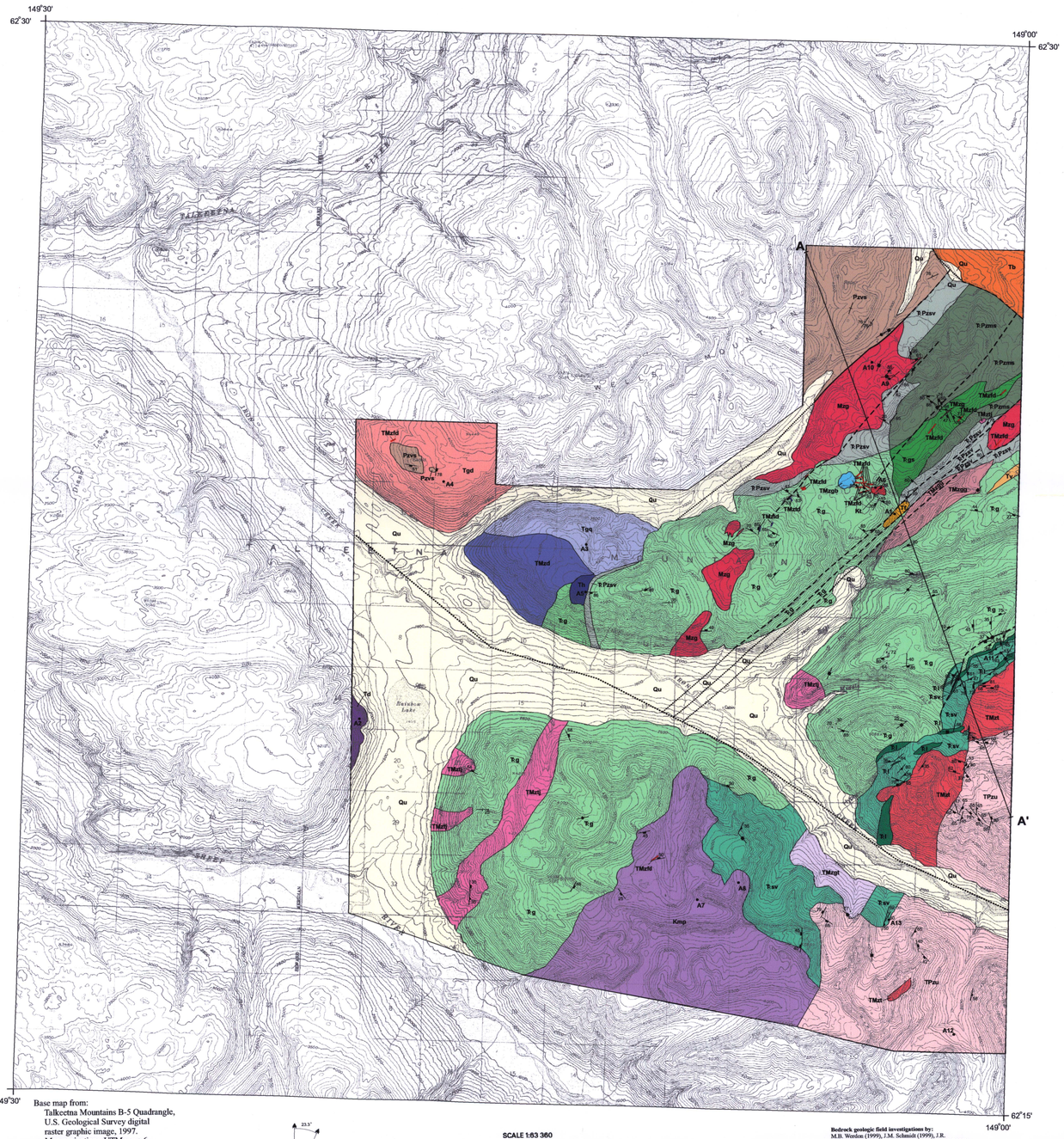

PROJECT SUMMARY

During the summer of 1999, the Alaska Division of Geological & Geophysical Surveys (DGGS) and the U.S. Geological Survey (USGS) participated in a 15-day cooperative geologic field mapping project within the boundary of the Iron Creek airborne geophysical survey tract (Staff, Alaska Division of Geological & Geophysical Surveys and others, 1998). The objective of this project was to provide ground-truth geologic mapping and to evaluate the mineral resource potential of the area. Approximately 100 square miles were mapped at a scale of 1:63,360 in the southeast quarter of the Talkeetna Mountains B-5 Quadrangle. The mapping is centered around known copper prospects in the Iron Creek drainage. As part of this mapping project, rocks were assayed for geochemically anomalous metals, whole-rock and trace-element compositions were determined for igneous rocks (Werdon and others, 2000), $^{40}Ar/^{39}Ar$ laser step-heating analyses were conducted on various phases in igneous, metamorphic, and hydrothermally altered rocks (Layer and others, in prep.), and limestones were dated by conodont identification (Schmidt and others, in press).

The Iron Creek area was previously mapped at 1:250,000 scale as predominantly Paleozoic volcanic rocks with minor limestone lenses; two plutons were also mapped (Csejtey and others, 1978). Our more recent mapping identified numerous other previously unrecognized plutonic and volcanic rocks, of many different compositions, with $^{40}Ar/^{39}Ar$ ages ranging from Permian(?) to Tertiary. A large portion of the central map area contains amygdaloidal basalt and gabbro, epidotized volcanic breccias, and fine-grained mafic rocks. These mafic units contain scattered quartz + hematite + epidote ± chalcopyrite ± bornite ± pyrite veins and alteration, and are spatially associated with limestone that contains Late Triassic conodonts (Schmidt and others, in press). These intrusive and extrusive mafic units share many characteristics, including their geochemistry, with the Nikolai greenstone, suggesting that these rocks can be assigned to the Wrangellia terrane. We also identified a separate unit consisting of mixed metasedimentary and metavolcanic rocks, which