Bedrock Geologic Map of the Northern Alaska Peninsula Area, Southwestern Alaska

Compiled by Frederic H. Wilson, Robert B. Blodgett, Charles D. Blome, Solmaz Mohadjer, Cindi C. Preller, Edward P. Klimasauskas, Bruce M. Gamble, and Warren L. Coonrad

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Contents

Table

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Abstract

The northern Alaska Peninsula is a region of transition from the classic magmatic arc geology of the Alaska Peninsula to a Proterozoic and early Paleozoic carbonate platform and then to the poorly understood, tectonically complex sedimentary basins of southwestern Alaska. Physiographically, the region ranges from the high glaciated mountains of the Alaska-Aleutian Range to the coastal lowlands of Cook Inlet on the east and Bristol Bay on the southwest. The lower Ahklun Mountains and finger lakes on the west side of the map area show strong effects from glaciation. Structurally, a number of major faults cut the map area. Most important of these are the Bruin Bay Fault that parallels the coast of Cook Inlet, the Lake Clark Fault that cuts diagonally northeast to southwest across the eastern part of the map area, and the presently active Holitna Fault to the northwest that cuts surficial deposits.

Distinctive rock packages assigned to three provinces are overlain by younger sedimentary rocks and intruded by widely dispersed latest Cretaceous and (or) early Tertiary granitic rocks. Much of the east half of the map area lies in the Alaska-Aleutian Range province; the Jurassic to Tertiary Alaska-Aleutian Range batholith and derivative Jurassic sedimentary rocks form the core of this province, which is intruded and overlain by the Aleutian magmatic arc. The Lime Hills province, the carbonate platform, occurs in the north-central part of the map area. The Paleozoic and Mesozoic Ahklun Mountains province in the western part of the map area includes abundant chert, argillite, and graywacke and lesser limestone, basalt, and tectonic mélange. The Kuskokwim Group, an Upper Cretaceous turbidite sequence, is extensively exposed and bounds all three provinces in the west-central part of the map area.

Introduction and Previous work

This map, located on the west side of Cook Inlet and north of Bristol Bay, shows an area we nominally call the northern Alaska Peninsula. It is a region of transition from the classic magmatic arc geology of the Alaska Peninsula to the accretionary geology of south-central and southwest Alaska and to the poorly understood, tectonically complex sedimentary basins of southwestern Alaska. A wide range of sources were used to compile this map, including the published mapping of Robert Detterman and others in the Iliamna and Kenai quadrangles (Detterman and Hartsock, 1966; Detterman and Reed, 1973, 1980; Magoon and others, 1976) and unpublished mapping of J.N. Platt and E.H. Muller in the Taylor Mountains quadrangle (J.N. Platt, unpub. data, 1957) and the Dillingham quadrangle (J.N. Platt and E.H. Muller, unpub. data, 1958). Field notes of J.M. Hoare and W.H. Condon (1969–1970) were especially useful in compiling the western Taylor Mountains and Dillingham quadrangles map area. A preliminary map of the Paleozoic rocks of the northeastern Taylor Mountains quadrangle was published by LePain and others (2000). Early mapping by J.B. Mertie and P.A. Davison in the 1930s (Mertie, 1938) laid the general framework for the region; subsequent mapping by Cady and others (1955) filled in parts of that framework. Re-examination of the field notes of Mertie, Davison, Hoare, Condon, and W.L. Coonrad helped define a number of the map units in the western part of the map area. Limited new field mapping was conducted as part of this compilation effort (for example, Blodgett and Wilson, 2001; Wilson and others, 2003), and extensive photo interpretative work has also contributed to this product. W.K. Wallace graciously provided field maps from his work in the region during the 1980s. Papers on the plutonic rocks by B.L. Reed and his coworkers provided the basis for much of the map in the southern Alaska Range and northern Aleutian Range (Reed and Lanphere, 1969, 1972, 1973). Studies around Redoubt and Iliamna Volcanoes (Till and others, 1993; Waythomas and Miller, 1999) also contributed. However, new mapping underway at the time of this map compilation is not included here.

During the course of this project, a surficial geologic map of the region, especially the Lake Clark National Park and Preserve region, was produced based on photo interpretation (Wilson and Preller, 2003; F.H. Wilson and T.K. Bundtzen, unpub. data, 2006). As a result, areas of apparent bedrock exposure were noted that were not shown on available bedrock maps. In general, our assignment of a bedrock rock unit to these previously unmapped areas in the Lake Clark quadrangle is based on extrapolation of the outcrop patterns on the maps by Nelson and others (1983) and Eakins and others (1978), data from W.K. Wallace (Wallace and others, 1989; Wallace, written commun., 2003), and additional interpretation by the authors of this map. In the Taylor Mountains and Dillingham quadrangles, previously unmapped apparent bedrock exposures, where appropriate, are assigned to map units based on outcrop patterns on the maps of Hoare and Coonrad (1978) and from the earlier unpublished maps of J.N. Platt and E.H. Muller of the U.S. Geological Survey, dating from the 1950s (J.N. Platt, unpub.

data, 1957; J.N. Platt and E.H. Muller, unpub. data, 1958).

In 1998, Wilson and others (1998) published a compilation of the geology of central Alaska that brought together 25 1:250,000-scale quadrangles. An Alaska Peninsula geologic map (Wilson and others, 2015) represents the compiled results of a concerted 10–15 year mapping effort on the Alaska Peninsula (see Detterman and others, 1996); digital data for this Alaska Peninsula map was released in 1999 (Wilson and others, 1999). The present map has been constructed, in part, to provide a join between the central Alaska and Alaska Peninsula maps. Every effort has been made to provide consistent and coherent geologic units and interpretation such that geologic units are carried across the boundaries between these three maps without break. Due to the detailed mapping, correlation of map units was easiest with the Alaska Peninsula map; however, the reconnaissance nature of much of the mapping in the southwestern part of the central Alaska map (Wilson and others, 1998) means that the correlations are more general.

Geographic, Geologic, and Physiographic Framework

Physiographically, the map area ranges from the high glaciated mountains of the southern Alaska Range and northern Aleutian Range to the coastal lowlands of the west side of Cook Inlet and northern Bristol Bay. The lower glaciated mountains and the finger lakes of the west side of the map area are extensively modified by Pleistocene and Holocene glaciation. In particular, the finger lakes of Wood-Tikchik State Park are well-developed landlocked fjords. Extensive glacial deposits provide abundant evidence for the glaciers and the two ice caps that are thought to have covered much of the eastern and western parts of the map area and probably coalesced in the early Pleistocene on the Bristol Bay lowlands. North of the coastal lowlands of Bristol Bay, the west-central part of the map area consists of heavily vegetated rolling hills that may be covered by local accumulations of eolian deposits including loess. Originally interpreted as never glaciated (see for example, Péwé, 1975), widespread features evident on aerial photographs suggest the past presence of local alpine glaciers, small ice caps, and large ephemeral glacial lakes, most likely pre-Late Wisconsin and probably pre-Wisconsin (F.H. Wilson, unpub. data; Wilson, 2006). Glacial erratic boulders found on many ridges in the eastern Taylor Mountains and Dillingham quadrangles (M.L. Miller, oral commun., 2005; F.H. Wilson, unpub. data, 1999–2006) also suggest extremely old and areally extensive glaciation.

