurs along southern margin of body. Textures equigranular to seriate. Rounded xenoliths common locally. A leucocratic phase that contains less than 10 percent mafics occurs in northern part of unit (less dense pattern). K-Ar age dates from hornblende from locality 1 (see map) are 63.5 ± 1.9 m.y. and 64.3 ± 1.9 m.y. (Turner and Smith, 1974).

TKbga EPIDOTE-HORNBLENDE GRANODIORITE—Medium-grained, equigranular to seriate, epidote-bearing hornblende granodiorite with minor biotite and accessory sphene. Green gray on fresh surface. Epidote occurs in abundant epidote-quartz veins and as fine, disseminated subhedral grains that replace plagioclase, hornblende, and olive-brown biotite; pink potassium feldspar phenocrysts present locally.

TKbgb HORNBLENDE GABBRO AND DIORITE—Medium- to very coarse grained hornblende gabbro and diorite exposed mainly as rubble crop. Include up to 5 percent biotite and local pegmatitic phases with green, altered plagioclase and hornblende prisms to 1.5-in. (4-cm) long. Irregular clots of dark hornblende gabbro in foliated diorite common in some areas. Rounded xenoliths locally abundant.

Other intrusive bodies

TKgd BIOTITE-HORNBLENDE GRANODIORITE TO DIORITE—Non-foliated, medium-grained, equigranular biotite-hornblende granodiorite with local diorite phases. Biotite and hornblende generally compose 10 to 20 percent of total volume. Xenoliths of foliated to nonfoliated, fine-grained country rock to several inches are common. K-Ar ages of 48.8 ± 1.5 m.y. (biotite) and 44.8 ± 1.3 m.y. (hornblende) were obtained from intrusive body about 3 mi (4.8 km) west of study area (Turner and Smith, 1974).

TKi SMALL INTRUSIVES OF INTERMEDIATE COMPOSITION—Medium- to coarse-grained, slightly foliated biotite-hornblende diorite to porphyritic quartz monzonite with local potassium feldspar and quartz phenocrysts. Occur mainly in high-grade metamorphic terrane in northwest part of quadrangle.

Mzi SMALL STOCKS, DIKES, AND SILLS—Mafic and intermediate intrusive bodies often associated with Amphitheatre Group of Triassic age. Include diabase sills and plugs, basaltic dikes, hornblende porphyry, and diorite bodies. Often weakly metamorphosed.

MAP SYMBOLS

- Contact—Dashed where approximately located; dotted where concealed; queried where inferred
- High-angle fault—Dashed where approximately located; dotted where concealed; queried where inferred. D, downthrown side; U, upthrown side
- Thrust fault—Dashed where approximately located. Sawteeth on upper plate. Arrow indicates dip of fault
- Inferred thrust fault—Extended to map area from adjacent Healy A-1 Quadrangle (Smith, 1981). Sawteeth on upper plate
- Shear zone—Showing average dip, where known
- Lineament—Inferred from aerial photographs. May represent fault

Strike and dip of beds—May be combined with linear or other planar symbols

- Inclined—Ball indicates top of beds known
- Overturned
- Vertical

Strike and dip of foliation and cleavage—May be combined with linear or other planar symbols

- Inclined foliation
- Vertical foliation
- Crenulated foliation
- Inclined cleavage, in most cases axial-plane cleavage
- Vertical cleavage

Strike and dip of joints

- Inclined
- Vertical
- Bearing and plunge of lineation
- Bearing and plunge of crenulated lineation
- Igneous dike
- Morainal ridge—Results from stillstand or readvance of ice terminus
- Solifluction lobe—Especially prevalent on gentle slope covered with veneer of older glacial drift
- Fossil locality (see unit description for detail)
- K-Ar age-date locality (see unit description for detail)
- Major-oxide analysis (table 1)

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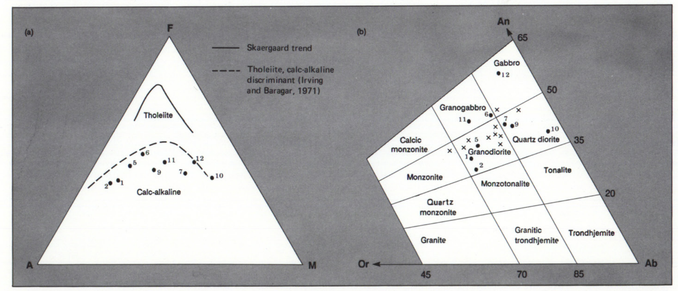
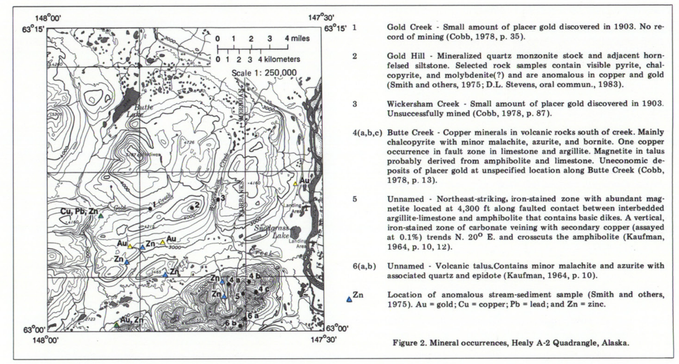


Figure 1. (a) AFM plot showing calc-alkaline nature of granitoid rocks (for raw data see table 1), Healy A-2 Quadrangle, Alaska; and (b) normative Or-Ab-An plot of plutonic rocks (for raw data see table 1), Healy A-2 Quadrangle, Alaska, showing similarities to Tertiary and Cretaceous rocks (x) from adjacent Healy A-1 Quadrangle (Smith, 1981). Rock-classification fields from Hietanen (1963).