tentatively may be correlative with Paleozoic rocks to the east. Locally, these rocks were intruded by mafic sills, which possibly represent feeder zones to the greenstone unit. The map pattern of the mixed metasedimentary–metavolcanic package indicates large-scale, locally isoclinal, folding of these units in the map area. A sub-parallel set of younger, northeast-trending, high-angle faults was identified, one of which has a component of strike–slip motion based on horizontal slickensides along the fault surface. Based on map patterns of geologic units and geophysical data there also appears to be a major northwest-trending, high-angle fault with north-side-down displacement along the main fork of Iron Creek.

The recognition of numerous new Mesozoic to Tertiary plutonic rocks of varying compositions, and Tertiary bimodal hypabyssal rocks, increases the potential of the Iron Creek area for skarn, pluton-hosted, and epithermal-style mineralization. Numerous disseminated and fracture-controlled, basalt-hosted copper–iron prospects were located and sampled. The presence of sills and dikes spatially associated with the Nikolai-equivalent greenstone suggests the potential for platinum-group-element mineralization.

DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Qu — UNDIFFERENTIATED ALLUVIAL, COLLUVIAL, AND GLACIAL SEDIMENTS

BEDROCK UNITS

Tertiary Volcanic Rocks

Tf — FELSITE/RHYODACITE FLOW (Tertiary) — Light gray to white, finely porphyritic rhyodacite with subtle planar parting. Phenocrysts compose about 7 percent of the rock and include quartz (rounded, ± embayed), potassium-feldspar (euhedral, concentrically zoned), plagioclase (large, euhedral), and biotite (fresh, small, euhedral). Matrix is very fine grained but has a bimodal size distribution. Larger matrix crystals are strongly aligned (trachytic), generally euhedral, elongate plagioclase, and square crystals of quartz (?) and (or) potassium feldspar (?). This material is mixed with an even finer matrix of granular plagioclase, quartz (?) and potassium feldspar (?). Crops out in headwater region of the east fork of Iron Creek. Biotite from a rhyodacite flow yielded a $^{40}Ar/^{39}Ar$ plateau age of 52.1 ± 0.4 Ma (sample A1; Layer and others, in prep.).