Other prominent physiographic features in the map area include the volcanoes of the modern Aleutian arc; Iliamna and Redoubt Volcanoes are the highest mountains in the map area. Augustine Volcano, though much smaller, is distinctive because it is an island. Other volcanic centers, such as Double Glacier Volcano (Reed and others, 1992) and the reported center named "Black" near Black Peak (Coats, 1950) are also part of the modern Aleutian arc but do not form prominent features. In fact, Black is yet to be located following Coats' (1950) report.

The dominant geologic feature of the eastern part of the map area is the Alaska-Aleutian Range batholith of Reed and Lanphere (1973), which forms the backbone of the southern Alaska Range and northern Aleutian Range in the map area. The volcanoes are emplaced through and on top of this backbone and the young volcanic rocks represent only a small fraction of the bedrock, even in the immediate vicinity of these volcanoes. Bedrock east of the batholith along the Cook Inlet coast consists of the Talkeetna Formation and overlying Jurassic sedimentary rocks of the Tuxedni Group and other sedimentary rock units as young as Tertiary (Detterman and Hartsock, 1966; Detterman and Reed, 1980; Nelson and others, 1983). The rocks of the southern Alaska Range and northern Aleutian Range at this latitude are characteristic of the Alaska Peninsula terrane (Wilson and others, 1985, 2015, 1999) where the batholith and roof pendants form the Iliamna subterrane and the sedimentary rocks are typical of the Chignik subterrane.

Immediately west of the batholith is a poorly defined sequence(?) of Mesozoic sedimentary and igneous rocks intruded by latest Cretaceous and early Tertiary granitic plutons and locally overlain by early Tertiary volcanic rocks (Nelson and others, 1983; Wallace and others, 1989; Wilson and others, 2003). These rocks have been variously associated with the southern Kahiltna terrane of Wallace and others (1989), the Kuskokwim Group (Decker and others, 1994), and the Kahiltna flysch of central Alaska (Wilson and others, 1998). On this map, these rocks are included in the informally defined Jurassic and Cretaceous Koksetna River sequence of Wallace and others (1989) (unit KJkr), which gives way to the west to rocks confidently mapped as the Kuskokwim Group (Kk). However, the exact location of this transition is difficult to place. Eakins and others (1978) mapped two Cretaceous-Jurassic clastic units (KJs and KJsh), which correspond well with rock units of the Kuskokwim Group and Koksetna River sequence of Wallace and others (1989) as shown by W.K. Wallace (written commun., 2004). Also widely distributed west of the batholith are latest Cretaceous and early Tertiary granitic plutons (Wilson, 1977; Wilson and others, 2003), some of which are peralkaline.

A complex assemblage in the westernmost part of the map area consists of Paleozoic and Mesozoic volcanic and sedimentary rocks and mélange traditionally assigned to the Gemuk Group. Originally somewhat loosely defined in the 1950s in the northwestern Taylor Mountains quadrangle and southward (Cady and others, 1955), the extent of the mapped Gemuk Group was subsequently extended (Hoare and Coonrad, 1959a,b, 1961; J.N. Platt, unpub. data, 1957; J.N. Platt and E.H. Muller, unpub. data, 1958) to become a catch-all unit for many Paleozoic to Cretaceous rocks in southwestern Alaska. Wilson and Coonrad (2005) discussed the history of usage of the term Gemuk Group and formally abandoned the Gemuk Group as a stratigraphic unit and term; rocks that were traditionally included in this unit were assigned to the Togiak-Tikchik Complex. Within this map area, rocks that range from early Paleozoic to Cretaceous are included in the Togiak-Tikchik Complex, a structural assemblage of a variety of rock units;

rudimentary subdivision of these rocks into informal rock units is made here on the basis of available data, especially the field notes of J.M. Hoare and W.H. Condon.

Lower Paleozoic carbonate rocks, assigned to the Farewell terrane of Decker and others (1994), extend into the north-central part of the map area from the Lime Hills and Sleetmute quadrangles to the north (Blodgett and Wilson, 2001; Blodgett and others, unpub. data). Immediately south of these carbonate rocks is a narrow belt of Late Triassic to Jurassic siliciclastic carbonate rocks of the same age as the Kamishak Formation and overlying clastic rocks that have a distinct faunal signature relative to Kamishak Formation (R.B. Blodgett, unpub. data, 2005).

Structurally, the map area is cut by a number of major faults and postulated faults, in addition to many faults mapped only locally. The Lake Clark Fault (Detterman and others, 1976) is an important feature that strikes southwest across the eastern part of the map area; however, available data does not indicate its location southwest of Lake Clark. On the basis of offset magnetic anomalies, Haeussler and Saltus (2005) postulated 26 km of right-lateral offset since late Eocene time along the Lake Clark Fault. They also postulated 11 km of right-lateral offset on an inferred fault they named the Telequana Fault (not shown here), which is about 35 km northwest of and strikes parallel to the Lake Clark Fault.

In the extreme northwest part of the map area, the Holitna Fault has long been considered an extension of the Denali Fault system of central Alaska. Field maps of J.M. Hoare and W.H. Condon (unpub. data, 1969, 1970) indicate northwest-side-up and right-lateral offset. Cady and others (1955) indicated a high-angle reverse sense of motion. The fault trace cuts surficial deposits and indicates it is presently active (F.H. Wilson, unpub. data, 2006). Offset along this fault is traditionally considered to have a right-lateral sense of motion (see, for example, Decker and others, 1994); however, a recent aeromagnetic survey (Saltus and Milicevic, 2004) could be interpreted to indicate left-lateral displacement.

The so-called Mulchatna Fault lies between the Lake Clark and Holitna Faults (Beikman, 1980). However, other than a topographic linear feature, there is little geologic evidence to support existence of a fault or to indicate fault offset along or across the trace of the lineament. Mohadjer and others (2006) examined available geologic and geophysical data in the vicinity of the fault and found little evidence to support the existence of a fault along the topographic linear. However, the gravity data, as well as mapping by Wallace and others (1989), do support the existence of a low-angle, west-dipping contact, which Wallace and others (1989) map as a thrust fault between the rocks of the Kuskokwim Group and the Koksetna River sequence of Wallace and others (1989). This contact does not follow the trace of the topographic linear. The aeromagnetic data for the Lake Clark quadrangle (Case and Nelson, 1986), in combination with recently completed aeromagnetic surveys of the Dillingham and Taylor Mountains quadrangles (U.S. Geological Survey, 2002; Saltus and Milicevic, 2004), show a definitive magnetic discontinuity along the topographic linear feature. However, the measured magnetic susceptibility of the exposed rocks do not match the aeromagnetic survey data, suggesting a buried strong magnetic source west of the trace.

The Bruin Bay Fault, another major fault system, is sub-parallel to the Cook Inlet coast east of the Alaska-Aleutian Range batholith and separates the batholith from sedimentary rocks derived from erosion of the batholith and overlying volcanic rocks of the Talkeetna magmatic arc. The Bruin Bay Fault is a high-angle-reverse fault and may have left-lateral offset (Detterman and Hartsock, 1966). It was a growth fault during deposition of the Jurassic sedimentary sequence and has approximately 3 km of stratigraphic throw (Detterman and Hartsock, 1966).

