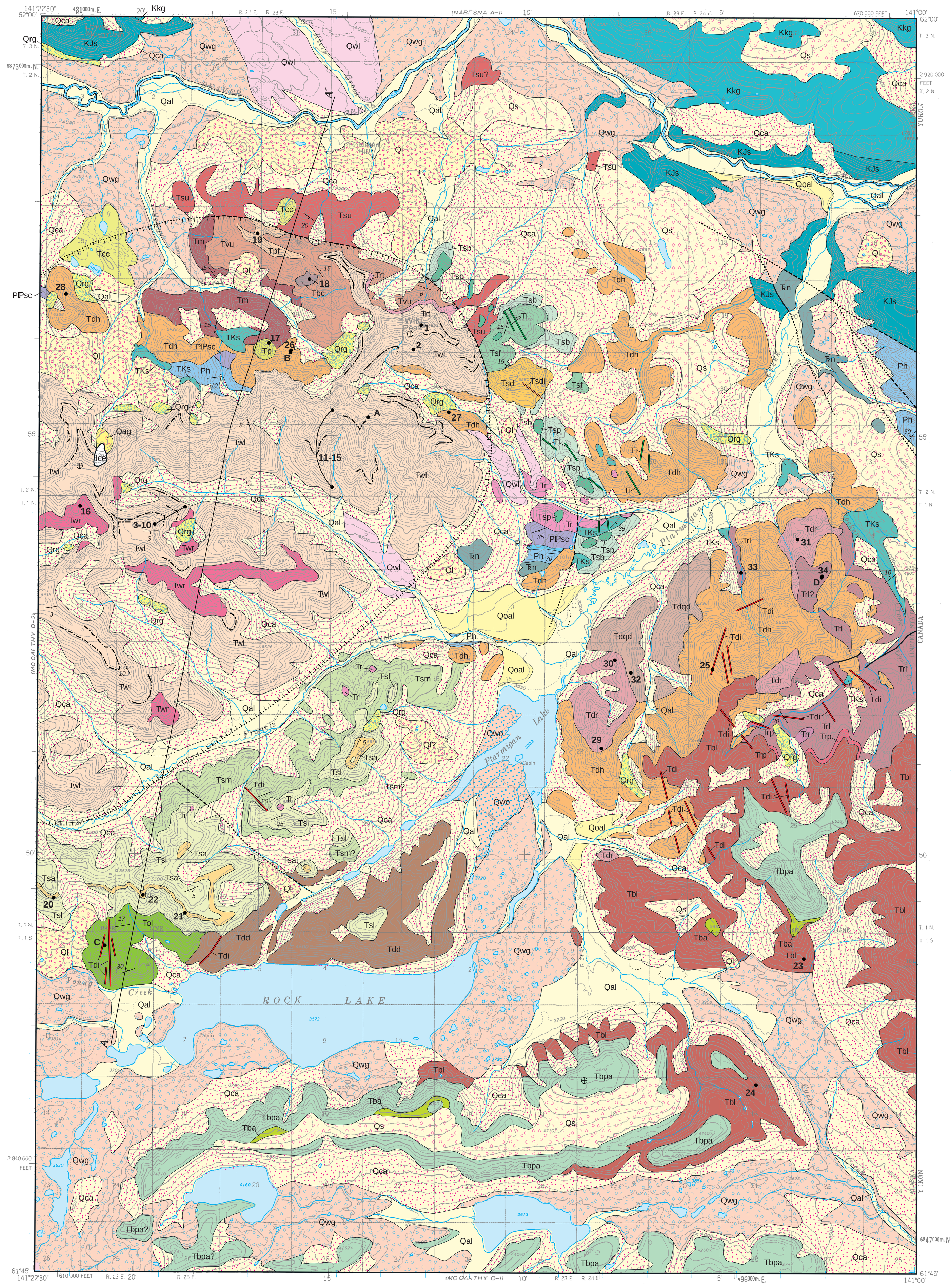


Base from U.S. Geological Survey, 1959
Universal Transverse Mercator projection
1927 North American Datum
10,000-foot grid based on Alaska coordinate system, zone 2