Tv — LITHIC TUFF-IGNIMBRITE, VOLCANIC BRECCIA, AND CRYSTAL TUFF (Tertiary) — Bright red-stained volcanic rocks with roughly horizontal layering between the coarse tuff breccia and smaller clast varieties. Lithic tuff-ignimbrite has a maroon tuffaceous matrix with dark gray angular clasts (up to 10 cm in diameter) composed of greenstone (T̄g?) rock fragments and other brecciated volcanic material. Crystal tuffs are white to pale tan, fine grained, granular/sugary, vuggy, and may be silica and clay altered. Crops out in the northeastern map area. Age interpretation based on similarity to rocks mapped as Tertiary by Csejtey and others (1978).

Tb — BASALT LAVA FLOWS (Tertiary) — Deep orangish-red weathering, dark gray, olivine(?)-phyric basalt flows with local columnar-jointing. Generally flat-lying flows that unconformably cap hills in the northeastern map area. Age interpretation based on similarity to rocks mapped as Tertiary by Csejtey and others (1978).

Tertiary to Mesozoic Igneous rocks

TMzfd — FELSIC DIKES (Tertiary or Mesozoic?) — Fine-grained felsic dikes of granitic composition; may include dikes of more than one age. Granite dikes are found in northeast, and are generally quartz-rich, fine-grained, and equigranular. Aplite dikes intrude the large multi-phase pluton (Kmp) south of Iron Creek and the granodiorite (Tgd) in the west, are fine-grained, and exhibit anhedral granular texture. Dacite dikes occur in the headwater region of the east fork of Iron Creek and are gray and white, and porphyritic to seriate textured. Dacites contain large phenocrysts of plagioclase, potassium feldspar, quartz, and biotite that are partially altered to clay sericite, epidote, and chlorite. Matrix consists of feldspars, quartz, chloritized biotite, apatite, and tiny opaque mineral(s).

TMzfd — TRACHYTE DIKES (Tertiary? or Mesozoic?) — Light gray, porphyritic trachyte dikes. Intrude the greenstone unit (T̄g) and are spatially associated with small syenite body within the south end of the largest granite pluton (TMzg). Abundant phenocrysts of square, color-zoned (pink-gray-white) potassium feldspar and white, elongate plagioclase. Hornblende, or perhaps pyroxene(?), occurs as dark green, 1- to 3-mm-long, faintly aligned phenocrysts. Locally the dikes contain xenoliths of greenstone (T̄g).

Td — HORNBLENDE DIORITE (Tertiary) — Medium gray, fine- to medium-grained hornblende diorite composed of 25-30 percent hornblende and 70-75 percent plagioclase. Appears equigranular but contains poikilitic hornblende crystals up to 2.5 cm in diameter. Plagioclase partially altered to epidote. Hornblende yielded a $^{40}Ar/^{39}Ar$ plateau age of 56.2 ± 0.4 Ma (sample A2; Layer and others, in prep.).

Tgq — GRANODIORITE AND QUARTZ DIORITE (Tertiary? or Mesozoic?) — Tan and black, fine- to medium-grained granodiorite and lesser quartz diorite. Texture varies from equigranular to seriate and poikilitic. Primary minerals include quartz, plagioclase, potassium feldspar, hornblende, biotite, apatite, and opaque mineral(s). Mafic minerals typically form about 15 percent of the rock. Biotite yielded a $^{40}Ar/^{39}Ar$ plateau age of 56.9 ± 0.3 Ma (sample A3; Layer and others, in prep.).

