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BEDROCK GEOLOGIC MAP OF THE KIGLUAIK MOUNTAINS, SEWARD PENINSULA, ALASKA

by

Jeffrey M. Amato and Elizabeth L. Miller
Department of Geological and Environmental Sciences
Stanford University, Standford, California

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Bedrock Geologic Map of the Kigluaik Mountains, Seward Peninsula, Alaska

Scale 1:63,360

Includes parts of the Teller A-1, A-2, A-3, Nome D-1, D-2, D-3, Solomon D-6, and Bendeleben A-6 Quadrangles

Compiled by Jeffrey M. Amato and Elizabeth L. Miller
Department of Geological and Environmental Sciences,
Stanford University, Stanford, California

INTRODUCTION

The Kigluaik Mountains comprise a region of rugged terrain located approximately 50 km north of Nome on the Seward Peninsula in northwestern Alaska (fig. 1) and are defined as the topographic high between the Imuruk Basin on the north, the Sinuk River area to the south, the Nome-Teller highway to the west, and the Nome-Council highway to the east. The Kigluaik Mountains have previously been mapped in reconnaissance (1:250,000 scale) by Sainsbury (1972, 1974), Sainsbury et al. (1972), and Till et al. (1986). More detailed maps (1:24,000 scale) of limited areas within the range were produced as parts of several M.S. or Ph.D. theses and papers (e.g., Pollock, 1982; Sturnick, 1984; Lieberman, 1988; Calvert, 1992, Miller et al., 1992). This compilation at 1:63,360 scale is the first detailed map of the entire Kigluaik Mountains and has been compiled from geologic mapping at 1:24,000 scale as part of a project initiated by E. L. Miller at Stanford University in 1987. Our mapping covers more than 3/4 of the area of the Kigluaik Mountains, the rest of which was compiled from the aforementioned thesis maps and other sources (fig. 2). This mapping took place during field seasons of a duration of approximately 4-8 weeks a year during the years of 1989, 1990, 1991, and 1992. Field parties ranged in size from 1-5 persons, with minimal helicopter support. The aim of the project was to elucidate the Cretaceous tectonic history of the region, and as a result, Quaternary geology and minor offset faults were deemphasized. The Quaternary sediments of the region were mapped by Kaufman (1989).