APPROXIMATE MEAN DECLINATION, 1959

SCALE 1:63 360

1 0 1 2 3 4 MILES

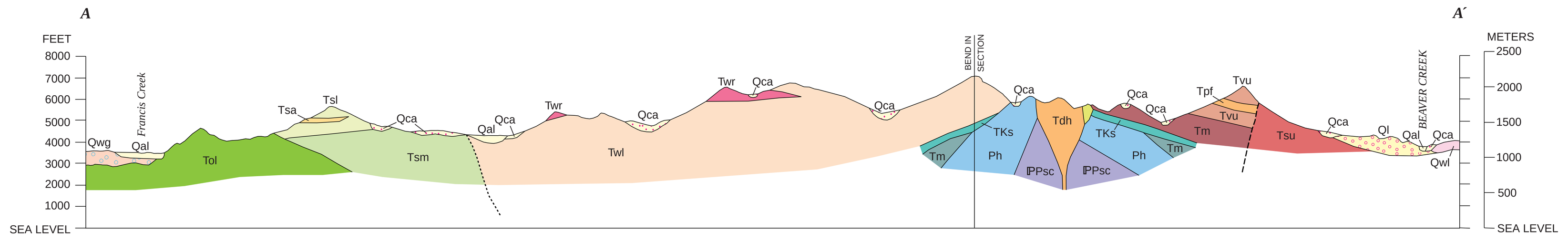
1 0 1 2 3 4 KILOMETERS

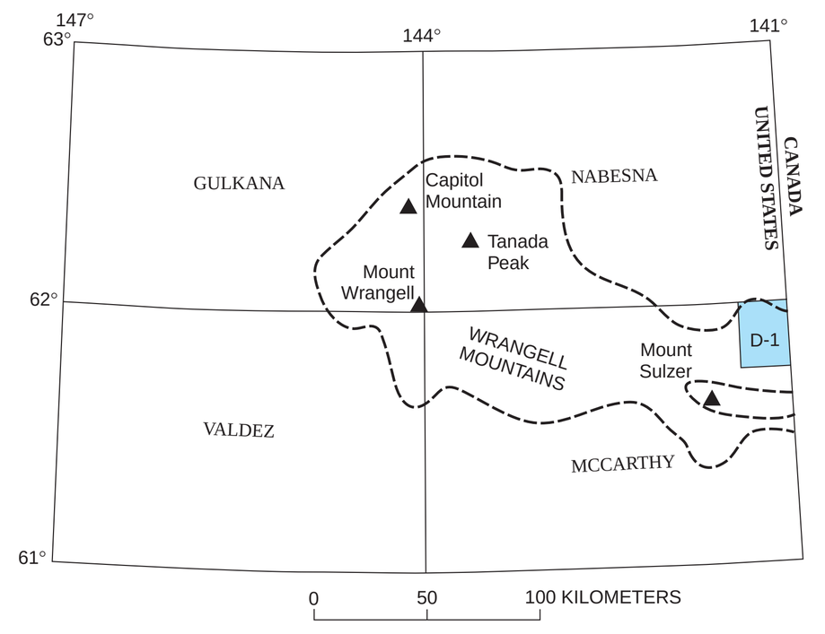
CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

Geology mapped by D.H. Richter, 1981, 1984, 1985, 1991, 1995; J.C. Ratte', 1984, 1985, 1995; W.P. Leeman and M. Menzies, 1985; S. Preece and R.G. McGimsey, 1991; E. Moll-Stalcup, 1995

Manuscript approved for publication December 13,1999





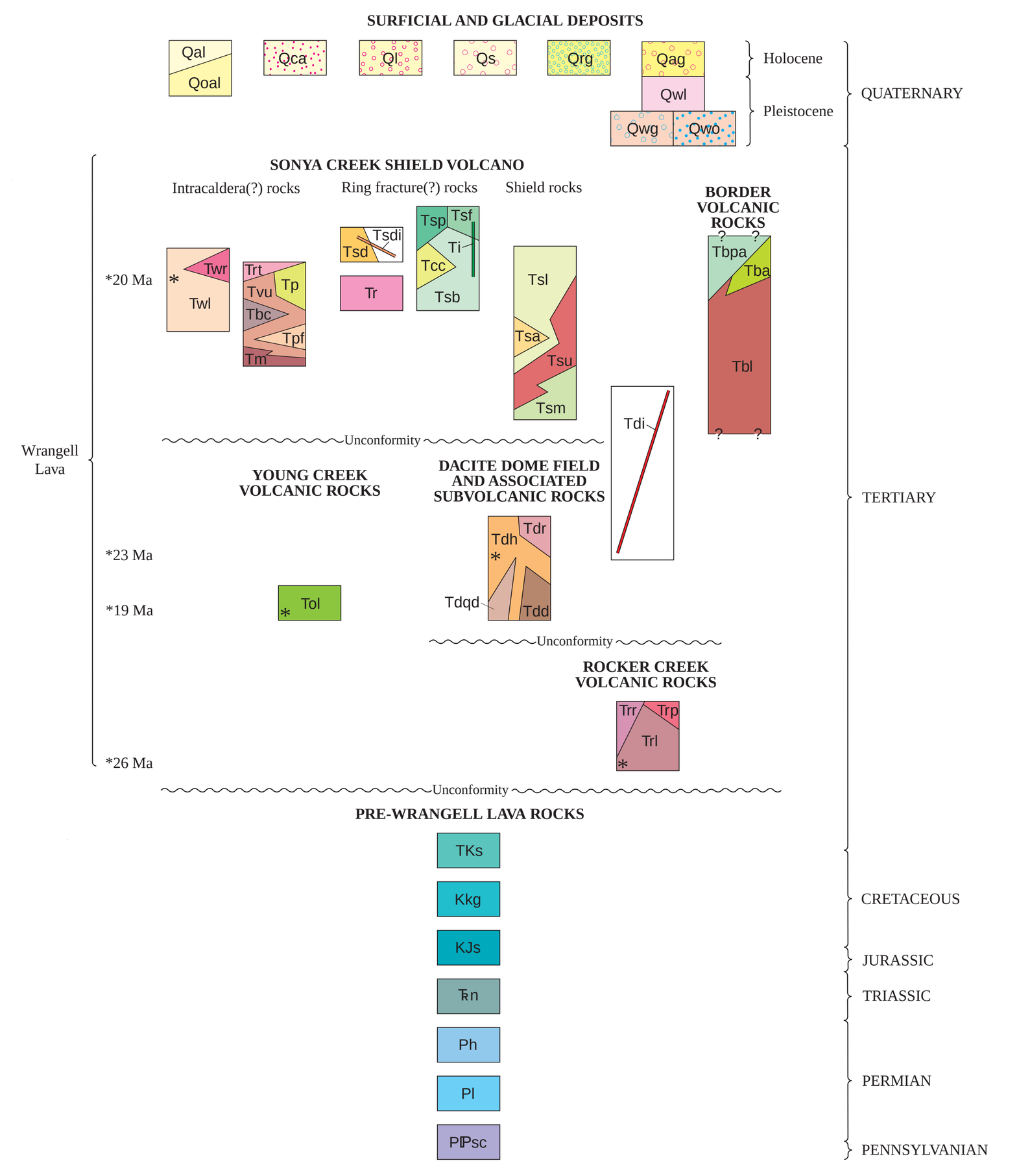
INDEX MAP SHOWING STUDY AREA (BLUE SHADING), SURROUNDING 1:250,000-SCALE QUADRANGLES, EXTENT OF WRANGELL VOLCANIC FIELD (DASHED LINE), AND GEOGRAPHIC FEATURES MENTIONED IN TEXT