Tgd — BIOTITE-HORNBLENDE GRANODIORITE (Tertiary? or Mesozoic?) — White and black, fine-grained, equigranular granodiorite. Potassium feldspar occurs as large, concentrically zoned, subhedral crystals with or without perthitic intergrowths with plagioclase. Plagioclase occurs as large, subhedral to euhedral, albite- and Carlsbad-twinned, concentrically zoned crystals. Feldspars are generally fresh but may contain trace sericite alteration. Quartz occurs as large anhedral grains that were deposited late in the open space between feldspar crystals. Biotite occurs as large subhedral crystals, some of which are partially altered to chlorite ± epidote. Hornblende forms large, euhedral to subhedral, occasionally twinned crystals, and rarely has cores of clinopyroxene. Primary opaques vary widely in size, have irregular to highly irregular (nebulous) shapes, and usually occur within mafic minerals. Apatite and zircon are common accessory minerals. Hornblende yielded a $^{40}Ar/^{39}Ar$ plateau age of 57.7 ± 0.5 Ma (sample A4; Layer and others, in prep.).

Th — HORNBLENDITE (Tertiary) — Dark green, medium grained, equigranular hornblendite composed of randomly oriented hornblende crystals (~90 percent), intergranular plagioclase (~10 percent), and opaque minerals (<1 percent; magnetic). Hornblende laths up to 1 cm. Hornblende yielded a $^{40}Ar/^{39}Ar$ isochron age of 63.0 ± 8.4 Ma (sample A5; Layer and others, in prep.). Hornblende spectra contains excess argon and exhibits a complex thermal history; hornblendite likely reheated by adjacent younger intrusions (Tgq and Tgd).

Kt — BIOTITE TONALITE (Cretaceous) — White, medium-grained, porphyritic biotite tonalite. Phenocrysts include plagioclase, with or without concentric zoning, and quartz up to 1 cm in diameter in a medium gray matrix. Potassium feldspar occurs as perthite and as concentrically zoned crystals with clay-altered cores. Biotite occurs throughout the groundmass as large primary crystals surrounded by margins of smaller secondary biotite, and it also is partially altered to chlorite, sericite, epidote, secondary opaques and (or) calcite. Contains accessory apatite and large primary opaques. Biotite yielded a $^{40}Ar/^{39}Ar$ plateau age of 68.9 ± 0.4 Ma (sample A6; Layer and others, in prep.).

Kmp — MULTI-PHASE PLUTON (Cretaceous) — Typically fine- to medium-grained, equigranular, diorite, quartz diorite, tonalite, and granodiorite. Generally highly magnetic. Exposed in a large, deeply eroded plutonic body in the southern part of the map area. Typically contains both biotite and hornblende although biotite- and hornblende-only varieties are present locally. Porphyritic phases, mafic-rich phases, and occasional minor foliation are present near the margins. In the cirque south of Iron Creek aplite dikes intrude the pluton in an area characterized by a low aeromagnetic signature (Staff, Alaska Division of Geological & Geophysical Surveys and others, 1998). Hornblende from two different samples yielded $^{40}Ar/^{39}Ar$ plateau ages of 75.5 ± 0.6 Ma and 77.2 ± 0.6 Ma (samples A7 and A8; Layer and others, in prep.). Biotite yielded a $^{40}Ar/^{39}Ar$ plateau age of 74.9 ± 0.4 Ma (sample A8; Layer and others, in prep.).