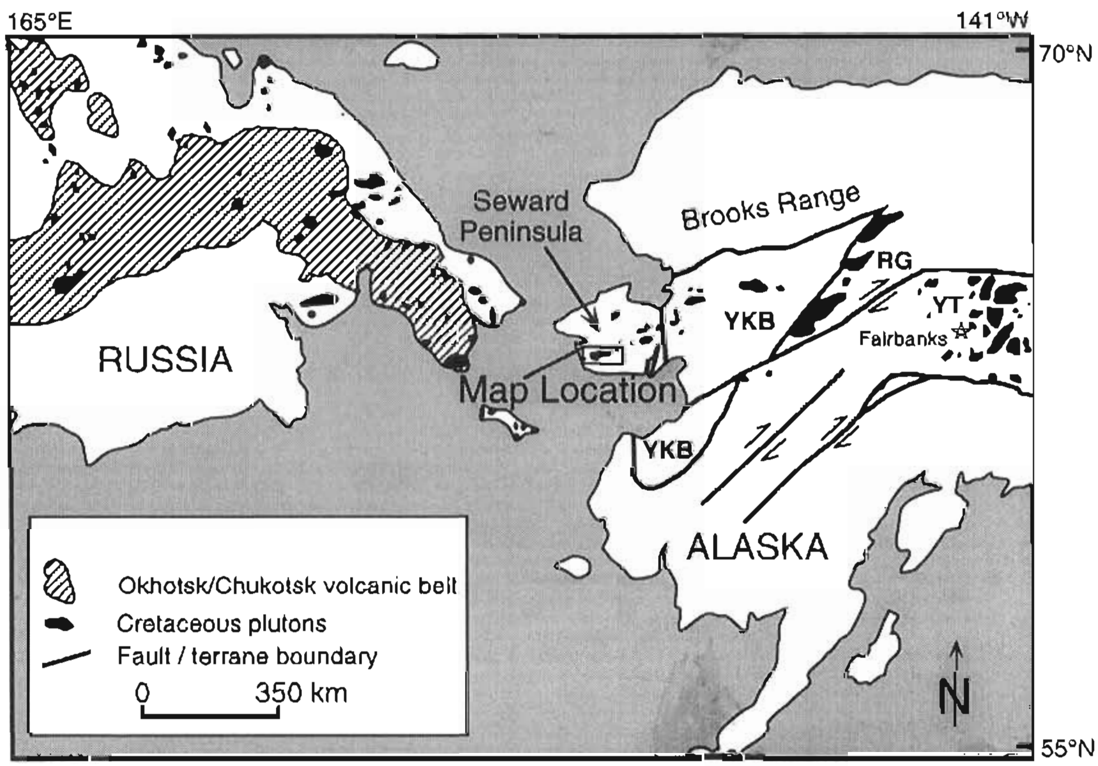
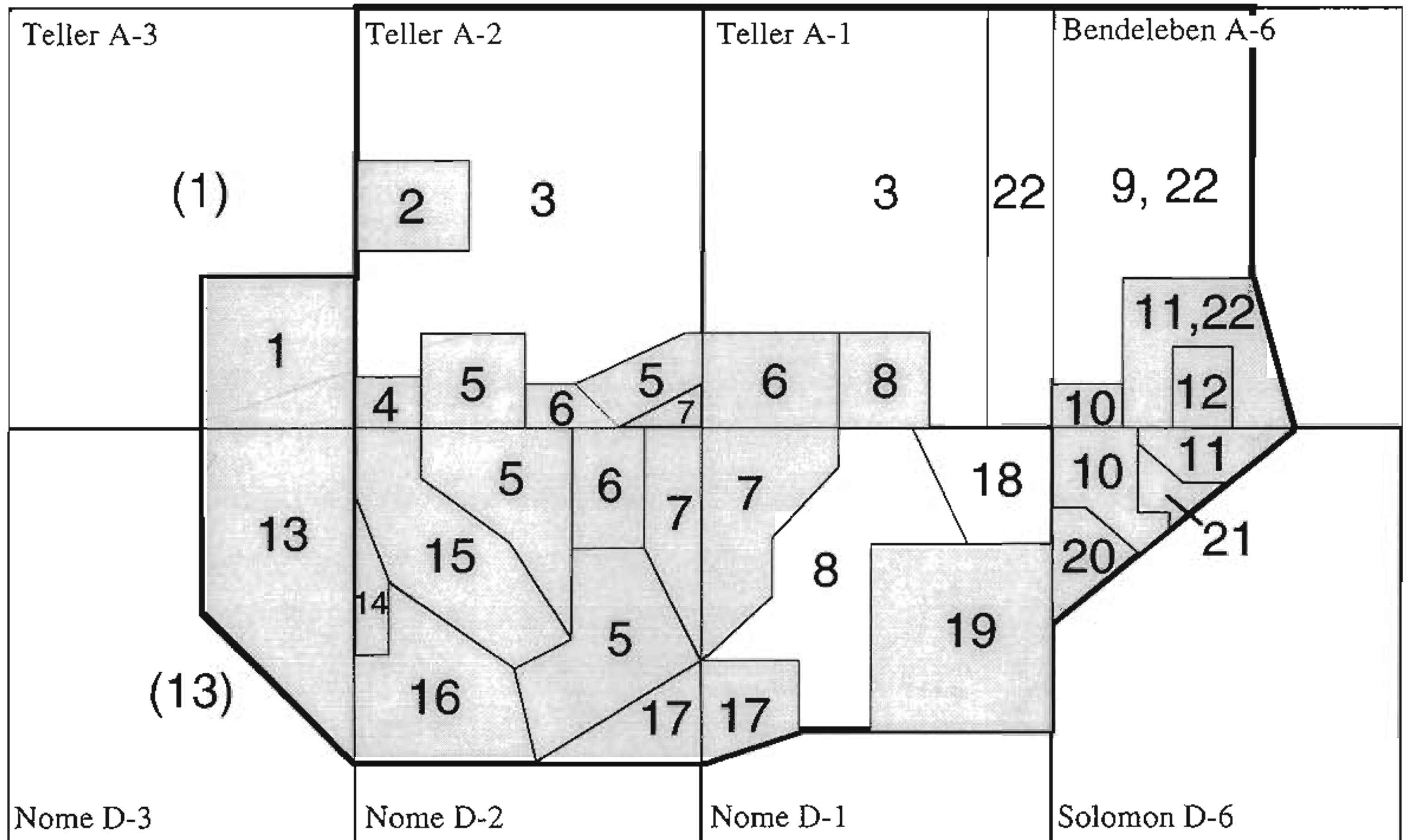


Figure 1. *Index map showing the location of Seward Peninsula, the map location, and the location of Cretaceous plutons and volcanic rocks in Russia and Alaska. Modified from Amato (1995).*

MAPPING CREDITS



Shaded area was mapped during this study. Unshaded area is compiled from previously published work.
References to published maps are in italics. Remaining listings are credits for mapping during this study.