GEOLOGIC MAP OF THE McCARTHY D–1 QUADRANGLE, ALASKA

By
Donald H. Richter, James C. Ratté, William P. Leeman, and Martin Menzies

2000

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

SURFICIAL AND GLACIAL DEPOSITS

Qal **Alluvium along streams and in fans (Holocene)**—Mainly in active flood plains and lowermost terraces of major and some minor streams and in larger active fans. Larger fan margins are outlined by fine dots. Chiefly stratified silt, sand, gravel, and boulders

Qoal **Older alluvium (Holocene and Pleistocene)**—Mainly outwash related to Alaskan glaciation and possibly younger phase of Wisconsin glaciation. Chiefly stratified silt, sand, gravel, and boulders

Qca **Colluvium, undifferentiated (Holocene and Pleistocene)**—Chiefly talus, but also includes deposits of small landslides, rock glaciers, other products of mass-wasting processes, and alluvium in small fans and cones. Chiefly poorly sorted silt, sand, gravel, and boulders

Ql **Landslide deposits (Holocene and Pleistocene)**—Includes large slump and debris avalanche deposits. Particularly common along steep north flank of mountain escarpment south of Beaver Creek. Slump deposits consist chiefly of masses of volcanic rock as much as hundreds of meters wide; debris deposits are chiefly diamicton and rubble

Qs **Solifluction deposits (Holocene and Pleistocene)**—Deposits on low-angle, low-relief slopes at relatively high elevations. Mostly bedrock rubble but may include some Wisconsin and older glacial drift

Qrg **Rock glacier deposits (Holocene)**—Deposits of active rock glaciers exhibiting well-defined lobate forms. Chiefly angular blocks and diamicton

Qag **Alaskan glaciation deposits (Holocene)**—Terminal and lateral moraine at base of small ice field in sec. 34, T. 2 N., R. 22 E. Chiefly diamicton

Qwl **Younger Wisconsin glaciation deposits (Pleistocene)**—Terminal and lateral moraines of late(?) phase of Wisconsin glaciation. Chiefly diamicton and rubble

Qwg **Older Wisconsin glaciation deposits (Pleistocene)**—Chiefly ground moraine of main(?) phase of Wisconsin glaciation. Diamicton, local gravel and sand

Qwo **Fluvio-glacial deposits (Pleistocene)**—Chiefly outwash related to main(?) phase of Wisconsin glaciation. Silt, sand, gravel, and boulders

VOLCANIC AND ASSOCIATED ROCKS (WRANGELL LAVA)

Sonya Creek Shield Volcano

Ring fracture(?) related rocks

Tsd **Dacite dome (Tertiary)**—Glassy, dense dacite dome exhibiting well-developed columnar joints. Rock is sparsely porphyritic containing phenocrysts (7 %) of plagioclase and altered hornblende

Tsdi **Dacite dike (Tertiary)**—Dark, fine-grained dike that is probably related to the dacite dome (unit Tsd). Dike contains sparse, microphenocrysts of plagioclase, clinopyroxene, and hornblende

Tr **Rhyolite dome and plugs (Tertiary)**—Light-colored, crystal-poor, flow-banded rhyolite. Rock contains a few percent of small plagioclase and biotite phenocrysts in a devitrified chalky matrix. The dome, exposed north of Ptarmigan Lake, apparently was endogenous, and it structurally deformed older sedimentary rocks (unit TKs) into which it was emplaced. The plugs exist as small (less than 30 m in diameter), isolated exposures in shield lavas and mudflows to the southwest of the dome near the inferred caldera margin

Ti **Andesite and basalt(?) dikes (Tertiary)**—Short, generally narrow (less than 3 m wide) dikes that appear to be associated with plugs, flows, and breccias of map units Tsp, Tsf, and Tsb. The dikes are dark, porphyritic, locally aphanitic, and contain phenocrysts of plagioclase and pyroxene