Geologic Discussion

The rocks of this map area consist of a number of distinctive packages or terranes. For presentation and discussion, they are divided here into three provinces, separated by mostly younger rocks and extensive surficial cover. From west to east, these provinces are the Ahklun Mountains province along the west margin of the map, the Lime Hills province near the western part of the north margin of the map, and the Alaska-Aleutian Range province constituting the east half of the map. These provinces are not to be confused with tectonostratigraphic terranes; in broad extent outside the map area, each province may constitute multiple terranes (see Decker and others, 1994; Plafker and others, 1994). The geology of each of the provinces consists of distinctive stratigraphic units; however, the nature of the boundaries between the provinces is not known. There are also a number of map units that either occur in all of the provinces or, in the case of the Kuskokwim Group flysch, seem to overlie all three provinces.

A number of distinctive Lower Jurassic and Triassic carbonate rock units occur within the map area. Most of these units also have associated chert. The Late Triassic (Norian) Kamishak Formation is the best described unit and has the most extensive area of exposure on the east side of the map area. Associated with the Chilikadrotna Greenstone of the central Lake Clark quadrangle are thin slivers of a similar age limestone, which is shown on this map as part of the Kamishak Formation. However, the faunas in this limestone are distinct from the Kamishak Formation faunas. Along the periphery of the Paleozoic carbonate rocks of the Farewell terrane of Decker and others (1994) in the northeast Taylor Mountains quadrangle are Lower Jurassic and Triassic carbonate and chert units intercalated with Paleozoic rocks. In the northwestern Taylor Mountains quadrangle, Triassic carbonate rocks are associated with mafic volcanic rocks formerly assigned to the Gemuk Group and now part of the Togiak-Tikchik Complex. Finally, in the southern exposures of the Togiak-Tikchik Complex in the southwestern Taylor Mountains and northwestern Dillingham quadrangles, small exposures of Triassic limestone are associated with the Paleozoic chert of the Tikchik Lakes region. All of these units, except the Lower Jurassic, contain Triassic, Norian, faunas; however, the distinct faunas of each suggests different depositional environments or points of origin (R.B. Blodgett, unpub. data).

Ahklun Mountains Province

The Ahklun Mountains province consists of Mesozoic and Paleozoic rocks variously assigned to multiple terranes (Box and others, 1993; Decker and others, 1994). These rocks were originally mapped as the now-abandoned Gemuk Group (Cady and others, 1955; Hoare and Coonrad, 1959a,b, 1961; J.N. Platt, unpub. data, 1957; J.N. Platt and E.H. Muller, unpub. data, 1958). The name "Gemuk Group" was abandoned by Wilson and Coonrad (2005) when they recognized that the rock units constitute a structural assemblage of poorly known lithologic packages; they redescribed and renamed the assemblage of lithologies the "Togiak-Tikchik Complex." In the map area, these rocks include abundant chert and graywacke and lesser limestone, basalt, and other volcanic and sedimentary rocks. We have subdivided these rocks on the basis of field notes by J.M. Hoare, W.L. Coonrad, and W.H. Condon dating from 1953 through 1970. Hoare and Coonrad (1978) mapped these rocks as Early Ordovician to Early Cretaceous unit MzPz in the southwestern Taylor Mountains and northwestern Dillingham quadrangles, as well as in the western Goodnews Bay quadrangle; unit MzPz included a wide range of lithologies. We have attempted to subdivide the Togiak-Tikchik complex into lithologic packages; in general, the nature of the boundaries between the lithologic packages is not known and clarification of this awaits further mapping. One of the lithologic packages is a mélange that includes blocks of the same lithologies in the other subdivisions. Due to the reconnaissance nature of the data, presentation of the lithologic packages, as shown in the vicinity of the Tikchik Lakes, has to be considered at best schematic.

Lime Hills Province

The oldest rocks of the map area occur in the Lime Hills province of the north-central part of the map area and consist of Proterozoic and early Paleozoic carbonate rocks of the Farewell terrane (Decker and others, 1994), which are best exposed in the Sleetmute and Lime Hills quadrangles north of the map area (Wilson and others, 1998; Blodgett and others, unpub. data). Proterozoic and Paleozoic rocks of this section extend a short distance south into the Taylor Mountains quadrangle. In the northeastern Taylor Mountains quadrangle, these rocks are Neoproterozoic to Silurian (Blodgett and Wilson, 2001) and contain fossils of Siberian affinity (Palmer and others, 1985; Blodgett, 1998; Blodgett and others, 1999, 2002; Dumoulin and others, 2002). Southwest of these rocks, across an abrupt transition that is modified by imbricate thrust faults, Triassic and Early Jurassic carbonate and siliciclastic rocks occur in a narrow (~500-m-wide), about 15-km-long, southeast-trending belt. Within the exposure area of the Silurian algal boundstone (unit Sab), slivers of the Jurassic siliciclastic rocks are thrust imbricated; however, this imbrication occurs at a scale too small to show on this map (sheet 1) or the enlarged part of the map (fig. 1, sheet 2). Lithologically and faunally similar Triassic siliceous carbonate rocks have been found on the north shore of Iliamna Lake in the Iliamna quadrangle. In the past (Detterman and Reed, 1980), the rocks at Iliamna Lake were referred to the Kamishak Formation. However, the faunas at these localities differ (Blodgett and others, 2000) from faunas typical of the Kamishak Formation in the type area along Cook Inlet and Shelikof Strait (south of the map area).

Alaska-Aleutian Range Province

Along the east margin of the map area, the plutonic rocks of the Tertiary to Jurassic Alaska-Aleutian Range batholith and the derivative Jurassic sedimentary rocks of the Tuxedni Group and younger sequences constitute the bulk of the bedrock exposures. The batholithic rocks show a rough age progression from older to younger, east to west. The older rocks are Middle to Late Jurassic, succeeded by limited areas of middle Cretaceous granitic rocks and, finally, Eocene granitic rocks. Country rock of the batholith ranges from Triassic carbonate and cherty rocks of the Kamishak Formation and associated basaltic rocks to Early Jurassic arc volcanic rocks of the Talkeetna Formation and derivative sedimentary rocks that range from Middle Jurassic to latest Jurassic. In the map area, an unconformity spans nearly the entire Cretaceous on the east side of the batholith. Jurassic and Tertiary volcanic rocks are exposed west of the main mountain mass and the batholith. Where mapped separately, the Jurassic rocks were assigned to the Talkeetna Formation (Detterman and Reed, 1980). The Tertiary rocks are Eocene and early Oligocene, based on limited radiometric dating, and are equivalent to the Meshik magmatic arc of the Alaska Peninsula (Detterman and Reed, 1980; Wilson, 1985). The west margin of the Alaska-Aleutian Range province consists of Late Jurassic to Early Cretaceous volcaniclastic sedimentary rocks of the Koksetna River sequence of Wallace and others (1989). During the time of deposition of the Jurassic volcaniclastic rocks of the Koksetna River sequence of Wallace and others (1989), sediments on the east side of the batholith, the Naknek Formation, were derived from erosion of plutonic rocks.