Mzg — BIOTITE GRANITE (Tertiary? or Mesozoic?) — Tan, fine- to medium-grained, generally equigranular, quartz-rich (up to 40 percent) granite. Occurs as deeply eroded, non-resistant plutonic bodies and as small apophyses and dikes. Commonly cut and (or) bounded by northeast-trending high-angle faults. Locally contains disseminated fluorite and is cut by pegmatite dikes. Primary minerals include quartz (large grains with undulatory extinction), plagioclase (subhedral to rarely euhedral, albite-twinned, ± compositionally zoned with altered cores and fresh rims), potassium feldspar (late, anhedral, often as perthitic intergrowths with plagioclase), biotite (sparse, forms large crystals that are partially altered to chlorite, white mica, and (or) secondary opaques), apatite, and zircon. White mica commonly replaces feldspars. Some myrmekite. Biotite yielded a $^{40}Ar/^{39}Ar$ pseudo-plateau age of 152.6 ± 1.8 Ma (sample A9; Layer and others, in prep.). The between-fraction scatter is just large enough to not fit the criteria for a plateau at the 95 percent confidence level. K-feldspar yielded a $^{40}Ar/^{39}Ar$ plateau age of 68.5 ± 0.6 Ma (sample A10; Layer and others, in prep.), and this closure age may reflect resetting by a younger intrusion (for example, Kt).

A small syenite plug or dike (?) of unknown extent intrudes in the southeast part of the largest granite body. Syenite is light gray, medium grained, and porphyritic- to seriate-textured, with phenocrysts of potassium feldspar (bright pink, equant, color-zoned), plagioclase (white and tan, slightly elongate, color-zoned), and hornblende/pyroxene(?) (dark green).

TMzgb — GABBRO (Tertiary? or Mesozoic?) — Dark brownish-black, very-fine-grained gabbro. Matrix predominantly has an equigranular, diabasic, subophitic texture, with sparse local ophitic texture. Contains fresh plagioclase laths, about 35 percent iddingsite (?) or sphene (?), clinopyroxene (?), late-crystallizing opaque mineral(s), and about 1 percent calcite. Rare amygdules filled with calcite and (or) quartz. Calcite occurs in thin cross-cutting veins. May be intrusive (?) into the greenstone (T̄g).

TMzgg — GRANULAR GRANITE (?) (Tertiary? or Mesozoic?) — White, fine-grained (about 1.5 mm average grain size), quartz-rich (up to 50 percent), sugary/granular- to seriate-textured pluton (of uncertain composition) with no mafic minerals. Composed of quartz and a white, anhedral, undetermined feldspar. Quartz occurs as anhedral grains intergrown with feldspar, and as slightly larger rounded grains up to 3 mm in diameter. Contains up to 5 percent orangish-tan limonite within intergranular spaces and as fracture coatings. Commonly cut and (or) bounded by northeast-trending high-angle faults.

TMzgt — BIOTITE-HORNBLENDE GRANITE AND TONALITE (Tertiary? or Mesozoic?) — Undifferentiated, foliated, multi-phase pluton composed of white biotite-hornblende monzogranite and biotite tonalite. Biotite-hornblende monzogranite is white, quartz-rich, hornfelsed, and contains 10 percent mafic minerals. Primary minerals have been partially recrystallized and altered, and include quartz, plagioclase, potassium feldspar, biotite, hornblende, and minor apatite and opaques. Biotite is extensively altered to secondary biotite, chlorite, epidote, and secondary opaques, and hornblende is partially altered to chlorite.

Biotite tonalite is white and gray, contains about 8 percent mafic minerals, and is porphyritic with quartz phenocrysts up to 1.5 cm in diameter. Matrix composed of partially recrystallized quartz and plagioclase, and minor apatite and opaques. Primary mafic minerals are altered to secondary biotite, epidote, clinozoisite, secondary opaques, and chlorite, and have been redistributed within the groundmass. Plagioclase has been partially replaced by sericite and epidote.

TMzt — BIOTITE-HORNBLENDE TONALITE (Tertiary? or Mesozoic?) — White and black, fine- to medium-grained, equigranular, locally foliated biotite-hornblende tonalite or granodiorite. Primary minerals include quartz, plagioclase, potassium feldspar, hornblende and biotite, apatite, and opaque mineral(s). Secondary minerals include sericite, clay, calcite, clinozoisite and (or) epidote, and large anhedral sphene crystals.