Tsp **Andesite and basalt plugs(?) (Tertiary)**—Dark, generally aphanitic, dense rock masses contained within breccias of unit Tsb

Tsf **Andesite flows and tephra (Tertiary)**—Dark, aphanitic lava flows and interlayered lapilli tuffs that overlie fragmental rocks of unit Tsb. May include some basalt flows

Tsb **Andesite and basalt fragmental rocks (Tertiary)**—Dark volcanic breccias and agglomerates, all generally welded, and minor mudflows that are locally palagonitized. Breccias contain clasts as much as 5 m in diameter; agglomerates contain round and spindle bombs as much as 1 m long. Rocks are aphanitic to locally sparsely porphyritic, containing small phenocrysts of plagioclase, olivine, and minor clinopyroxene. Unit appears to form the base of the sequence of lava flows and tephra in unit Tsf

Tcc **Andesite cinder cones (Tertiary)**—Reddish, oxidized cinder and scoria. West of Sonya Creek, unit may include thin andesite flows

Intracaldera(?) rocks

Twl **Lavas of Wiki Peak (Tertiary)**—Extensive, thin to locally thick (as much as 35 m), lava flows and subordinate interlayered lahars and lapilli tuffs that show an aggregate thickness of more than 1,000 m. Lavas range in composition from basalt to dacite (50.0–63.4 % SiO_2; map nos. 1–15, Table 1), but are predominantly basaltic andesite and andesite. Lavas are characteristically plagioclase-phyric containing 12–40 % phenocrysts of plagioclase, clinopyroxene, olivine, and ± orthopyroxene. A flow high in the intracaldera section has a whole rock K-Ar age of 20.0±0.6 Ma (map letter A, Table 2)

Twr **Rhyolite flow(s) (Tertiary)**—Thick (as much as 200 m), light-colored and intricately flow-banded rhyolite (74.6 % SiO_2; map no. 16, Table 1) lava containing abundant, pristine black obsidian. Unit locally includes as much as 2 m of overlying rhyolitic lapilli tuff and 10 m of rhyolitic volcanic sandstone. Non-devitrified glass contains sparse microphenocrysts of clinopyroxene, orthopyroxene, and zircon

Trt **Rhyolite tephra (Tertiary)**—Bedded, light-colored, rhyolitic air-fall deposits locally as much as 25 m thick. Exposed in the extreme northeast sector of caldera; may represent distal air-fall deposits of unit Twr

Tp **Andesite plug (Tertiary)**—Very dark andesite (58.6 % SiO_2; map no. 17, Table 1) plug that may mark a principal eruptive area of the Sonya Creek volcano. Rock is aphanitic, containing sparse microphenocrysts of plagioclase, orthopyroxene, and clinopyroxene

Tbc **Basalt cinder cone and flow (Tertiary)**—Red cinder cone and dark basalt (48.3 % SiO_2; map no. 18, Table 2) flow. Flow contains aligned microphenocrysts of plagioclase, clinopyroxene, and olivine

Tpf **Dacite pyroclastic flow (Tertiary)**—Light-colored, paleovalley-filling dacite (63.8 % SiO_2; map no. 19, Table 1) ash-flow tuff containing phenocrysts of plagioclase, quartz, and minor hornblende and clinopyroxene in a welded pumiceous groundmass

Tm **Mudflows(?) (Tertiary)**—Structureless to locally stratified mudflows(?) containing clasts of angular volcanic rock as much as 10 m in diameter and minor rounded clasts of exotic plutonic rock. Unit appears to form basal unit in Sonya Creek caldera(?)

Tvu **Intracaldera (?) lavas, undifferentiated (Tertiary)**—Mainly lava flows of intermediate composition; also includes interlayered mafic flows, pyroclastic deposits, lahars, and tuffs

Shield rocks

Tsl **Andesite flows (Tertiary)**—Chiefly aphanitic to porphyritic andesite and possibly dacite lava flows and minor interbedded mudflows and glassy agglomerates. Flows are mostly flat-lying and are generally less than 10 m thick; aggregate thickness about 350 m

Tsa **Dacite agglutinate (Tertiary)**—Extensive but relatively thin (25–35 m) dacite (64.8–65.5 % SiO_2; map nos. 20–22, Table 1) agglutinate consisting of densely welded flattened pumice, stretched glass fragments (fiamme), and equidimensional lithic fragments exhibiting a well developed eutaxitic texture. Rock is sparsely porphyritic containing phenocrysts of plagioclase (1–5 %), minor clinopyroxene, and occasional rounded quartz and olivine. Agglutinate appears to be single flow interlayered in unit Tsl

Tsm **Andesitic mudflows (Tertiary)**—Chiefly thick (as much as 25 m), poorly sorted, and clast-supported mudflows and minor thin interbeds of mud-rich sand and gravel. Clasts as much as a meter in diameter are rounded to angular and consist chiefly of andesite lava. Unit may include a few thin andesite lava flows. Aggregate thickness more than 230 m; base is not exposed

Tsu **Shield lavas, undifferentiated (Tertiary)**—Mapped only along the north margin of the inferred caldera where access is difficult. Chiefly south-dipping andesite lava flows, but includes a variety of flows and volcaniclastic rocks. Thickness probably more than 500 m