1) K. A. Hannula, E. L. Miller, and C. Rubin, 1991
2) E. L. Miller and C. Rubin, 1991
3) *Sainsbury, 1974*
4) J. M. Amato, E. L. Miller, and J. Toro, 1992
5) J. M. Amato, 1992
6) P. B. Gans, J. M. Amato, A. T. Calvert, T. A. Little, 1991
7) P. B. Gans, J. M. Amato, A. T. Calvert, K. A. Hannula, 1990
8) *Todd and Evans, 1993*; *Lieberman, 1988*
9) *Till et al., 1986*
10) *Sturnick, 1984*
11) E. L. Miller and A. T. Calvert, 1989
12) A. T. Calvert, 1989
13) E. L. Miller, T. A. Little, and A. T. Calvert, 1989
14) A. T. Calvert and J. Lee, 1991
15) J. M. Amato, E. L. Miller, J. Toro, and J. E. Wright, 1992
16) J. M. Amato, K. A. Hannula, and A. T. Calvert, 1991
17) *Bundtzen et al., 1994*
18) *Hummel, 1963*
19) Pollock, 1982
20) E. L. Miller, J. Toro, F. Cole, 1991; J. M. Amato and E. L. Miller, 1994
21) T. A. Little, 1989
22) *Turner et al., 1980*

Figure 2. *Mapping credits.*

BEDROCK UNITS

Metamorphic Rocks

Rocks of the southern Seward Peninsula were divided by Moffit (1913) into two groups on the basis of metamorphic grade, and our map follows that division. The lower grade Nome Group experienced a blueschist-facies metamorphic event at some time before ~120 Ma (Hannula and McWilliams, 1995), but most of the rocks were later overprinted by greenschist facies assemblages. The Nome Group thus includes all units metamorphosed in the blueschist and lower greenschist facies though the upper greenschist facies. The Kigluaik Group structurally underlies the Nome group and presumably also experienced the earlier high-pressure metamorphic event. These rocks, however, were subjected to high-temperature metamorphism during the mid-Cretaceous that resulted in a Barrovian-type metamorphic progression that entirely obliterates evidence for this older metamorphism. The Kigluaik Group thus includes all units metamorphosed in the upper greenschist facies through granulite facies. The metamorphic and structural history as well as detailed geochronology of the Nome and Kigluaik Groups has been summarized by Forbes et al. (1984), Thurston (1985), Patrick and Evans (1989), Calvert (1992), Hannula (1993), Amato et al. (1994), Till and Dumoulin (1994), Hannula and McWilliams (1995), Hannula et al. (1995), and Amato (1995).

In the field, all units containing visible metamorphic biotite are included within the Kigluaik Group and the contact between the Nome and Kigluaik Group is marked by a "biotite-in" Barrovian-type isograd. In the map area it is generally found within a black, graphitic and silicious unit (Pzb), and therefore this unit appears in the legend as part of both the Nome Group and the Kigluaik Group.

Age assignments for the protoliths of metamorphic rock units are generally uncertain. Paleozoic fossils have been found within the Nome Group (Till and Dumoulin, 1994) and thus much of the section was presumed to be Paleozoic. However, a 680 Ma orthogneiss has been reported to intrude the middle part of the section (Patrick and McClelland, 1995). Because of these ages, all metamorphic units in the map are designated as Precambrian (?) - Paleozoic (?) (pC-Pz). Because the Kigluaik Group is structurally lower than the Nome Group, it is possible that its protoliths are older. The Thompson Creek orthogneiss, located within the upper part of the Kigluaik Group, was dated by U-Pb method on zircon as ~550 Ma (Amato and Wright, in press). Thus, the protoliths of the Kigluaik Group are likely Precambrian and possibly also Early Cambrian and therefore we have also assigned them a Precambrian (?) - Paleozoic (?) age.