TMzd — BIOTITE-HORNBLENDE DIORITE (Tertiary? or Mesozoic?) — Coarse-grained diorite with 30 percent mafic minerals. Pluton is metamorphosed, but relict equigranular texture is preserved. Primary minerals include plagioclase, quartz, hornblende, remnant clinopyroxene, and biotite(?). Plagioclase occurs as anhedral albite-twinned crystals intergrown with anhedral quartz. Hornblende is partially recrystallized and altered to secondary hornblende, epidote, and secondary opaques. Biotite occurs as small randomly oriented secondary grains in patches (pseudomorphs after primary biotite(?)) and is partially altered to chlorite and secondary opaques. Pseudomorphs after probable orthopyroxene consist of chlorite, sphene, and opaque mineral(s).

TMzj — TRONDHJEMITE (Tertiary? or Mesozoic?) — White to very light green, fine- to medium-grained, equigranular trondhjemite. Primary minerals include large anhedral quartz and subhedral to anhedral plagioclase. Albite twinning and myrmekite common. In some areas, up to 95 percent of the rock consists of graphically-intergrown quartz and plagioclase crystals. Primary mafic minerals were very minor (<1 percent) and have been completely altered to epidote, secondary opaques, chlorite, and (or) minor sericite. Forms large plutonic bodies in the central and southwestern map area.

Triassic Metasedimentary and Metavolcanic Rocks

Tl — LIMESTONE (Triassic) — Light tan and gray, relatively fine grained limestone with a planar to mottled color distribution. Occurs in several stratigraphic horizons within a metasedimentary-metavolcanic unit (T̄sv) in eastern map area. Thickness of limestone beds varies from a meter to about 60 meters, and is locally structurally thickened, folded, and rarely brecciated. Average calcite grain diameter is <0.04 mm. Limestone is pure, but locally contains minor detrital quartz and white mica, rhomb-shaped dolomite(?) crystals, disseminated pyrite, calc-silicate alteration, and stylolites. Contains Late Triassic conodonts (Schmidt and others, in press).

Tsv — METASEDIMENTARY AND METAVOLCANIC ROCKS (Triassic?) — Sequence of interlayered metasedimentary and metavolcanic rocks of unknown thickness. Metasedimentary rocks include Late Triassic limestone (T̄l), minor white, finely crystalline dolomite, and sparse maroon shale. Metavolcanic rocks include fissile gray tuff with white feldspar phenocrysts, dark green, very fine grained, highly foliated chlorite phyllite ± oval-shaped chlorite patches along foliation, and orange to pale maroon weathering, fissile, felsic tuff (?). Metasedimentary and metavolcanic unit locally intruded by finely crystalline, metamorphosed, ± amygdaloidal microgabbro sills. A white, fine-grained quartz-white mica schist horizon within the metasedimentary-metavolcanic unit extends for about 1 km along strike. Quartz-white mica schist contains disseminated pyrite and is locally intensely cut by quartz veins. The high silica content suggests the schist is the product of hydrothermal alteration. White mica yielded a $^{40}Ar/^{39}Ar$ plateau age of 145.7 ± 1.0 Ma (sample A11; Layer and others, in prep.); this closure age is interpreted to reflect the age of the hydrothermal event.

Tg — GREENSTONE (Triassic?) — Dark forest green, variably magnetic, massive outcrops of basalt, microgabbro, and greenstone. Metamorphosed in lower greenschist facies and variably foliated. Textures include amygdaloidal, massive, and subophitic, to less commonly porphyritic and (or) glomeroporphyritic with 1- to 3-mm-long plagioclase phenocrysts. Primary minerals include intergrown plagioclase and clinopyroxene, and late-crystallizing opaques. Primary textures and minerals partially to completely replaced during metamorphism and deformation. Metamorphic minerals include abundant epidote, actinolite, clinozoisite, calcite, chlorite, albite, pumpellyite, secondary opaques, and minor quartz and sericite. Amygdules commonly filled with quartz, epidote, calcite, chlorite, and pumpellyite, and rarely by pyrite, chalcopyrite, and (or) hematite. The greenstone is locally cut by veinlets and shear zones filled with quartz, epidote, actinolite, chlorite, calcite, albite, chalcopyrite, malachite, bornite, pyrite, hematite, and (or) minor magnetite. Tentatively thought to be Triassic based on spatial association with Triassic limestone (T̄l). Possibly correlates with the Amphitheater Group about 150 km to the northeast (Smith, 1981).

