Shaded-relief base from National Elevation Dataset (NED) 43.2-meter Digital Elevation Models (DEMs)
Universal Transverse Mercator projection; Zone 5N
1927 North American Datum

SCALE 1:250 000

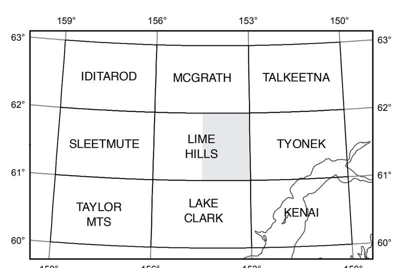
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped by B.L. Reed, 1963-1992; M.A. Lanphere, 1968-1991; B.M. Gamble, 1985-1992; D.H. Richter, 1988-1992; R.G. McGimsey, 1987; and D.C. Bradley, 1988

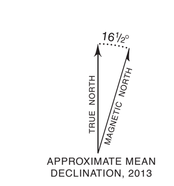
GIS database and digital cartography by N.B. Shew, K.A. Labay, B.M. Gamble, and D. Peterson

Manuscript approved for publication April 23, 2013

MAP LOCATION



LOCATION INDEX



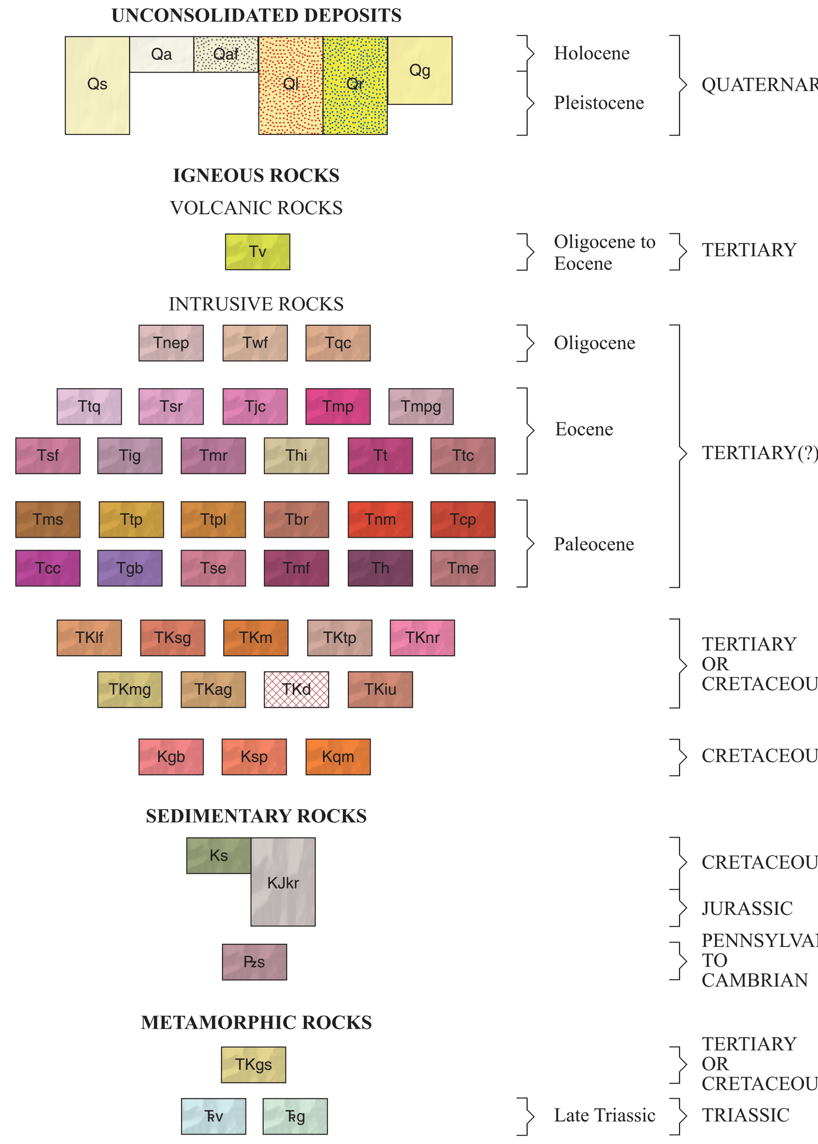
APPROXIMATE MEAN DECLINATION, 2013

Geologic Map of the East Half of the Lime Hills 1:250,000-Scale Quadrangle, Alaska