Igneous Rocks

The Kigluaik Group contains a variety of igneous rocks. The Thompson Creek orthogneiss, dated as ~550 Ma, represents the earliest phases of magmatism in the region (Amato and Wright, in press). Abundant Cretaceous igneous rocks in the range are important in that they likely provided a heat source for the mid-Cretaceous thermal event discussed above. The Cretaceous igneous rocks can be divided into three groups: (1) orthogneiss bodies; (2) the undeformed Kigluaik pluton and related dikes; and (3) a diabase dike swarm.

The Cretaceous orthogneiss bodies are small in volume and extent, but they are important marker units in the map area. A distinctive syenitic orthogneiss (Ksog) is exposed in the Mt. Osborne area near the northwest corner of the Nome D-1 quadrangle. This unit is similar to other reported potassic intrusions in the Bering Strait region (Miller, 1972). A garnet-bearing orthogneiss is exposed just north of this area. Both bodies are approximately 105-110 Ma based on U-Pb zircon geochronology (Amato and Wright, in press; W. McClelland, pers. comm.).

The Kigluaik pluton and related dikes represent the largest volume of igneous rocks in the Kigluaik Mountains. This intrusion is part of a broad magmatic belt that includes the Okhotsk/Chukotsk volcanic belt in the Russian Far East and a diffuse belt of Cretaceous plutons on Seward Peninsula and interior Alaska (fig. 1). The Kigluaik pluton is a 100 km2 compositionally diverse granitoid pluton that intrudes the western half of the range. Two major compositional phases can be mapped: an upper "cap" of biotite granite overlies a mafic "root" of tonalite, diorite, and granodiorite. The two units are separated by a transitional zone of mafic enclaves within a granitic matrix, with textures indicating that the two magmas were intruded simultaneously, or nearly so. U-Pb zircon geochronology indicates an intrusive age of 91 Ma (Amato and Wright, in press). Petrology of the pluton is reported in Amato and Wright (submitted to JGR, 1996).

The youngest Cretaceous igneous rocks consist of a diabase dike swarm which cuts the country rock adjacent to the pluton, and in several localities cuts the pluton itself. Dikes typically strike approximately N30E, and a 83 Ma 40Ar/39Ar date of hornblende probably indicates the time of intrusion of the dikes (Amato and Wright, in press).

ACKNOWLEDGMENTS

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REFERENCES CITED

Amato, J. M., Tectonic evolution and petrogenesis of the Kigluaik gneiss dome, Seward Peninsula, Alaska: An integrated structural and geochemical study of extensional processes in mid-crustal rocks, Ph.D. thesis, 150 pp., Stanford Univ., Stanford, Calif., 1995.

Amato, J. M., J. E. Wright, P. B. Gans, and E. L. Miller, Magmatically induced metamorphism and deformation in the Kigluaik gneiss dome, Seward Peninsula, Alaska, Tectonics, 13, 515-527, 1994.

Bundtzen, T. K., R. D. Reger, G. M. Laird, D. S. Pinney, K. H. Clautice, S. A. Liss, and G. R. Cruse, Preliminary geologic map of the Nome Mining District, Alaska Div. Geol. Geophys. Surv. Public-Data File 94-39.

Calvert, A. T., Structural evolution and thermochronology of the Kigluaik Mountains, Seward Peninsula, Alaska, M.S. thesis, 50 pp. Stanford Univ., Stanford, Calif., 1992.

Forbes, R. B., B. W. Evans, and S. P. Thurston, Regional progressive high-pressure metamorphism, Seward Peninsula, Alaska, J. Meta. Geol., 2, 43-54, 1984.

Hannula, K. A., Relations between deformation, metamorphism, and exhumation in the Nome Group blueschist-greenschist terrane, Seward Peninsula, Alaska, Ph.D. thesis, 171 pp., Stanford Univ., Stanford, Calif., 1993.

Hannula, K. A., and M. O. McWilliams, Reconsideration of the age of blueschist-facies metamorphism on the Seward Peninsula, Alaska, based on phengite 40Ar/39Ar results, J. Meta. Geol., 13, 125-139, 1995.