Map Units Not Assigned to a Province

By far, the most extensively exposed map unit in the area is the Kuskokwim Group, an Upper Cretaceous flysch deposit. This unit is widely distributed throughout southwestern Alaska; in the Taylor Mountains, Dillingham, and Lake Clark quadrangles, it consists largely of marine turbidites (Box and Elder, 1992) with minor nearshore facies rocks in the vicinity of the Proterozoic(?) and Paleozoic carbonate rocks (J.N. Platt, unpub. data, 1957). However, an enigmatic aspect of these nearshore facies rocks is the absence of carbonate clasts, even where in contact with carbonate rocks (F.H. Wilson, unpub. data, 1999). Intruding the Kuskokwim Group are widely dispersed latest

Cretaceous and (or) early Tertiary granitic rocks. Some of these plutons have associated gold, such as at Taylor Mountain and in the Shotgun Hills (Rombach, 2000); tin, such as the Sleitat prospect (Burleigh, 1991); and somewhat distantly, mercury deposits, such as at Marsh Mountain (Sainsbury and MacKevett, 1965). In the northeastern Dillingham quadrangle, a large peralkaline plutonic complex and associated ignimbrite deposit are locally overlain by a bimodal sequence of olivine basalt and rhyolite (Wilson and others, 2003; Iriondo and others, 2003).

An outstanding problem is the relation of four Jurassic and Cretaceous map units. In the center of the map area, at the join of four quadrangles, map trends suggest that the volcaniclastic sedimentary rocks of the Koksetna River sequence of Wallace and others (1989; KJkr herein), the Graywacke of Kulukak Bay of Hoare and Coonrad (1978; Jkw herein), the Jurassic to Cretaceous volcanic and sedimentary rock sequence of Hoare and Coonrad (1978; KJvs herein), and the Kuskokwim Group (Kk herein) come together. In the northeast Dillingham quadrangle Wilson and others (2003) mapped the latter three units, whereas Wallace and others (1989) showed only their Koksetna River sequence in this vicinity on their sketch map. The description of the Koksetna River sequence by Wallace and others (1989) does not indicate the presence of volcanic rocks or tuff within the section, yet rocks of this type are interlayered with sedimentary rocks in the central part of the map. Wilson and others (2003) assigned these interlayered sedimentary and volcanic rocks to map unit KJvs and are shown within that unit herein. The volcaniclastic sandstone in the northeastern Dillingham quadrangle could be assigned to either map unit KJkr or Jkw based on lithology and fossil collections; neither unit has been sufficiently studied to determine whether they are truly different map units. Although assigned to different provinces here, the inferred depositional environment and transport directions (Wallace and others, 1989; Box, 1985) could be interpreted to indicate a single depositional system.

Digital Data

This map and associated digital files (http://dx.doi.org/10.3133/sim2942) represent part of a systematic effort to release geologic map data for the United States in a uniform manner (see for example, Wilson and others, 1998, 2005a,b,c; Stoeser and others, 2005; Nicholson and others, 2005). This map presents a compilation of geologic map data in an integrated fashion; all of the various sources have been merged to produce as uniform a mapping style as possible. The digital data is uniformly structured and coded to facilitate production of derivative products at nominal scales of about 1:250,000 to 1:500,000, although individual digital datasets may contain data suitable for use at larger scales. The metadata provides more detailed information on sources and appropriate scales for use. Associated attribute databases accompany the spatial database and are similarly uniformly structured for ease in developing regional- and national-scale maps.

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Three mentors, Robert L. Detterman, Warren L. Coonrad, and Joseph M. Hoare, guided the senior author early in his career and their guidance comes together in this map, which adjoins areas where they mapped We also are grateful for thoughtful and constructive reviews by William W. Patton, Jr., Dwight C. Bradley, and an anonymous reviewer. Robert B. Blodgett provided a geologic names review of the manuscript. Assistance in digital processing by Keith A. Labay and Chad P. Hults also is gratefully acknowledged, as is the preparation of metadata by Nora Shew. The manuscript was edited by Theresa Iki and Jan Zigler and prepared for final publication by Kathryn Nimz.

DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS AND ROCKS NOT ASSIGNED TO A PROVINCE

Qs **Surficial deposits, undivided (Quaternary)**—Unconsolidated, poorly sorted to well-sorted, poorly stratified to moderately well stratified deposits; consist predominantly of alluvial, colluvial, glacial, marine, lacustrine, eolian, and swamp deposits. Include small areas of glacially scoured bedrock covered by a thin(?) mantle of unconsolidated surficial deposits based on interpretation of aerial photographs. Also, locally includes reworked volcanic debris as well as block and ash flows

bu **Bedrock unknown (age unknown)**—Areas of known or apparent bedrock exposures. Bedrock type unknown. In the Taylor Mountains quadrangle, a number of the areas shown as bedrock unknown are in areas mapped as largely Kuskokwim Group; however, on aerial photographs these areas appear distinctive and, therefore, are highlighted for examination by future workers

Kk **Kuskokwim Group, undivided (Cretaceous, Campanian(?) to Albian(?))**—Sandstone, siltstone, shale, and conglomerate (Cady and others, 1955). Fine- to medium-grained sandstone, commonly micaceous gray graywacke or silty graywacke that is occasionally crossbedded or contains siltstone partings. Rare argillite pebbles. Originally described by Cady and others (1955), unit is widespread in southwestern Alaska; although largely a flysch deposit, unit represents a range of local depositional environments. Cady and others (1955) assigned it to the early Late Cretaceous but acknowledged fossil collections outside their map area might indicate an age older than Late Cretaceous and as young as Tertiary. Hoare and Coonrad (1959a) reported it as Albian to Coniacian based on fossils in the Bethel quadrangle, west of the map area, whereas Box and others (1993) assigned assigned late Cenomanian to early Turonian based on new collections and reexamination of existing fossil collections from the same area (see also, Elder and Box, 1992). Other age assignments have ranged from as young as Santonian (Decker and others, 1995) to Campanian (based on interbedded tuff, Miller and Bundtzen, 1994). The age range for the Kuskokwim Group throughout its extent is not well constrained due to the scarcity of fossils; however, reexamination of available fossil collections (Elder and Box, 1992) indicates most fossils are Cenomanian and Turonian, including all inoceramids collected within the map area as shown by Elder and Box (1992). Wallace and others (1989) reported an Albian(?) microfossil fauna in the Mulchatna River region. Within the map area, data is not always sufficient to distinguish these rocks from the Koksetna River sequence of Wallace and others (1989) or the argillite and graywacke (unit KTrag) of the Togiak-Tikchik Complex. As a result, this map unit may well include rocks that, in fact, belong in those units and vice versa, or belong in other units yet to be recognized. Locally subdivided into the following units: Kkn and Kkv

Kkn **Nearshore facies (Cretaceous)**—Sandstone, siltstone, shale, and conglomerate as mapped by J.N. Platt (unpub. data, 1957) in the northeastern Taylor Mountains quadrangle. This informal subdivision of the Kuskokwim Group was originally defined by J.N. Platt (unpub. data, 1957). Miller and Bundtzen (1994) also described a nearshore facies to the north of the map area in the Iditarod quadrangle. In the Taylor Mountains quadrangle, this unit was particularly noted in the vicinity of the Taylor Mountain pluton and eastward along the southern periphery of the Paleozoic carbonate rocks