By
Bruce M. Gamble, Bruce L. Reed, Donald H. Richter, and Marvin A. Lanphere
2013

CORRELATION OF MAP UNITS

[See Description of Map Units for precise unit ages]



DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Qs **Surficial deposits, undivided (Holocene to Pleistocene)**—Unconsolidated silt, sand, and rocks, including colluvial deposits, solifluction deposits, talus, and undifferentiated alluvial and glacial deposits

Qa **Alluvial deposits (Holocene)**—Silt- to boulder-size material in active stream courses. Typically coarser and more poorly sorted at highest elevations and finer and better sorted at lowest elevations

Qaf **Alluvial fan deposits (Holocene)**—Typically poorly sorted, silt- to boulder-size material in alluvial fans and cones

Ql **Landslide deposits (Holocene to late Pleistocene?)**—Unsorted and unstratified, fine to coarse angular debris in matrix of finer grained material; chiefly debris avalanches

Qr **Rock glaciers (Holocene to Pleistocene)**—Poorly sorted, angular, fine- to boulder-size, ice-cemented rock debris

Qg **Glacial deposits, undivided (Holocene to late Pleistocene?)**—Sand- to boulder-size material of diverse composition; chiefly till and glacial outwash. Only more prominent lateral and terminal moraines are depicted on map

IGNEOUS ROCKS

VOLCANIC ROCKS

Tv **Volcanic rocks (Tertiary, earliest Oligocene to Eocene)**—Chiefly rhyolite and lesser amounts of dacite and andesite. Mostly crystal-rich and crystal-lithic-rich biotite-hornblende tuffs and minor lava flows, local accumulations of volcaniclastic rocks, local hypabyssal intrusions, and rare lahar deposits. Overlies and appears to have been deposited on the Merrill Pass pluton (Tmp). Locally bounded by curvilinear faults suggestive of caldera-fill accumulations. $^{40}Ar/^{39}Ar$ ages range from 33.6±3.4 Ma to 41.0±1.6 Ma (Marvin Lanphere, oral commun., 1989)

INTRUSIVE ROCKS

Tertiary

Tnep **Nep pluton (Oligocene)**—Fine- to coarse-grained, seriate, biotite or biotite-amphibole granite. Locally porphyritic, containing alkali-feldspar crystals 3 cm by 5 cm. Color Index (CI), 3-15. K-Ar ages: 25.4±0.8 Ma, 26.5±0.8 Ma, 26.7±0.8 Ma, 25.8±0.8 Ma (Reed and Lanphere, 1972)

Twf **Windy Fork pluton (Oligocene)**—Chiefly fine- to medium-grained, seriate to nearly equigranular alkali-feldspar granite. Plagioclase typically absent. Hornblende locally has overgrowths of deep blue-green amphibole (riebeckite?). Accessory minerals include opaque oxides, fluorite, monazite, zircon, sphene(?), and apatite. Locally, is more typical plagioclase-bearing granite containing as much as 16 percent plagioclase. CI, 5-10. K-Ar ages: 29.3±0.8 Ma, 31.1±0.9 Ma, 29.0±0.9 Ma (Reed and Lanphere, 1972; Solie and others, 1991)

Tqc **Quartz crystal pluton (Tertiary?)**—Fine- to medium-grained, light-colored, amphibole±biotite alkali-feldspar granite having graphic or mixed graphic–hypidiomorphic-granular texture. CI, 1-5. Amphibole (riebeckite?) exhibits green to deep, dark-blue pleochroism. Presumed to be Oligocene age because of similarities to the nearby 29.0 to 31.1 Ma Windy Fork pluton (Twf)

Ttq **Telequana Pass pluton (Tertiary)**—Medium- to coarse-grained, seriate, biotite-hornblende hypidiomorphic-granular granodiorite. CI, 9-19. Discordant ages on biotite and hornblende are 31.9±0.9 Ma and 36.3±1.8 Ma, respectively (Reed and Lanphere, 1972)