Hannula, K. A., E. L. Miller, T. A. Dumitru, J. Lee, and C. M. Rubin, Structural and metamorphic relations in the southwest Seward Peninsula, Alaska: Crustal extension and the unroofing of blueschists, Geol. Soc. Am. Bull., 107, 536-553, 1995.

Hummel, C. H., Preliminary geologic map of the Nome D-1 quadrangle, Seward Peninsula, Alaska, U.S. Geol. Surv. Misc. Invest. Field Stud. Map MF-248, 1962.

Kaufman, D. S., P. E. Calkin, W. B. Whitford, B. J. Przybyl, D. M. Hopkins, B. J. Peck, and R. E. Nelson, Surficial geologic map of the Kigluaik Mountains area, Seward Peninsula, Alaska, U.S. Geol. Surv. Misc. Invest. Field Stud. Map MF-2074, 1989.

Lieberman, J. E., Metamorphic and structural studies of the Kigluaik Mountains, Western Alaska, Ph.D. thesis, 192 pp., Univ. Washington, Seattle, 1988.

Miller, E. L., A. T. Calvert, and T. A. Little, Strain-collapsed metamorphic isograds in a sillimanite gneiss dome, Seward Peninsula, Alaska, Geology, 20, 487-490, 1992.

Moffit, F. H., Geology of the Nome and Grand Central Quadrangles, Alaska, U.S. Geol. Surv. Bull., 533, 140 pp., 1913.

Patrick, B. E., and B. W., Evans, Metamorphic evolution of the Seward Peninsula blueschist terrane, J. Petrol., 30, 531-555, 1989.

Patrick, B. E., and W. C. McClelland, Late Proterozoic granitic magmatism on Seward Peninsula and a Barentian origin for Arctic Alaska-Chukotka, Geology, 23, 81-84, 1995.

Pollock, S. M., Structure, petrology, and metamorphic history of the Nome Group blueschist terrane, Salmon Lake area, Seward Peninsula, Alaska, Ph.D. thesis, 222 pp., Univ. of Washington, Seattle, 1982.

Sainsbury, C. L., Geologic map of the Teller Quadrangle, western Seward Peninsula, Alaska, U.S. Geol. Surv. Misc. Invest. Map., I-285, 1972.

Sainsbury, C. L., Geologic map of the Bendeleben 1:250,000 Quadrangle, Seward Peninsula, Alaska, Air Samplex, Golden, CO, 31 pp., 1974.

Sainsbury, C. L., C. L. Hummel, and T. Hudson, Reconnaissance geologic map of the Nome Quadrangle, Seward Peninsula, Alaska, U.S. Geol. Surv. Open File Rep., 72-326, 1972.

Sturnick, M. A., Metamorphic petrology, geothermo-barometry, and geochronology of the eastern Kigluaik Mountains, Seward Peninsula, Alaska, Ph.D. thesis, 175 pp. Univ. Alaska, Fairbanks, 1984.

Thurston, S. P., Structure, petrology, and metamorphic history of the Nome Group blueschist terrane, Salmon Lake area, Seward Peninsula, Alaska, Geol. Soc. Am. Bull., 96, 600-617, 1985.

Till, A. B., and J. A. Dumoulin, Geology of Seward Peninsula and Saint Lawrence Island, in The Geology of Alaska, The Geology of North America, v. G-1, edited by G. Plafker and H.C.Berg, pp. 141-152, Geol. Soc. Am., Boulder, 1994.

Till, A. B., J. A. Dumoulin, B. M. Gamble, D. S. Kaufman, and P. I. Carroll, Preliminary geologic map and fossil data, Solomon, Bendeleben, and Southern Kotzebue quadrangles, Seward Peninsula, Alaska, U.S. Geol. Surv. Open File Rep., 86-276, 1986.

Todd, C. S., and B. W. Evans, Limited fluid-rock interaction at marble-gneiss contacts during Cretaceous granulite-facies metamorphism, Seward Peninsula, Alaska, Contrib. Mineral. Petrol., 114, 27-41, 1993.

Turner, D. L., S. Swanson, R. B. Forbes, and D. Maynard, Geologic map of the Bendeleben A-6 and eastern part of the Teller A-1 quadrangles, Alaska, in A geological and geophysical study of the geothermal energy potential of Pilgrim Springs, Alaska, edited by D. L. Turner and R. B. Forbes, University of Alaska Geophysical Institute Report 271, 1 sheet, scale 1:63,360, 1980.