Kkv **Volcanogenic rocks (Cretaceous(?))**—Volcanogenic sedimentary rocks and tuff. Contains some cherty argillite, minor limestone, and, locally, dikes. Unit defined on the basis of field notes of J.M. Hoare and W.H. Condon (U.S. Geological Survey, 1969 and 1970). Unit occurs in the northwestern part of the Taylor Mountains quadrangle and north and northeast of Flattop Mountain, as well as in the west-central part of the Taylor Mountains quadrangle east of the Gemuk River. An age of 70±0.4 Ma was obtained on basalt provisionally assigned to this unit (J.R. Riehle, unpub. data, 2001; table 1 herein). Correlated with unit Kkt of Miller and Bundtzen (1994) in the Iditarod quadrangle north of the map area

AHKLUN MOUNTAINS PROVINCE

SEDIMENTARY ROCKS

KJvs **Volcanic and sedimentary rocks (Lower Cretaceous to Middle Jurassic)**—Thick marine unit consisting of low-grade metamorphic or contact-metamorphosed volcanic and sedimentary rocks (Hoare and Coonrad, 1978). This rock unit was mapped by Hoare and Coonrad (1978) in the western Dillingham and adjacent Goodnews Bay quadrangles. According to Hoare and Coonrad (1978), "the volcanic rocks range in composition and type from mafic pillow basalts to more abundant andesitic and trachytic flows, tuff, and breccia. Interbedded with the volcanic rocks are tuffaceous siltstone, tuffaceous chert, and massive or thin-bedded argillite." Late Jurassic to Early Cretaceous radiolaria and fragmentary Jurassic ammonites have been collected from this unit in the Goodnews Bay quadrangle to the west of the map area (Hoare and Coonrad, 1978). The unit was mapped in the northeastern Dillingham quadrangle by Wilson and others (2003). In the Dillingham quadrangle, altered volcanic breccia is relatively abundant; however, locally, unit consists largely of vertically standing beds of contact-metamorphosed shale, siltstone, and lesser sandstone and also locally includes fresh-appearing fragmental volcanic rocks. Contact metamorphism is evidenced in outcrop by recrystallization where weathered surfaces show textures and structures, but fresh surfaces appear aphanitic. In thin section, mafic minerals are largely replaced by chlorite and feldspars and altered, in part, to sericite. Wallace and others (1989) included these rocks in their Koksetna River sequence (KJkr, herein); however, the presence of volcanic rocks is not characteristic of the Koksetna River sequence as defined. The map by Wallace and others (1989) is highly generalized; the small area of these rocks should not be expected to show on their sketch map. Locally subdivided into the following unit: KJv

KJv **Olivine basalt and fragmental volcanic rocks (Cretaceous or Jurassic)**—Olivine basalt flows and fragmental mafic volcanic rocks. Composition ranges from andesite to basalt. Unit is contact metamorphosed by nearby latest Cretaceous and early Tertiary plutonism. Part of unit KJvs volcanic and sedimentary rocks; mapped separately only locally in the northeastern Dillingham quadrangle

Jkw **Graywacke of Kulukak Bay (Upper to Middle Jurassic)**—A thick marine sedimentary unit consisting of very hard, dark-green or gray, massive graywacke and siltstone containing local conglomerate horizons. Typically consists of sandstone, although coarse pebble conglomerate is locally present. According to Hoare and Coonrad (1978), sandstone composition varies from quartz- and plagioclase-rich wackes to quartz-poor volcanic wackes. These rocks were originally referred to as the “Weary graywacke” by Hoare and others (1975) and later referred to as the “Graywacke of Kulukak Bay” by Hoare and Coonrad (1978). This unit is widely exposed in the southern Goodnews Bay and the Nushagak Bay quadrangles, as well as in the southwestern Dillingham quadrangle (Hoare and Coonrad, 1978). Rocks in the adjacent Iliamna quadrangle (Detterman and Reed, 1980, unit KJs) were correlated with this unit; however, on this map those rocks have been assigned to map unit KJkr, the Koksetna River sequence of Wallace and others (1989). In the Goodnews Bay and Nushagak Bay quadrangles, *Buchia*, *Inoceramus*, belemnites, and rare ammonite fragments ranging from Middle to early Late Jurassic have been found. Wilson and others (2003) assigned volcaniclastic graywacke mapped in the northeastern Dillingham quadrangle to this unit, in keeping with the correlation with the adjacent Iliamna quadrangle (Detterman and Reed, 1980, unit KJs). However, on this map, that graywacke is also assigned to map unit KJkr. The relation between map unit Jkw and the Koksetna River sequence of Wallace and others (1989), unit KJkr, is uncertain; although they overlap in age, age control is sparse for both units. Lithologically, the two units are similar and therefore may be equivalent units in part. Paleocurrent indicators suggest that the sediments of unit Jkw were derived from the west (Box, 1985), and paleocurrent indicators for unit KJkr suggest northeasterly sediment transport (Wallace and others, 1989), possibly indicating they had a common and long-lasting depositional system

STRUCTURAL ASSEMBLAGE

Togiak-Tikchik Complex (Lower Cretaceous to Lower Paleozoic)—Formerly called the Gemuk Group (Cady and others, 1955), this unit consists of a wide variety of rock types in a structural collage of blocks. Locally, unit has an internal stratigraphy, but overall it is unlikely that the entire assemblage represents a stratigraphic package. Unit, as originally defined as the Gemuk Group, consisted chiefly of dense, dark, massive siltstone having interbeds of chert, volcanic rocks, limestone, graywacke, and breccia. The name Gemuk Group was formally abandoned and the assemblage was subsequently redefined as the Togiak-Tikchik Complex in recognition of its structural character (Wilson and Coonrad, 2005). Included rock packages are shown as the following units: Mƶm, K₮agi, K₮ag, Jms, J₮p, ₮cg, ₮v, ₮₽zrc, Pv, Pls, Pcs, MDv, and ₽z

Mƶm **Mélange (Mesozoic(?))**—Located in the southwestern Taylor Mountains and northwestern Dillingham quadrangles, unit consists of two or more rock types in close proximity, typically tightly folded, sheared, and (or) altered: pillow basalt and massive basalt, chert, gabbro, graywacke, shale, siltstone, limestone, and dolostone. Hoare (1969 field note) described an individual outcrop area as consisting of dark calcareous siltstone and fine-grained, dirty limestone pinched into boudins, gray sugary chert, fine-grained biotite intrusive rocks, contorted massive gray dolomitized limestone and altered green phyllitic volcanic rocks, and red phyllitic argillite. The mélange, which has a siltstone matrix, appears to include clasts or blocks from units K₮ag, ₮₽zrc, ₽z, Pcs, and MDv. The mélange description is largely based on the 1969 and 1970 field notes of J.M. Hoare and W.H. Condon and limited fieldwork by F.H. Wilson and M.L. Miller in 2001. Unit corresponds generally to unit MzPz of Hoare and Coonrad (1978) and correlates with unit TrPz of Box and others (1993)

K₮agi **Argillite and graywacke, cut by dike swarms (Lower Cretaceous to Upper Triassic)**—Felsic dike swarms or shallow intrusions intruding primarily calcareous argillic graywacke and cherty argillite. Host rocks are map unit K₮ag and possibly other map units