Tgs — GREENSTONE WITH MAFIC SILLS (Triassic?) — Greenstone (T̄g) intruded by volumetrically minor (about 5 percent) mafic sills. Sills are medium to dark green, fine-grained, and equigranular; diabasic texture is common. Sill composition ranges from diorite to gabbro. Primary minerals include plagioclase, clinopyroxene, and opaque mineral(s). Metamorphic minerals include epidote, actinolite, clinozoisite, chlorite, and secondary opaques.

Triassic to Paleozoic Metasedimentary and Metavolcanic Rocks

T̄Pzsv — METASEDIMENTARY AND MINOR METAVOLCANIC ROCKS (Triassic? to Paleozoic?) — Generally light colored metasedimentary rocks with lesser metavolcanic rocks; interbedded on the scale of millimeters to tens of centimeters. Dip of most beds is near vertical. Rock types include: 1) pale green- and orange-weathering, light greenish-gray, very finely granular siliceous metaquartzite or sandstone; 2) thinly planar bedded, gray to pale pinkish-green, fine-grained, interbedded sandstone and dark gray siltstone; 3) minor, medium to light gray, tan, white, and pale maroon, thinly bedded, finely granular marble/limestone; 4) argillite; 5) chert; and 6) minor pale green- and orange-weathering, light greenish-gray metavolcaniclastic sandstone layers. Some granular siliceous metasedimentary rocks are hornfelsed near granite (TMzg), and limestones locally contain 2-3 mm diameter garnets. In the northwestern map area (near hornblendite [TMzhl]), there is a >10-meter-thick band of white, equigranular, finely crystalline (1-3 mm average grain diameter), slightly impure (1 percent epidote and clinopyroxene), calcite marble of unknown age.

T̄PZmz — MAFIC SILLS WITH MINOR METASEDIMENTARY AND METAVOLCANIC ROCKS (Triassic? to Paleozoic?) — White and green, or dark green mafic sills and minor metasedimentary and metavolcanic rocks (T̄Pzsv). Mafic sills are fine- to medium-grained, and range in composition from diorite to gabbro to rarely clinopyroxenite(?). Generally equigranular but occasionally diabasic textured. Most sills are composed of plagioclase, clinopyroxene, and primary opaque mineral(s). One diorite sill contains randomly oriented hornblende laths intergrown with plagioclase.

TPzu — METAVOLCANIC AND METASEDIMENTARY ROCKS (Paleozoic?) — Tuffaceous and volcaniclastic rocks and minor metasedimentary rocks. Commonly thinly bedded and tightly folded. Locally contains diabase and microgabbro sills or flows (?). Rock types include: 1) tuffaceous sandstone and crystal-lithic tuff; 2) medium green, medium grained, volcanic conglomerate and tuff breccia with a tuffaceous matrix; 3) pale green, very-fine-grained fissile tuff; 4) tannish-gray to brown, fine grained, fissile sandstone, siltstone, siliceous mudstone, and argillite, ± thin limestone and rare chert partings; and 5) light tannish-gray, well-cemented, clast-supported limestone breccia cemented by a tan calcareous clay matrix. Hornfelsed adjacent to intrusions. Tentatively correlated with Csejtey and others (1978) Pzv unit, which they interpreted as a Paleozoic submarine volcanic arc.