1 Gold Creek - Small amount of placer gold discovered in 1903. No record of mining (Cobb, 1978, p. 35).

2 Gold Hill - Mineralized quartz monzonite stock and adjacent hornfelsed siltstone. Selected rock samples contain visible pyrite, chalcopyrite, and molybdenite(?) and are anomalous in copper and gold (Smith and others, 1975; D.L. Stevens, oral commun., 1983).

3 Wickersham Creek - Small amount of placer gold discovered in 1903. Unsuccessfully mined (Cobb, 1978, p. 87).

4(a,b,c) Butte Creek - Copper minerals in volcanic rocks south of creek. Mainly chalcopyrite with minor malachite, azurite, and bornite. One copper occurrence in fault zone in limestone and argillite. Magnetite in talus probably derived from amphibolite and limestone. Uneconomic deposits of placer gold at unspecified location along Butte Creek (Cobb, 1978, p. 13).

5 Unnamed - Northeast-striking, iron-stained zone with abundant magnetite located at 4,300 ft along faulted contact between interbedded argillite-limestone and amphibolite that contains basic dikes. A vertical, iron-stained zone of carbonate veining with secondary copper (assayed at 0.1%) trends N. 20° E. and crosscuts the amphibolite (Kaufman, 1964, p. 10, 12).

6(a,b) Unnamed - Volcanic talus.Contains minor malachite and azurite with associated quartz and epidote (Kaufman, 1964, p. 10).

Location of anomalous stream-sediment sample (Smith and others, 1975). Au = gold; Cu = copper; Pb = lead; and Zn = zinc.

Figure 2. Mineral occurrences, Healy A-2 Quadrangle, Alaska.

Table 1. *Major-oxide analyses[a] and CIPW normative mineralogy of selected igneous and metamorphic rocks[b], Healy A-2 Quadrangle, Alaska.*

	1 Kgn	2 TKbgd	3 TKbgc	4 TKbgd	5 TKbgm	6 Kp	7 TKcd	8 KJa	9 TKgd	10 TRas	11 TRab	12 Mzi
						Major Oxides (wt %)						
SiO_2	64.9	59.3	55.6	61.4	63.8	55.7	52.4	63.2	55.3	50.3	53.9	52.2
Al_2O_3	15.5	17.0	18.4	17.5	16.4	13.4	14.6	15.6	18.0	10.3	16.5	15.4
Fe_2O_3	0.9	2.3	2.8	2.8	2.3	0.8	1.7	1.5	0.8	1.0	1.4	1.5
FeO	6.4	4.0	4.7	2.2	2.4	5.8	6.3	4.5	5.6	7.6	6.6	7.0
MgO	2.9	2.1	2.3	1.6	1.5	3.5	7.2	3.1	3.8	10.7	4.7	6.8
CaO	0.9	6.5	8.0	5.6	4.6	9.4	6.9	5.4	8.9	12.3	7.8	10.9
Na_2O	1.8	3.4	3.4	3.6	3.7	1.9	3.1	3.2	3.9	2.8	2.7	2.4
K_2O	1.9	2.8	1.9	3.4	3.3	1.5	1.5	1.1	1.5	0.32	2.4	0.8
H_2O+	1.7	0.95	0.83	0.61	0.78	1.4	2.5	3.0	1.1	1.5	1.5	2.8
H_2O-	0.19	0.05	0.01	0.03	0.10	0.18	0.35	0.07	0.05	0.05	0.10	0.06
TiO_2	0.79	0.77	0.92	0.62	0.63	0.93	1.30	0.73	1.2	1.2	0.93	0.92
P_2O_5	0.27	0.35	0.44	0.30	0.24	0.16	0.33	0.15	0.38	0.12	0.35	0.09
MnO	0.89	0.14	0.15	0.11	0.10	0.10	0.13	0.09	0.09	0.16	0.13	0.14
CO_2	0.02	0.02	0.06	0.06	0.02	4.1	0.62	0.10	0.03	0.83	0.08	0.04
Total	99.1	99.7	99.5	99.8	99.9	98.9	99.7	98.6	99.2	99.1	101.0	
						CIPW Norms (wt %)						
Quartz	37.6	12.4	8.6	14.5	18.3	15.9	2.7	27.1	5.1	--	4.2	2.6
Orthoclase	11.6	16.7	11.4	20.3	19.7	9.5	9.3	3.4	9.1	1.9	14.5	4.8
Albite	15.7	29.1	29.2	30.7	31.6	17.2	27.5	6.7	23.8	24.5	23.4	20.7
Anorthite	2.8	23.1	29.7	21.7	18.5	25.3	22.5	28.0	27.9	15.0	26.5	29.4
Diopside	--	5.9	6.3	3.4	2.3	19.5	8.9	16.5	3.9	38.0	8.9	20.4
Hypersthene	19.1	6.9	7.9	3.3	4.3	9.0	23.1	14.2	15.8	4.2	17.5	17.9
Magnetite	1.3	3.4	4.1	4.1	3.4	1.2	2.6	2.3	1.2	1.8	2.1	2.2
Ilmenite	1.5	1.5	1.8	1.2	1.2	1.9	2.6	1.4	2.3	2.4	1.8	1.8
Apatite	0.6	0.8	1.0	0.7	0.6	0.4	0.8	0.4	0.9	0.3	0.8	0.2
Olivine	--	--	--	--	--	--	--	--	--	12.2	--	--
Corundum	9.7	--	--	--	--	--	--	--	--	--	--	--
Total	99.9	99.8	100.0	99.9	99.9	99.9	100.0	100.0	90.0	100.0	99.7	100.0

[a]Analyses by U.S. Geological Survey; methods by Shapiro and Brannock (1962).
[b]Numbers correspond to sample site on map.
-- = Not present in norm.