K₮ag **Argillite and graywacke (Lower Cretaceous to Upper Triassic)**—Gray to gray-green argillite, cherty argillite, graywacke, and minor mudstone, tuffaceous sandstone, and chert. These rocks primarily occur in the northwestern part of the map area and were originally defined as constituting a major proportion of the type area of the now abandoned Gemuk Group. The presence of argillite, cherty argillite, and chert distinguishes unit from the Kuskokwim Group. Map unit also includes limited areas of multi-colored chert and gray to gray-green argillite or argillite, graywacke, and mudstone. Tuff or tuffaceous sedimentary rocks are only locally part of this unit; in similar-age rocks to the south in the Dillingham quadrangle, the absence of volcanic rocks is conspicuous in unit K₮ag. Locally, unit K₮ag may include areas of Kuskokwim Group (unit Kk) where data is insufficient to distinguish these units, for example in outcrops shown at the east end of Lake Chauekuktuli and those north of Tikchik Lake, as well as outcrops in the vicinity of unit Mƶm in the north-central Dillingham quadrangle. Cady and others (1955) reported Lower Cretaceous fossils north of the map area in the Sleetmute quadrangle, and Box and others (1993) reported poorly preserved Early Cretaceous and Jurassic radiolarians from rocks correlated with this unit in the adjacent Bethel quadrangle. Cady and others (1955) and Sainsbury and MacKevett (1965) reported Triassic (Norian and Carnian) fossils in the vicinity of Cinnabar Creek in the northwestern Taylor Mountains quadrangle. Miller and others (2005) reported data on a number of additional fossil collections and detrital zircon studies, providing added age control on the unit. Jurassic radiolarians from siltstone and chert ranged from Hettangian to Oxfordian, whereas graywacke yielded detrital zircons as young as 130 Ma or Early Cretaceous. Unit KŦag lithologic description is largely derived from the field notes and field maps of J.M. Hoare, W.H. Condon (1969–1970), and W.M. Cady (1943–1944)

Jms **Sedimentary rocks (Lower Jurassic)**—Marine unit consisting of micaceous, fine-grained black graywacke, siltstone, and slate and gritty limestone. Contains Early Jurassic *Weyla* pelecypods. Crops out along the Allen River area near where river drains into Lake Chauekuktuli. Outcrops are surrounded by and structurally lower than exposures of Paleozoic rocks on the adjacent ridges

JŦp **Phyllite and chert (Lower Jurassic and Upper Triassic(?))**—Gray to black cherty phyllitic shale, highly contorted thin-bedded siliceous argillite, and local cherty dark calcareous phyllite crop out along the west margin of the Taylor Mountains quadrangle in association with greenstone of unit MDv. The phyllite is occasionally sulfide-bearing along fault zones. Unit appears to be an extension of unit JŦp of Box and others (1993). Distribution on map based on the 1969 field notes of J.M. Hoare and W.H. Condon. Unit also includes apple-green tuff and chert in the extreme northwestern part of the Taylor Mountains quadrangle, which J.M. Hoare and W.H. Condon thought to be Jurassic or Triassic (1970 field notes)

Ŧcg **Chert and limestone (Upper Triassic)**—Marine unit consisting of chert, tuffaceous cherty rocks, argillite, siltstone, volcanic wacke, conglomerate, limestone, and mafic flows and breccia. Limestone is generally white to cream colored and recrystallized, however, locally is dark gray and only finely crystalline. Occurs in possibly fault bounded exposures along the south shore of Nuyakuk Lake in the northwestern Dillingham quadrangle. Also occurs in the vicinity of the Cinnabar Creek mine on Cinnabar Creek in the northwestern Taylor Mountains quadrangle (Sainsbury and MacKevett, 1965; J.M. Hoare and W.H. Condon, unpub. data, 1970). Triassic (Norian) fossils reported by Mertie (1938) and others in written communications cited in Hoare and Coonrad (1978). This is map unit Trvs of Hoare and Coonrad (1978) and, as mentioned by them, is only shown on the northwestern Dillingham quadrangle region of the map “in the vicinity of fossil localities because the rocks resemble other rocks of Paleozoic and Mesozoic ages with which they are tectonically associated.” (Hoare and Coonrad, 1978)

Ŧv **Volcanic rocks (Upper Triassic)**—Volcanic rocks comprising at least five separate flows, locally as much as 200 ft thick, interbedded with cherty siltstone. In the Cinnabar Creek area, associated with sparsely distributed Triassic limestone that yielded Late Triassic (Norian) *Monotis* and *Halobia*. Mapped only at northwest edge of Taylor Mountains quadrangle, including at Cinnabar Creek (Sainsbury and MacKevett, 1965). In the Cinnabar Creek area, occurs near the top of now abandoned Gemuk Group section (Wilson and Coonrad, 2005). Correlates with unit Trb of Box and others (1993) in the adjacent Bethel quadrangle

ŦⱣzrc **Rainbow chert (Triassic(?) to Paleozoic(?))**—Mostly highly deformed, white, gray, red, minor green, or black, thin-bedded to massive chert. Locally banded or brecciated and interbedded with minor red siliceous shale, argillite, dolomitic limestone, graywacke, and rare red volcanic rocks and agglomerate. Hoare and Jones (1981) reported Paleozoic(?) radiolarians in outcrops of this unit along the shore of Chikuminuk Lake, as well as Permian megafossils in associated and presumably overlying limestone. One locality on the shore of Chikuminuk Lake yielded Triassic radiolaria, which is yet to be explained due to lack of map data but may be due to the structural inclusion of slivers of younger rocks. East of Chikuminuk Lake, apparently overlain by rocks of the Kuskokwim Group (Kk). Mertie (1938) considered these rocks to be Mississippian(?); clearly Mississippian is highly speculative. Similarly described varicolored chert and limestone (Patton and others, 1980) or chert and argillite (Chapman and Patton, 1979) units have been mapped in the Medfra and Ruby quadrangles to the north of the map area; these are Carboniferous and Devonian. Patton and others (2009) included these rocks in a chert, argillite, and volcaniclastic rocks unit to which they assigned an age range of Triassic(?) to Devonian

Pv **Volcanic rocks (Permian(?))**—Predominantly dark green to black, altered mafic volcanic rocks having abundant amygdules. Volcanic breccia, calcareous tuff, and pillow lava constitute lower beds; pillow lavas in middle beds; and phyllitic calcareous tuff and tuffaceous limestone constitute upper beds. Primarily located along the north shore of Nuyakuk Lake at the west edge of the map area and extends into the Goodnews Bay quadrangle (Hoare and Coonrad, 1978)

Pls **Limestone (Permian)**—Lenses of thin-bedded to massive, light- to dark-gray limestone either interbedded or intercalated with clastic and volcanic rocks in the vicinity of the Lake Chauekuktuli and Nuyakuk Lake. Locally is gritty conglomeratic, contains siliceous interbeds, or has a fetid odor. *Atomodesma* sp., crinoid stems, brachiopods, pelecypods, and possible bryozoans reported. Fossil reports (see http://www.alaskafossil.org) note that fossils were commonly deformed by stretching. Unit description is largely based on the 1969 and 1970 field notes and maps of J.M. Hoare and W.H. Condon, augmented by air-photo interpretation. Rocks of this unit are associated with many of the older(?) rock units of the Togiak-Tikchik Complex, yet the nature of the association is rarely clear. In some areas it is clearly a structural intercalation, whereas elsewhere the association may be stratigraphic