Tsr **Stony River pluton (Tertiary)**—Fine- to medium-grained, seriate, hypidiomorphic-granular biotite-hornblende granodiorite to quartz monzodiorite. CI, 12-25. Age determinations: biotite K-Ar age, 34 Ma (Reed and Lanphere, 1972); concordant biotite and hornblende K-Ar ages, 33.5±1.0 Ma, 35.2±1.1 Ma, respectively (Marvin Lanphere, oral commun., 1988); $^{40}Ar/^{39}Ar$ ages on biotite and hornblende, 34.9±1.0 Ma to 35.9±0.3 Ma, respectively (Marvin Lanphere, oral commun., 1989)

Tjc **Johnson Creek pluton (Tertiary)**—Fine- to medium-grained, seriate to subporphyritic, quartz monzodiorite exhibiting hypidiomorphic-granular, locally graphic, textures. Mafic minerals include various combinations of orthopyroxene, clinopyroxene, amphibole, and biotite. CI, 12-25. Age determinations: biotite K-Ar age, 36.8±0.7 Ma (Reed and Lanphere, 1972); biotite $^{40}Ar/^{39}Ar$ age, 38.6±0.4 Ma (Marvin Lanphere, oral commun., 1989)

Tmp **Merrill Pass pluton (Tertiary)**—Chiefly biotite granite; hornblende locally present. Grades into alkali-feldspar granite in northern part of pluton, and, in southern part of pluton, into granodiorite. Typically medium- to coarse-grained seriate and hypidiomorphic-granular; locally porphyritic in north. Textures and presence of miarolotic cavities suggest progressively shallower levels of pluton are exposed toward north. CI, 0-10. Age determinations: seven biotite K-Ar ages, 35.6±1.1 Ma to 40.0±1.2 Ma (Reed and Lanphere, 1972); three biotite $^{40}Ar/^{39}Ar$ ages, 40.0±0.4 Ma to 41.6±0.8 Ma (Marvin Lanphere, oral commun., 1989)

Tmpg **Merrill Pass granodiorite (Tertiary?)**—Compositionally variable rocks; spatially associated with, and possibly phases of, the Merrill Pass pluton (Tmp). Chiefly fine- to medium-grained, hypidiomorphic-granular, biotite-hornblende granodiorite; locally grades into quartz monzodiorite or clinopyroxene-bearing quartz diorite. CI, 7-21

Tsf **South Fork stock (Tertiary?)**—Fine- to medium-grained, seriate to subporphyritic, hypidiomorphic-granular biotite granite. CI, 5-12. Similar to, and possibly related to, the Merrill Pass pluton (Tmp)

Tig **Igitna granite (Tertiary?)**—Fine- to medium-grained, seriate to porphyritic, biotite-hornblende granite having hypidiomorphic-granular or graphic fabric. CI, 5-7. Thought to be Oligocene or Eocene age because of similarity to other light-colored granites in region

Tmr **Mount Rich pluton (Tertiary)**—Fine- to medium-grained, seriate hornblende-biotite granodiorite to tonalite. CI, 3-11. Texture is hypidiomorphic-granular, although graphic intergrowths of quartz and alkali feldspar are common locally. Biotite $^{40}Ar/^{39}Ar$ age, 38.6±0.4 Ma (Marvin Lanphere, oral commun., 1989)

Thi **Hypabyssal intrusions (Tertiary?)**—Shallow-level intrusions that are spatially and, presumably, genetically associated with Tertiary volcanic rocks. Possibly intrusive domes. Two varieties noted: (1) relatively phenocryst poor (5-10%), and (2) phenocryst rich (40-60%). Phenocrysts are quartz, plagioclase±hornblende, and biotite. No age determinations, but presumed to be Tertiary age because of close spatial relationship with nearby Tertiary volcanic rocks

Tt **Tlikikila stock (Tertiary)**—Fine- to medium-grained, seriate to subequigranular, hypidiomorphic-granular, biotite-hornblende quartz diorite to granodiorite. CI, 7-13; may contain as much as 23 percent light-colored clinopyroxene. Biotite K-Ar age: 44.6±1.3 Ma (Marvin Lanphere, oral commun., 1988)

Ttc **Terra Cotta plutons (Tertiary)**—Two compositionally variable plutons. Fine- to medium-grained, seriate to porphyritic, hypidiomorphic-granular, hornblende-pyroxene-biotite quartz monzodiorite to granite. CI, 10-27. Originally mapped as part of the Hartman plutons (Th) (Reed and Elliott, 1970) but have since yielded ages that are distinctly younger: western pluton yielded biotite $^{40}Ar/^{39}Ar$ age of 45.8±0.7 Ma (Marvin Lanphere, oral commun., 1989); eastern pluton, biotite $^{40}Ar/^{39}Ar$ age of 37.9±1.14 Ma (Solie and others, 1991)