Border volcanic and volcaniclastic rocks

Chiefly undated lava flows from a volcanic complex whose center apparently is in Yukon Territory, Canada, a few kilometers east of the Alaska-Yukon border

Tbpa **Porphyritic andesite flows (Tertiary)**—Very extensive and thick (as much as 300 m) two-pyroxene andesite lava flows that exhibit well-defined vertical columnar jointing. Rock is coarsely porphyritic containing 30–50 % phenocrysts of plagioclase, clinopyroxene, and orthopyroxene. Presence of minor lithic clasts and association with andesitic agglutinates (unit Tba) suggest that some of these lavas may also have originated as agglutinates

Tba **Andesite agglutinates (Tertiary)**—Locally extensive 2-pyroxene andesite agglutinates as much as 30 m thick. Rock contains lithic clasts and, locally, streaks of glassy fiamme. Unlike the associated columnar-jointed flows (unit Tbpa), the agglutinates are only sparsely porphyritic, containing 4–8 % phenocrysts of plagioclase, clinopyroxene, and orthopyroxene

Tbl **Volcanic and volcaniclastic rocks, undifferentiated (Tertiary)**—Sequence of interlayered flows and lahars, chiefly of andesite composition (57.6–60.3 % SiO_2; map nos. 23 and 24, Table 1), and, locally, volcanic gravel and conglomerate. Upper part of unit overlies the dacite dome field and associated rocks (unit Tdh), but lower part of unit appears to be intruded by dacite porphyry (unit Tdh), hence may include rocks of the older Rocker Creek lavas (unit Trl)

Dacite dome field and associated subvolcanic rocks

Tdi **Dacite porphyry and andesite dikes, undifferentiated (Tertiary)**—Chiefly dacite porphyry dikes, as much as 10 m wide, petrographically similar to the hornblende-bearing dacite domes (unit Tdh). Includes andesite dikes (55.6 % SiO_2; map no. 25, Table 1) possibly related to the andesitic Border volcanic rocks (unit Tbl)

Tdh **Dacite porphyry domes (Tertiary)**—Broad belt of at least eight coalesced endogenous and exogenous dacite domes that extends more than 19 km around and under the Sonya Creek shield volcano. The dacite (65.8–66.3 % SiO_2; map nos. 26–28, Table 1) is coarsely porphyritic containing as much as 30 % large (as much as 5 mm) phenocrysts of plagioclase and locally highly altered hornblende. A K-Ar date of 23 Ma (Map letter B, Table 2) was obtained on hornblende from a dome overlain by Sonya Creek intracaldera(?) rocks

Tdr **Rhyolite domes (Tertiary)**—Light-colored, fine-grained rhyolite (75.3–75.8 % SiO_2; map nos. 29–31, Table 1) containing sparse microphenocrysts of plagioclase, hornblende, biotite, and, locally, rosettes of black tourmaline

Tdqd **Quartz diorite (Tertiary)**—Chiefly medium-grained, subhedral granular quartz diorite (64.1 % SiO_2; map no. 32, Table 1) containing plagioclase, quartz, orthoclase, clinopyroxene, and minor hornblende and biotite. Locally highly altered. Variants include fine-grained plagioclase-rich rock containing small sparse phenocrysts of biotite, quartz, and clinopyroxene and dark fine-grained rock containing sparse phenocrysts of plagioclase, hornblende, and clinopyroxene in a felty microcrystalline groundmass. Probably mostly subvolcanic and a variant of the diorite intrusive (unit Tdd)

Tdd **Diorite (Tertiary)**—Medium-grained, subhedral granular diorite consisting of subhedral plagioclase (80–90 %), clinopyroxene (5–15 %) generally altered to actinolite, and locally minor hornblende and biotite

Young Creek volcanic and volcaniclastic rocks

Tol **Andesite lavas and mudflows (Tertiary)**—A sequence of tilted and interlayered porphyritic to aphanitic andesite lava flows and mudflows that dip 20–30° north. Two whole-rock K-Ar determinations on the same sample give ages of 18.6 and 19.1 Ma (map letter C, Table 2). These ages are too young, and probably have been reset, because unit is unconformably overlain by shield lavas of the Sonya Creek volcano (about 20 Ma) and is intruded and tilted by subvolcanic rocks (unit Tdd) that are probably 23 Ma or older. Unit has an aggregate thickness of about 1,000 m, but base is not exposed

Rocker Creek volcanic and volcaniclastic rocks

Trr **Rhyolite dome (Tertiary)**—Small light-colored dome or shallow intrusion that is locally highly brecciated. Rock is fine grained and chalky and contains occasional quartz eyes

Trp **Rhyolite volcaniclastic rocks (Tertiary)**—Light-colored pyroclastic flows and tephra. Pyroclastic flows contain glassy and fine-grained breadcrust bombs in an ash-rich matrix. Source is probably the rhyolite dome of unit Trr