Pcs **Clastic rocks (Permian(?))**—Fine- to coarse-grained, locally conglomeratic or brecciated, light-gray, greenish-gray, or black streaky, slaty, phyllitic, micaceous or silty, bedded to massive graywacke. Cigar-sized and cigar-shaped pits, boudins, or slightly contact metamorphosed in some areas. Intercalated with minor gray to black, slaty siltstone having graded bedding, thin argillite, phyllite, limestone, dolomite, and black chert. Unit is associated with limestone yielding Permian fossils in the vicinity of Lake Chauekuktuli (see http://www.alaskafossil.org)

MDv **Greenstone and schist (Mississippian(?) and (or) Devonian(?))**—Fine- to coarse-grained, massive, green to purple, altered greenstone, occasionally calcareous or schistose, rarely interbedded with green chert, argillite, and tuff. Greenschist with occasional chert boudins and minor shale-chip agglomerate. Greenstone is locally cut by quartz and calcite veins containing epidote and copper sulfides. Unit occurs north of Chikuminuk Lake on the west edge of the map area and extends into the adjoining Bethel quadrangle (Box and others, 1993). Phyllite of unit J₮p may overlie this MDv. Unit MDv description is largely based on the 1969 and 1970 field notes of J.M. Hoare and W.H. Condon and correlation with similar rocks in the adjoining Bethel quadrangle (Box and others, 1993). Age of map unit based on inferred protolith age that is based on fossils in an overlying unit in the Bethel quadrangle (Box and others, 1993)

Ᵽzc **Black chert (lower Paleozoic(?))**—Predominantly black and gray chert, but includes rare white, buff, red, or green, bedded to massive chert. Occasionally vitreous, banded, or fractured. Interbedded or structurally interleaved with minor amounts of limestone, amygdaloidal basalt, and thin pitted calcareous graywacke. Occurs in the vicinity of Nuyakuk Lake and Lake Chauekuktuli at the west-central edge of the map. Unit is distinguished from the rainbow chert (unit ₮Ᵽzrc) by the dominance of black and gray chert and, as based on Hoare and Condon field notes, the uncommon red and green chert, which is much more common in unit ₮Ᵽzrc. Hoare and Jones (1981) reported lower Paleozoic (Devonian(?) and pre-Devonian) and Paleozoic(?) radiolarians, as well as Permian megafossils, in the map area. The limited geologic information provided in Hoare and Jones (1981) does not indicate the nature of the occurrence of the Permian fossils. Based on the available map data, we suggest that the Permian fossils are in inclusions of fault-bounded blocks or slivers of the mélange (M̶zm) or units Pls and Pcs. Based on lithology and crude age, the black chert may correlate with the Ordovician chert and phyllite in the Medfra quadrangle (Patton and others, 2009; Wilson and others, 2005b)

LIME HILLS PROVINCE

[See figure 1 on sheet 2]

SEDIMENTARY ROCKS

Jssc **Chert, sandstone, and siltstone (Lower Jurassic)**—Medium-gray to yellowish-gray-weathering, medium- to thick-bedded, predominantly chert and sandstone unit with locally abundant phosphatic nodules developed in more cherty phases (R.B. Blodgett, unpub. data, 2005). Unit exposed along the periphery of and intercalated with the Paleozoic limestone of the Farewell terrane in the northeastern Taylor Mountains quadrangle. Predominantly sandstone beds in lower part of section; predominantly chert-rich beds in upper part of section. Contains undifferentiated Early Jurassic megafauna (most bivalves and belemnites; R.B. Blodgett, unpub. data, 2004) and undifferentiated Early Jurassic radiolarians (internal report of Emile Pessagno to M.L. Miller; also earlier report of C.D. Blome to F.H. Wilson). Minimum estimated thickness of unit is 100 m. Contact with underlying ₮lc unit is conformable where observed

₮lc **Limestone, silty limestone, and chert (Upper Triassic, Norian)**—Cream-colored to dark-gray limestone, silty limestone, and chert. Divided into two subunits: (1) a lower unit of massive- to thick-bedded, light-gray to cream-colored limestone with common scleractinian corals, spongiomorphs, and lesser brachiopods (Blodgett and others, 2000), minimum thickness 50 m, grading into (2) a late Norian upper unit of thinner bedded platy limestone, silty limestone, and minor chert containing locally well developed silicified megafauna (brachiopods, bivalves, gastropods) (see McRoberts and Blodgett, 2002; Blodgett and others, 2000). Upper unit represents slightly deeper, more offshore environment than lower unit. Minimum thickness estimated at 100 m. Many of the gastropods in upper unit (for example, *Chulitnacula alaskana* (Smith), *Andangularia wilsoni* (Blodgett)) are also known from coeval rocks of the Alexander terrane of southeastern Alaska. The relations of the chert to other parts of upper unit uncertain; may be structurally interleaved. Contact of ₮lc with next oldest regionally exposed unit, the Silurian Algal Boundstone (Sab), is uncertain, but is probably structural in some places. Overlain conformably by unit Jssc

D₽n **Farewell terrane, Nixon Fork subterrane of Decker and others (1994), undivided (Devonian(?) to Proterozoic)**—The map units described here come largely from the unpublished work of R.B. Blodgett and co-workers. Subdivided into the following units: Sab, Sls, Olss, Os, Oab, Ols, Ꞓls, Ꞓs, and ₽s