Tms **McKinley sequence(?) granites (Tertiary)**—Fine- to coarse-grained, seriate, hypidiomorphic-granular or porphyritic biotite granite. CI, 1-8. $^{40}Ar/^{39}Ar$ age on porphyritic phase, 65.0±0.5Ma (Marvin Lanphere, oral commun., 1989); although this $^{40}Ar/^{39}Ar$ age is approximately 10 m.y. older than K-Ar ages for McKinley sequence plutons in area, B. Reed (oral commun., 1990) believed that chemistry (unpublished) and mineralogy data suggest that these granites belong to McKinley sequence of granitic rocks of Lanphere and Reed (1985)

Ttp **Tired Pup pluton (Tertiary)**—Biotite or biotite-hornblende granite; locally, granodiorite. Chiefly medium to coarse grained, seriate to subequigranular, locally porphyritic; contains alkali-feldspar megacrysts as long as 5 cm. Member of McKinley sequence of granitic rocks of Lanphere and Reed (1985). CI, 4-16. Four K-Ar ages range from 56.7±1.7 to 58.6±1.8 Ma; two other K-Ar ages, 40.1±1.2 Ma, 40.9±1.2 Ma (Reed and Lanphere, 1972). Older ages fit well with other McKinley sequence intrusions, whereas younger ages might represent resetting by younger, unexposed intrusions

Ttpl **Tired Pup pluton leucogranite (Tertiary)**—Very light-colored, fine- to coarse-grained, seriate, hypidiomorphic-granular biotite granite. CI, 2-6. Contact with the Tired Pup pluton (Ttp) appears to be gradational. Presumed to be Tertiary age, as is the main Tired Pup pluton

Tbr **Big River pluton (Tertiary?)**—Medium- to coarse-grained, seriate, biotite granite. CI, 3-8. Similar to, and possibly apophysis of, the 56.7 to 58.69 Ma Tired Pup pluton (Ttp) that is exposed about 1.25 km to south

Tnm **Necola Mountains pluton (Tertiary)**—Medium- to coarse-grained, seriate, hypidiomorphic-granular, biotite-hornblende quartz diorite, granodiorite, and granite. These compositions were determined from modal analyses, but separate phases were not mapped. CI, 9-29. K-Ar age, 57.5±1.7 Ma (Marvin Lanphere, oral commun., 1988)

Tcp **Chilligan porphyry (Tertiary)**—Fine- to coarse-grained, biotite or biotite-hornblende, hypidiomorphic-granular granite to granodiorite porphyry containing alkali-feldspar phenocrysts as long as 6 cm. CI, 5-24. K-Ar ages: 60.6±1.8 Ma, 61.3±1.8 Ma (Reed and Lanphere, 1972)

Tcc **Crystal Creek pluton (Tertiary)**—Medium- to coarse-grained, seriate to porphyritic, hypidiomorphic-granular, biotite-hornblende alkali-feldspar granite to granodiorite. CI, 4-16. Concordant biotite and hornblende K-Ar ages: 60.0±1.7 Ma, 60.0±2.9 Ma (Reed and Lanphere, 1972). Contact between this pluton and the Chilligan porphyry (Tcp) is not well exposed, but mineralogy, chemistry (unpublished), and age data suggest this pluton and the Chilligan porphyry might actually represent single intrusion

Tgb **Gabbro (Tertiary)**—Dark hornblende gabbro or pyroxene-hornblende gabbro. Fine to medium grained; seriate to equigranular, hypidiomorphic-granular texture. Locally exhibits cumulate(?) mineral layering. CI, typically 30-44; one sample had CI of 18. Limited sampling and mapping suggests this is complex, multiphase intrusion. $^{40}Ar/^{39}Ar$ age of 61.4±0.7 Ma (Marvin Lanphere, oral commun., 1989)