Trl **Rocker Creek volcanic and volcaniclastic rocks, undifferentiated (Tertiary)**—Chiefly dark basalt to andesite lava flows (47.5–60.4 % SiO_2, map Nos. 34 and 33, Table 1) and minor interlayered mudflows and maroon to dark-green volcanic siltstone, sandstone, and pebble conglomerate. Unit has been structurally deformed; bedding dips 20° to the southwest. A whole-rock K-Ar age of 26 Ma (map letter D, Table 2) was obtained on a basalt lava flow

PRE-WRANGELL LAVA ROCKS

Exposed chiefly in the northeast corner of the quadrangle and locally underlying Wrangell Lava rocks in the northern half of the quadrangle. With the exception of unit TKs (continental sedimentary rocks), only limited sections of the map units are exposed. Mapping and description of most units modified from MacKevett (1978)

TKs **Continental sedimentary rocks (Tertiary and Cretaceous)**—Predominantly conglomerate, grit, and coarse sandstone. Conglomerate ranges from clast-supported massive beds, as much as 5 m thick, to bedded conglomeratic sandstone. Clasts, as much as 20 cm in diameter, consist of rounded to subrounded crystalline rock, gneiss, gray chert, greenstone, and quartz, all Cretaceous or older in age. Sandstone and grit are generally cross-bedded and locally may consist almost entirely of white quartz grains or black magnetite grains. Fragments of lignitized wood, as much as 30 cm long, are locally abundant. In lower Rocker Creek, unit is intruded by several hornblende dacite sills that are not shown on map. Thickness about 130 m

Kkg **Klein Creek pluton (Cretaceous)**—Chiefly hornblende-biotite granodiorite and quartz monzonite. K-Ar ages indicate emplacement age of 105–117 Ma (Richter and others, 1975)

KJs **Marine sedimentary rocks (Cretaceous and Jurassic)**—Chiefly thin- to medium-bedded argillite and graywacke; the graywacke is typically graded and rhythmically bedded. Metamorphosed to hornfels near Klein Creek pluton (map unit Kkg). Rocks are part of the informal Nutzotin Mountains sequence (Berg and others, 1972)

Ŧn **Nikolai Greenstone (Triassic)**—Amygdaloidal tholeiitic basalt lava flows and minor associated volcaniclastic rocks. Pillow structures common along lower Ptarmigan Creek, but lavas are typically subaerial

Ph **Hasen Creek Formation (Permian)**—Chiefly marine argillite and minor sandstone and chert, locally fossiliferous. May include some volcaniclastic rocks. Unmapped gabbro sills of Triassic age locally abundant. Correlative with the Mankomen Group (Richter, 1976) to the north in the Nabesna quadrangle

Pl **Limestone (Permian)**—Thin unit (10–30 m) of sand- and silt-rich limestone that appears to separate sedimentary rocks of the Hasen Creek Formation (Ph) from the underlying volcaniclastic rocks of the Station Creek Formation (PIPsc). Abundant crinoid and coral fragments. Crops out only in the small block of Paleozoic and Mesozoic rocks north of Ptarmigan Lake

PIPsc **Station Creek Formation (Pennsylvanian and Permian)**—Chlorite-rich amygdaloidal andesitic lava flows and volcaniclastic rocks. Correlative with the Tetelna Volcanics (Richter, 1976) to the north in the Nabesna quadrangle

Contact—Known, approximate, or inferred

Fault—Dashed where inferred, dotted where concealed

Inferred caldera margin—Dashed where inferred, dotted where concealed. Hachures on inner caldera wall

Alluvial fan margin—Shows contact of larger alluvial fans and stream alluvium in unit Qal

Lahar deposits—Locally shown only in the intracaldera lavas of Wiki Peak (unit Twl)

Andesitic tephra deposits—Locally shown only in the intracaldera lavas of Wiki Peak (unit Twl)

Strike and dip of bedding and flow layering

15 **Inclined**

Horizontal

B 20 11-15 **Sample locality**—Single sample locality (dot) and sampled section (connected dots). Numbers refer to chemical analyses in Table 1 and letters refer to K-Ar ages in Table 2

GEOLOGIC NOTE

The McCarthy D–1 quadrangle in the easternmost Wrangell Mountains of south-central Alaska contains the oldest known volcanic rocks in the extensive subduction-related Quaternary-Tertiary Wrangell volcanic field (Richter and others, 1990). The quadrangle includes most of the large 20 Ma Sonya Creek shield volcano and an extensive 23 Ma dacite dome field that overlies 26 Ma lavas of unknown source. It also includes approximately coeval lavas of unknown age from a source apparently to the east in Yukon Territory, Canada, and older lavas in the Young Creek area.

The Sonya Creek shield volcano, which has had much of its edifice removed by erosion, may contain a 10 by 14 km non-explosive caldera (fig.1), which is similar to, but larger than, the non-explosive calderas of the younger Wrangell, Capitol, and Tanada volcanoes to the northwest (Richter and others, 1990). More than 1,000 m of thick, flat-lying lava flows and minor pyroclastic deposits ranging in composition from rhyolite to andesite, fill the inferred caldera. The remnant shield is composed of shallow-dipping lava flows, lahars, and agglutinates, all chiefly of andesitic composition. Rhyolite plugs and domes and andesite and basalt plugs, dikes, and flows intrude and overlie shield rocks along and near the ring-fracture margin (fig.1) of the inferred caldera. Cretaceous or Tertiary continental sedimentary rocks and Triassic to Pennsylvanian sedimentary and volcanic rocks of the Wrangellia terrane are locally exposed underlying the volcano.