Tertiary to Paleozoic Rocks

Pzvs — UNDIFFERENTIATED METAVOLCANIC, METAPLUTONIC, PLUTONIC, AND METASEDIMENTARY ROCKS (Tertiary? to Paleozoic?) — Predominantly greenstone, amygdaloidal metabasalt, diabase, fine- to medium-grained metagabbro and diorite, and minor amphibolite mixed with lesser metasedimentary and metavolcaniclastic rocks. Occurs in southeastern map area. Rocks in this area are intruded by porphyritic dacite and rhyodacite plugs, a tonalite pluton, and dikes and sills of granite through diorite composition, and are commonly hornfelsed. Intrusions are both non-foliated and foliated, suggesting two different ages of emplacement. Some of the rocks in this undifferentiated unit are hornfelsed and (or) metamorphosed to a higher grade than seen elsewhere in the map area. White mica from a porphyritic, quartz-eye rhyodacite plug yielded a $^{40}Ar/^{39}Ar$ plateau age of 132.8 ± 0.9 Ma (sample A12; Layer and others, in prep.). Biotite from the same sample yielded a $^{40}Ar/^{39}Ar$ plateau age of 100.5 ± 0.7 Ma (sample A12); biotite age is interpreted to be a reset age. Hornblende from a hornblende diorite intrusion yielded a $^{40}Ar/^{39}Ar$ plateau age of 251.1 ± 2.1 Ma (sample A13; Layer and others, in prep.); hornblende contains excess argon, hence, the plateau age may be biased to be slightly old due to excess argon throughout the sample.

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This DGGS Preliminary Interpretive Report is a preliminary report of scientific research. It has received modest technical review but has not been reviewed for conformity to the final publication standards of DGGS.

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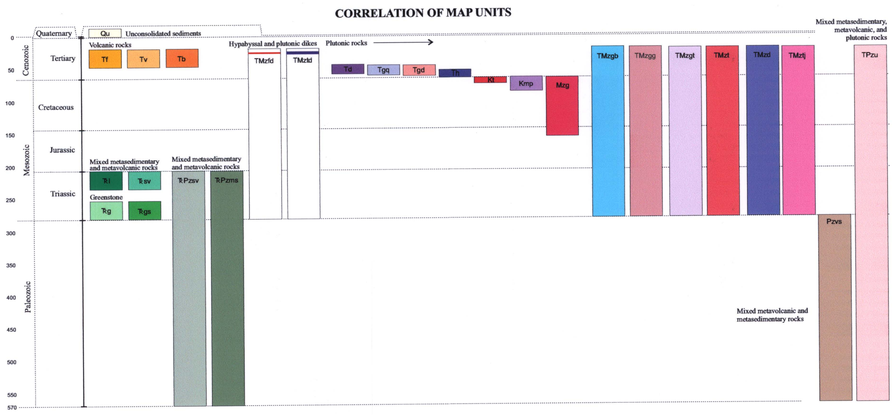
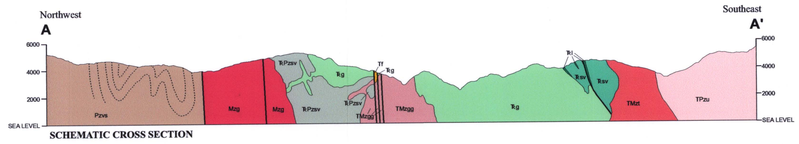
Map symbol key

- Strike and dip of bedding
- Strike of vertical bedding
- Strike and dip of overturned bedding
- Strike and dip of foliation
- Strike of vertical foliation
- Strike and dip of joint
- Strike of vertical joint
- Strike and dip of vein
- Strike of vertical vein
- Geologic unit contacts
- Fault (generally high angle)
- Fault (interpreted)
- Fault (inferred)
- $^{40}Ar/^{39}Ar$ locality





SCHEMATIC CROSS SECTION

GEOLOGIC MAP OF THE IRON CREEK AREA, TALKEETNA MOUNTAINS B-5 QUADRANGLE, ALASKA

by
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