Tse **Snowcap east pluton (Tertiary?)**—Compositional and age variation suggests that this unit probably consists of multiple plutons. Modal compositions include gabbro, quartz monzodiorite, quartz monzonite, and granite. Contact relations between various phases could not be mapped owing to steepness of terrain. CI, 16-30. Age determinations: two biotite K-Ar ages from quartz monzodiorite, 41.5±1.2 Ma, 50.1±1.5 Ma (Reed and Lanphere, 1972); biotite $^{40}Ar/^{39}Ar$ age from quartz monzonite, 64.8±0.5 Ma (Marvin Lanphere, oral commun., 1988)

Tmf **Middle Fork stock (Tertiary)**—Porphyritic biotite-hornblende quartz monzodiorite. CI, 20. K-Ar age, 63.9±0.5 Ma (Marvin Lanphere, oral commun., 1988). Small gold-bearing skarn reported along northeast contact (P. Sainsbury, oral commun., 1987; T.K. Bundtzen, oral. commun., 1993)

Th **Hartman plutons (Tertiary)**—At least four plutons and smaller satellite bodies. Chiefly fine- to medium-grained, seriate, hornblende-biotite granodiorite and lesser amounts of quartz monzonite, granite, and quartz monzodiorite. CI, 9-29. One pluton yielded biotite K-Ar age of 64.0±1.3 Ma (Reed and Lanphere, 1972); two other plutons yielded $^{40}Ar/^{39}Ar$ biotite ages of 65.1±0.4 Ma, 65.1±0.6 Ma (Marvin Lanphere, oral commun., 1989)

Tme **Mount Estelle pluton (Tertiary)**—Chiefly medium- to coarse-grained, seriate, hypidiomorphic-granular biotite-hornblende granodiorite. Locally, grades into granite. CI, 8-26. Concordant biotite and hornblende K-Ar ages: 62.1±1.9 Ma, 64.1±1.8 Ma (Reed and Lanphere, 1972)

Tertiary or Cretaceous

TKlf **Lyman Fork plutons (Tertiary or Cretaceous?)**—Southern pluton is chiefly granite to monzodiorite; northern pluton is monzodiorite. Both are fine to medium grained, seriate, and hypidiomorphic-granular, and they contain biotite and amphibole. CI, 18-40. Presumed to be Tertiary or Cretaceous age, as are all dated igneous rocks in map area

TKsg **Sled Pass gabbro (Tertiary or Cretaceous?)**—Fine- to medium-grained, seriate, hypidiomorphic-granular gabbro. Highly variable mineral composition; contains plagioclase, biotite, amphibole±quartz, orthopyroxene, clinopyroxene, olivine, and as much as 6 percent opaque oxides and 4 percent apatite. CI, 21-40

TKm **Goldpan Peak gabbro (Tertiary or Cretaceous?)**—Fine- to coarse-grained gabbro that has hypidiomorphic-granular or intergranular fabric. CI, typically 42-55; one leucogabbro sample had CI of 15. Contains both clinopyroxene and orthopyroxene and, locally, minor amounts of olivine

TKtp **Tex Peak gabbro (Tertiary or Cretaceous?)**—Fine-grained equigranular or fine- to medium-grained seriate, hypidiomorphic-granular, hornblende-clinopyroxene±biotite gabbro. Pyroxene variably altered to actinolite. CI, 25-40. At least partly fault bounded

TKnr **Necons River pluton (Tertiary or Cretaceous?)**—Fine- to coarse-grained, seriate, hypidiomorphic-granular, hornblende-biotite granite to granodiorite; locally, fine grained equigranular or porphyritic. Dark phases of diorite to gabbro composition are present locally and may be large rafts of older intrusion. Intrudes and supports several large roof pendants of Koksetna River sequence sedimentary rocks. CI, 10-30. K-Ar ages: 64.0±1.8 Ma, 69.5±2.5 Ma (Reed and Lanphere, 1969; Reed and Lanphere, 1972)

TKmg **Mount Estelle gabbro (Tertiary or Cretaceous?)**—Very fine- to fine-grained, subequigranular, pyroxene-amphibole gabbro intrusion. CI, 20-30

TKag **Apocalypse gabbro (Tertiary or Cretaceous?)**—Fine-grained, equigranular, clinopyroxene ±amphibole diorite or gabbro. Hypidiomorphic-granular to subophitic texture. CI, 30-40

TKd **Dikes (Tertiary and Cretaceous?)**—Mapped in areas where dikes may exceed 50 percent of bedrock; however, none of these areas are well exposed. Dike composition, which is variable, even within single zone, ranges from light-colored felsic porphyry to dark gabbro. Widths range from 3 m to 15 m. Intrudes unit Ks