The extensive 23 Ma dacite dome field and associated subvolcanic rocks form a rough arcuate band around the south and east sides of the Sonya Creek shield volcano and locally extend under the northern part of the inferred caldera (fig.2). This dome-subvolcanic unit consists chiefly of a series of coalesced exogenous and endogenous hornblende dacite domes and subvolcanic rocks that range in composition from rhyolite to diorite.

East of the Sonya Creek shield volcano, a series of deformed lava flows and minor interbedded volcaniclastic rocks, referred to as the Rocker Creek volcanic rocks and dated at 26 Ma, underlie the dacite dome field and exist as roof pendants in the dome field's associated subvolcanic rocks. These volcanic and volcaniclastic rocks are the oldest known rocks in the Wrangell volcanic field, but their source is not known.

In the extreme eastern and southern areas of the quadrangle a series of undated volcanic rocks, referred to as the Border volcanic and volcaniclastic rocks, may be contemporaneous with the Sonya Creek shield volcano. The source of the lavas in this informal unit is apparently east of the map area in Yukon Territory, Canada. The most extensive of the lavas is a single(?) massive flow of porphyritic andesite that characteristically exhibits well-developed columnar joints possibly suggesting emplacement over ice.

A series of north-dipping volcanic rocks, informally called the Young Creek volcanic rocks, are exposed west of Rock Lake. These rocks, predominantly andesitic lavas and mudflows, are overlain by Sonya Creek shield lavas.

Pleistocene glaciation has modified much of the landscape throughout the quadrangle. Large Wisconsin glaciers that flowed in from both the south (White River area) and the north (Beaver Creek area) covered most of the area below 4,000 ft in elevation. Smaller, late Wisconsin(?) glaciers were probably present in many of the large valleys draining the Sonya Creek shield volcano.

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Figure 1. View to west showing the inferred caldera wall (arrow 1) of the Sonya Creek shield volcano. Intracaldera rocks to left of caldera wall consist of interlayered flows and pyroclastic deposits of map unit Tvu. Shield rocks to the right of the wall, consisting chiefly of andesite flows, belong to map unit Tsu. Contact (arrow 2) at base of dacite (Tpf) that fills paleovalley.

Figure 2. View to the southwest showing the great thickness of flat-lying intracaldera lavas (map unit Twl) of the Sonya Creek shield volcano. Lavas overlie 23 Ma hornblende dacite dome (unit Tdh) and are probably contemporaneous with the dark andesite plug (unit Tp) to the right of the dome. Ice-capped Mount Sulzer (elevation 10,926 ft), 41 km away, is visible in the left distance.

Table 1. *Chemical analyses of volcanic rocks from the McCarthy D-1 quadrangle, Alaska*

[Analyses performed in the laboratories of the U.S. Geological Survey. Analysts: J. Ardith, J. Bartel, E. Brandt, S. Roof, K. Stewart, J. Taggart, --, no analysis made]

Rock Unit	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twl	Twr	Tp	Tbc
Map No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Sample No.	84ARh-47	84ARh-47A	84ARh-42	84ARh-42A	84ARh-42B	84ARh-42C	84ARh-42D	84ARh-42E	84ARh-42F	84ARh-42G	85ARh-45A	85ARh-45B	85ARh-45C	85ARh-45D	85ARh-45E	84ARh-41A	84ARa-9	84ARa-15
SiO_2	55.3	53.0	54.4	54.2	50.0	62.6	63.4	51.2	50.2	58.8	59.5	54.8	54.2	59.3	62.1	74.6	58.6	48.3
Al_2O_2	15.9	17.3	16.4	16.8	15.8	15.8	15.9	16.5	17.5	17.0	17.7	17.4	16.9	17.9	17.3	13.2	17.6	14.7
Fe_2O_3	3.51	4.46	--	--	--	--	--	--	--	--	1.80	2.89	2.71	3.87	2.55	0.40	3.57	2.65
FeO	4.31	2.98	--	--	--	--	--	--	--	--	3.26	4.13	4.63	1.85	2.38	0.65	3.00	5.79
$FeTiO_3$	8.29	7.77	8.16	8.47	9.39	5.98	5.78	9.03	8.90	7.20	5.42	7.47	7.85	5.92	5.19	1.21	6.90	9.08
MgO	5.27	4.97	6.20	5.98	8.01	1.52	1.38	7.05	5.54	2.86	3.80	4.93	5.83	2.31	1.61	0.28	3.03	9.70
CaO	7.55	8.10	8.54	8.92	9.85	3.83	3.66	9.85	10.00	6.26	6.83	8.03	7.78	6.05	4.77	0.82	6.13	9.04
Na_2O	3.97	4.12	3.59	3.62	3.69	5.04	5.11	3.78	3.87	4.30	4.11	4.30	3.80	4.49	5.04	4.06	4.45	3.40
K_2O	1.40	1.14	0.83	0.85	1.17	2.23	2.30	0.96	1.24	1.70	1.18	0.99	1.21	1.28	1.82	4.23	1.17	1.05
TiO_2	1.34	1.17	1.08	1.13	1.52	1.25	1.22	1.46	1.56	1.09	0.72	1.15	1.16	0.91	0.86	0.21	0.99	1.25
P_2O_5	0.42	0.49	0.26	0.26	0.61	0.40	0.39	0.48	0.64	0.33	0.21	0.35	0.34	0.28	0.30	<0.05	0.31	0.40
MnO	0.12	0.11	0.12	0.13	0.14	0.10	0.09	0.13	0.14	0.09	0.09	0.12	0.13	0.12	0.09	0.04	0.11	0.15
H_2O+	0.29	0.48	--	--	--	--	--	--	--	--	0.28	0.21	0.63	0.50	0.25	0.11	0.17	1.68
H_2O-	0.55	1.14	--	--	--	--	--	--	--	--	0.16	0.29	0.59	0.97	0.41	0.11	0.56	0.88
CO_2	<0.01	0.07	--	--	--	--	--	--	--	--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.06	0.14