TKiu **Undifferentiated plutonic rocks (Tertiary and Cretaceous?)**—Small intrusions of unknown age; affiliation with other, more well known intrusions is uncertain. Compositions range from granite to gabbro. Textures include seriate, equigranular, and porphyritic. CI, about 10-40

Cretaceous

Kgb **South Fork gabbro (Cretaceous)**—Fine- to medium-grained, seriate, hypidiomorphic-granular hornblende-pyroxene-biotite gabbro. Has crude foliation defined by subparallel alignment of plagioclase crystals. CI, 52-55. Biotite K-Ar age, 71.4±2.0 Ma (Reed and Lanphere, 1972)

Ksp **Sled Pass pluton (Cretaceous)**—Fine- to coarse-grained, seriate monzonite and monzodiorite. CI, 22-41. Locally well-developed cataclastic foliation. Age determinations: hornblende K-Ar age, 76.0±2.2 Ma (Reed and Lanphere, 1972); discordant $^{40}Ar/^{39}Ar$ ages, 70.1±0.4 Ma, 75.6±0.5 Ma, on biotite and hornblende (from same sample), respectively, and another biotite $^{40}Ar/^{39}Ar$ age of 73.5±0.3 Ma (Marvin Lanphere, oral commun., 1989)

Kqm **Quartz monzodiorite stocks (Cretaceous)**—Fine- to medium-grained, seriate to porphyritic, hornblende quartz-monzodiorite. CI, 7-12. Hornblende K-Ar age, 79.1±1.4 Ma (Marvin Lanphere, oral commun., 1988)

SEDIMENTARY ROCKS

Ks **Sedimentary rocks, undifferentiated (Cretaceous)**—Dark-gray to black, interbedded mudstone, siltstone, and graywacke turbiditic sequences. Thickness of individual beds typically ranges from a few millimeters to 10 cm. Percentage of fine-grained and coarse-grained beds varies, but rocks are dominantly fine grained. In map area, rocks are folded, faulted, and, adjacent to plutons, altered to hornfels. Sandstones rich in volcanic-lithic fragments are similar in composition to sandstones of Kahiltna assemblage of Kalbas and others (2007); sandstones rich in monocrystalline quartz are similar in composition to sandstones of Kuskokwim Group of Cady and others (1955). Preliminary compositional and age data indicate complicated distribution of sandstones that have different compositions, supporting possible repetition of section by folding or faulting. Our limited data is best represented by this undifferentiated Cretaceous sedimentary map unit

KJkr **Koksetna River sequence(?) (Cretaceous to Jurassic)**—Interbedded mudstone-graywacke turbiditic sequence and minor volcanic flows. Lithic grains consist of argillite, chert, and volcanic rocks; sedimentary and volcanic lithic grains are present in approximately equal amounts. Locally, strongly altered to hornfels. Tentatively correlated with Koksetna River sequence of Wallace and others (1989) on basis of overall lithologic composition. Fossil collections reported by Wallace and others (1989) yielded Kimmeridgian (Upper Jurassic) and Valanginian (Lower Cretaceous) ages

Pzs **Mystic and Dillinger sequences of Farewell terrane of Decker and others (1994) (Pennsylvanian? to Cambrian)**—Interbedded limestone, mudstone, shale, sandstone, and conglomerate, as described in McGrath 1:250,000-scale quadrangle to northeast (Bundtzen and others, 1987; Gilbert and others, 1988). Platform carbonate deposits of White Mountain sequence are not present in map area. In fault contact with Kahiltna assemblage of Kalbas and others (2007) (unit Ks) and intruded by the Tired Pup pluton (unit Ttp) and several smaller intrusions

METAMORPHIC ROCKS

TKgs **Orthogneiss (Tertiary or Cretaceous?)**—Fine- to coarse-grained orthogneiss; texture varies from cataclastic to noncataclastic. Contains approximately 40 to 60 percent feldspar, 20 to 40 percent quartz, and 15 percent biotite and hornblende. White mica and garnet are locally present. Contact with the middle Tertiary Merrill Pass pluton (unit Tmp) not exposed, but gneiss presumably was intruded by pluton. Age of protolith and of metamorphism unknown