Rock Unit	Tpf	Tsa	Tsa	Tsa	Tbl	Tbl	Tdi	Tdh	Tdh	Tdh	Tdr	Tdr	Tdr	Tdqd	Trl	Trl
Map No.	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Sample No.	84ARa-35A	84ARa-49B	85ARh-14	85ARh-17	85ARh-41	85ARh-70	85ARh-25	84ARh-70	84ARh-49	84ARh-70B	85ARa-45B	85ARa-45A	85ARa-48A	85ARa-43	85ARa-23	85ARa-47A
SiO_2	63.8	65.3	35.5	34.8	60.3	57.6	55.6	66.2	66.3	65.8	75.7	75.3	75.8	64.1	60.4	47.5
Al_2O_2	15.3	14.7	14.9	14.8	16.4	16.7	16.3	15.7	15.5	15.8	13.5	13.9	13.5	16.1	16.7	14.9
Fe_2O_3	1.95	1.92	2.09	1.53	2.93	3.88	4.10	--	2.02	2.71	0.13	0.68	0.99	2.57	1.73	3.75
FeO	2.10	1.66	1.76	3.17	1.51	3.11	2.59	--	0.86	0.50	0.36	0.17	0.16	2.27	4.48	6.08
$FeTiO_3$	4.28	3.76	4.04	5.05	4.60	7.33	6.97	3.19	2.97	3.26	0.53	0.87	1.17	5.09	6.70	10.50
MgO	3.54	1.02	1.06	1.27	2.46	3.12	2.09	2.20	1.26	2.10	0.17	0.27	0.22	1.95	2.63	9.67
CaO	5.21	2.34	2.47	3.05	5.05	6.43	5.05	4.19	4.22	4.19	0.37	0.34	0.32	4.53	5.18	10.60
Na_2O	3.93	4.03	4.14	4.80	4.31	4.59	4.22	3.82	4.14	4.17	3.51	3.50	3.77	4.59	4.92	2.78
K_2O	1.34	3.56	3.40	2.99	1.57	1.38	1.78	1.40	1.53	1.50	4.45	3.35	2.49	1.80	1.75	0.59
TiO_2	0.56	0.84	0.90	1.16	0.63	1.38	1.28	0.34	0.36	0.39	0.07	0.17	0.15	0.70	1.20	1.56
P_2O_5	0.25	0.18	0.18	0.32	0.21	0.36	0.41	0.13	0.14	0.14	<0.05	<0.05	<0.05	0.20	0.32	0.37
MnO	0.07	0.07	0.07	0.09	0.05	0.10	0.12	0.03	0.04	0.04	<0.02	<0.02	<0.02	0.09	0.10	0.16
H_2O+	0.32	2.62	2.57	1.17	0.50	0.53	2.48	0.63	0.08	0.47	0.50	1.05	1.23	0.47	0.25	0.74
H_2O-	0.75	0.54	0.31	0.03	0.68	0.39	0.35	1.31	0.58	1.38	<0.01	0.06	0.27	<0.01	<0.01	0.05
CO_2	<0.01	0.02	<0.01	<0.01	0.01	0.01	3.11	0.22	1.65	0.06	<0.01	<0.01	<0.01	0.22	0.02	0.80

Table 2. *K-Ar ages of volcanic rocks from the McCarthy D-1 quadrangle, Alaska*

[Analyses performed in the laboratories of the U.S. Geological Survey. Analysts: N. Shew, J. Smith. F. Wilson]

Rock Unit	Twl	Tdh	Tol	Tol	Trl
Map No.	A	B	C	C	D
Sample No.	81ASj-20	84ARh-70	81ASj-30	81ASj-30	85ARa-47A
Phase dated	Whole rock	Hornblende	Whole rock	Whole rock (acid)	Whole rock (acid)
K_2O (wt %)	1.714±0.004	0.241±0.002	0.492±0.008	0.464±0.009	0.586±0.003
Ar^{40} rad (%)	81.3	26.8 & 25.2	34.4	34.4	32.9 & 35.1
Calc. Age (Ma)	20.0±0.6	23.3±1.0	19.1±0.6	18.6±0.6	26.34±0.79

CONVERSION FACTORS

Multiply	By	To obtain
inches (in.)	2.54	centimeters (cm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)

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