Ŧv **Chilikadrotna Greenstone (Late Triassic)**—Mafic lava flows, metamorphosed to greenstone, and lesser amounts of marble and chert. Highly deformed and sheared. Greenstone locally has rounded outcrop appearance, suggesting deposition as submarine pillow lava flows. Marble converted to skarn near intrusive bodies. Wallace and others (1989) reported conodonts of Norian (Late Triassic) age and brachiopods of probable Norian age from unit in Lake Clark 1:250,000-scale quadrangle

Ŧg **Massive greenstone member of the Chilikadrotna Greenstone (Late Triassic)**—Dark greenish-black, massive, fine-grained equigranular body that contains approximately equal amounts of plagioclase and altered mafic minerals. Strongly shear foliated near fault contacts

EXPLANATION OF MAP SYMBOLS

Contact—Solid where location is certain; long-dashed where approximate; short-dashed where inferred; dotted where concealed

Fault—Solid where location is certain; long-dashed where approximate; dotted where concealed

Moraine—End, recessional, and lateral moraine limit

Lake Clark National Park and Preserve boundary

Strike and dip of beds
- 70 **Inclined**
- 70 **Approximate**
- **Vertical**
- **Vertical approximate**
- 62 **Overturned**

Strike and dip of foliation
- 70 **Inclined**
- **Vertical**

Strike and dip of cleavage
- 70 **Inclined**

INTRODUCTION

This map is compiled from geologic mapping conducted between 1985 and 1992 by the U.S. Geological Survey as part of the Alaska Mineral Resource Assessment Program (AMRAP). That mapping built upon previous USGS work (1963-1988) conducted chiefly by Bruce L. Reed and colleagues, notably Marvin A. Lanphere and Raymond L. Elliott. Bruce Reed spent most of his career conducting geologic mapping in the western Alaska Range and, with Marvin Lanphere, unraveling the magmatic history of the Alaska–Aleutian Range batholith. Quaternary unit contacts depicted on this map are derived largely from aerial-photograph interpretation by Donald Richter. K-Ar ages made prior to this study have been recalculated using 1977 decay constants (Steiger and Jager, 1977).

The east half of the Lime Hills 1:250,000-scale quadrangle includes part of the Alaska–Aleutian Range batholith (Reed and Lanphere, 1969, 1972, 1973) and several sequences of sedimentary rocks or mixed sedimentary and volcanic rocks. The Alaska–Aleutian Range batholith contains rocks that represent three major igneous episodes, (1) Early and Middle Jurassic, (2) Late Cretaceous and early Tertiary, and (3) middle Tertiary; only rocks from the latter two episodes are found in this map area. Cretaceous sedimentary rocks, previously divided into the Kahiltna terrane (in the northeastern part of the map area) and the Kuskokwim Group (in the southwestern part of the area), are herein shown as a single, undivided unit; recent unpublished compositional and age data, which indicate a complicated distribution of sandstones of different compositions, suggest that these rocks are best represented by an undifferentiated Cretaceous sedimentary map unit (Ks). Other sedimentary-rock units are the Koksetna River sequence (in the southeastern part of the map area) and (in the northwestern part of the map area) the Mystic and Dillinger sequences of Farewell terrane of Decker and others (1994). The correlation of sedimentary rocks in the southeastern part of the map area with the Koksetna River sequence to the south is tentative and is based largely on published descriptions (for example, Wallace and others, 1989).

The map area is one of very steep and rugged terrain; elevations range from a little under 1,000 ft (305 m) to 9,828 ft (2,996 m). Foot traverses are generally restricted to lowermost elevations. Areas suitable for helicopter landings can be scarce at higher elevations. Most of the area was mapped from the air, supplemented by direct examination of rocks where possible. The Goldpan Peak gabbro (unit TKm), for example, was described and sampled entirely from talus deposits. This restricted access greatly complicates understanding some of the more complex geologic units. For example, we know there are plutons whose compositions vary from gabbro to granodiorite, but we have little insight as to how these phases are distributed and what their relations might be to each other. It is also possible that some of what we have described as compositionally complex plutons might actually be several distinct intrusions.

All plutonic rock names used herein, which are from Streckeisen (1974), were determined from modal analyses (unpublished) of thin sections or rock slabs. Where mineral modifiers are given for igneous rocks (for example, biotite-hornblende granite), the most abundant mineral is listed first, and the least abundant mineral is listed last.

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