Sab	**Algal boundstone (Upper Silurian, Pridoli and Ludlow)**—Thick-bedded to massive, light-gray algal boundstone, locally dolomitic; composed primarily of spongiostromate algal heads (including abundant oncoid forms). Unit represents a barrier reef complex on the outer or seaward margin of the Silurian carbonate platform (Blodgett and Clough, 1985). Contains scattered pockets of brachiopods, mostly belonging to the superfamily Gypiduloidea. Aphrosalppingid sponges are locally abundant (Rigby and others, 1994), which are known elsewhere only from the Ural Mountains of Russia and the Alexander terrane of southeastern Alaska. Equivalent to unit Sl of Gilbert (1981)
Sls	**Lime mudstone (Upper Silurian, Wenlock to late Llandovery)**—Primarily thin- to medium-bedded, laminated, dark-gray to dark-brown, platy lime mudstone, having strong petroliferous odor (Blodgett and Wilson, 2001). Coarse-grained limestone debris flows having clasts of algal boundstone reef material common in uppermost part of unit, immediately below contact with overlying unit Sab. Age control based on graptolites and conodonts (see Blodgett and Wilson, 2001). Equivalent to unit uOll of Gilbert (1981) and Paradise Fork Formation of Dutro and Patton (1982)
Olss	**Tcherskidium-bearing limestone (Upper Ordovician, Ashgillian)**—Brown, medium- to thick-bedded, skeletal lime packstone to wackestone (Blodgett and Wilson, 2001). Contains abundant pentameroid brachiopods (*Tcherskidium*, *Eoconchidium* (or *Proconchidium*) and new genus (smooth) aff. *Tcherskidium*)
Os	**Shale (Ordovician)**—Extremely poorly exposed brown and dark-gray “chippy” (breaks into small chips) shale, silty shale, and minor silicified limestone (Blodgett and Wilson, 2001). Outcrops in Taylor Mountains D–1 1:63,360-scale quadrangle consist only of frost-boil exposures; however, one better exposed rubble outcrop in Taylor Mountains D–2 1:63,360-scale quadrangle (NE1/4 sec. 12, T. 9 N., R. 42 W.) contains numerous diplograptid graptolites
Oab	**Algal boundstone and lime mudstone (Lower Ordovician)**—Medium- to thick-bedded, dark-gray to brown algal thrombolites (boundstone) interbedded with light-gray-weathering, thin- to medium-bedded lime mudstone (Blodgett and Wilson, 2001). Contains trilobites and conodonts (identified by N.M. Savage, written commun., 1985), and fossils of the trilobite genus *Hystricurus* indicate Early Ordovician (Blodgett and Wilson, 2001)
Ols	**Lime mudstone (Lower Ordovician)**—Thin- to medium-bedded, dark-gray, yellow-gray-weathering, burrow-mottled lime mudstone (Blodgett and Wilson, 2001). Peloidal mudstone locally common. Age control based on poorly preserved, low-spired gastropods and conodonts, including *Drepanoistodus?* Sp., *Fryxellodontis?* n. sp., and other conodonts (Blodgett and Wilson, 2001)
€ls	**Limestone (Middle Cambrian)**—Two separate Middle Cambrian limestone subunits are included in this unit in the adjoining Sleetmute A–2 1:63,360-scale quadrangle where unit is best developed and exposed (Blodgett and others, unpub. data). The upper and thicker overlying subunit, exposed in the Taylor Mountains quadrangle, is composed of medium- to thick-bedded, commonly light-gray to dark-gray, rarely pink-weathering (light-gray fresh) lime mudstone having locally abundant, well-developed wavy styolites. Minor green-gray shale intervals present locally. Trilobites, locally abundant and diverse in this subunit, are Mayan (late Middle Cambrian in terms of Siberian Platform nomenclature) (Palmer and others, 1985; Babcock and Blodgett, 1992; Babcock and others, 1993; St. John, 1994; St. John and Babcock, 1994, 1997). Thickness of upper Mayan limestone subunit is at least 15 m. The lower subunit is poorly exposed (not yet observed in the Taylor Mountains 1:250,000-scale quadrangle) and consists only of scattered rubble crop of coquinoid limestone (lime wackestone to packstone) containing an abundant and diverse trilobite fauna (agnostids notably common); ancillary acrotretid brachiopods, hyoliths, and cap-shaped fossils are Amgan (early Middle Cambrian in terms of Siberian Platform nomenclature). Trilobites from lower subunit are discussed by Palmer and others (1985), Babcock and Blodgett (1992), Babcock and others (1993), Kingsbury (1998), Kingsbury and Babcock (1998), and Kingsbury and others (2003). Thickness of lower subunit is uncertain, but probably at least 5 m. Faunas from both subunits are most closely allied biogeographically with coeval faunas from the Siberian Platform. Contact with underlying unit €s is covered
€s	**Clastic and carbonate rocks (Lower Cambrian)**—Unit is quite heterogeneous and consists of dark-gray, light-gray-weathering orthoquartzite, locally having well-developed parallel laminations; light-gray, white-weathering, thin- to medium-bedded lime mudstone having abundant trilobites (observed in cross section) and tube-like fossils (possibly *Salterella*); orange-yellow, light-yellow-weathering dolomudstone, locally having weakly developed parallel laminations; medium- to dark-gray chert forming rubble crop; and red-orange- to maroon-weathering siltstone and chippy shale also forming rubble crop. Total thickness of unit uncertain, but minimally 100 m. Unit is poorly exposed in both the Sleetmute A–2 and Taylor Mountains D–2 1:63,360-scale quadrangles, and exposures consist mainly of frost boils in tundra, as well as rarer large rubble crops and small isolated limestone outcrops. Early Cambrian is inferred by its stratigraphic position immediately beneath Middle Cambrian limestone (unit €ls) and above the underlying unit Ꝑs correlative with Upper Proterozoic(?) strata in the McGrath quadrangle (Babcock and others, 1994). Early Cambrian age is

also indicated by the presence of the *Salterella*-like fossils, a tube-like fossil restricted to the Lower Cambrian. Trilobites were collected from this unit in the Taylor Mountains D–2 1:63,360-scale quadrangle, but a fossil report has not yet been received on this collection. Exact nature of contact with overlying Ꞓls and underlying Ᵽs units uncertain due to extensive tundra cover

Ᵽs **Dolostone, limestone, orthoquartzite, and minor chert (Neoproterozoic(?))**—Medium-bedded, medium-gray, orange-weathering dolostone, limestone, orthoquartzite, and minor chert. Dolostone has locally abundant floating quartz grains, is locally trough cross-stratified, but also has well-developed parallel laminations, low domal stromatolites, and local paleokarst intervals. Total thickness of unit uncertain, but minimally is at least 300–400 m thick. Several repeated sedimentary cycles observed in unit. Unit is best exposed in adjoining Sleetmute A–2 1:63,360-scale quadrangle (R.B. Blodgett and others, unpub. data, 2005). Unit is thought to be Upper Proterozoic, based on closely similar to identical distinctive lithologies shared with presumed Late Proterozoic units exposed to the northeast in the McGrath 1:250,000-scale quadrangle (Babcock and others, 1994; Blodgett and others, unpub. data)

ALASKA-ALEUTIAN RANGE PROVINCE

SEDIMENTARY ROCKS

Ts **Sedimentary rocks (Tertiary, Pliocene or Miocene)**—Consists of mainly light- to medium-gray and light-tan, fine- to medium-grained, tuffaceous feldspathic to arkosic wacke and siltstone containing scattered pebbles and lenticular beds of pebble conglomerate (Detterman and Reed, 1980). Micaceous clay and silt having moderately abundant glass shards constitute 40–60% of this moderately indurated rock unit. Rock and pumice fragments, as well as a few volcanic bombs, were reported from the wackes. Plant debris and carbonaceous material are common but largely unidentifiable or nondiagnostic. J.A. Wolfe (reported in Detterman and Reed, 1980) identified *Picea* sp. and suggested it indicated possible middle or late Tertiary. The rocks of this map unit, as described, occur only in a small area in the Iliamna quadrangle, west of the batholith on the south shore of eastern Iliamna Lake. However, recent observations indicate that similar rocks underlie the highlands between Turquoise and Telequana Lakes in the Lake Clark quadrangle; these exposures were mapped by Nelson and others (1983) as their unit Qu. In this area, moderately indurated, bedded rocks appear to underlie glacial deposits and overlie indurated rocks of unit KJkr; unfortunately, the data is not adequate to show the distribution of these rocks on the map. Detterman and Reed (1980) suggested a possible correlation of the rocks on Iliamna Lake with lithologically similar rocks in the Seldovia quadrangle (Detterman and Hartsock, 1966) on the west side of Cook Inlet that they assigned to the Kenai Formation (now Kenai Group). Work by Calderwood and Fackler (1972) and Kirschner and Lyon (1973) resulted in the assignment of the Seldovia quadrangle rocks to the West Foreland Formation (Twf), as shown here

Ttyh **Kenai Group, Tyonek Formation, and Hemlock Conglomerate, undivided (Tertiary, Miocene and Oligocene)**—Sandstone, conglomerate, and siltstone. Known within the map area only in the vicinity of Harriet Point in the Kenai quadrangle. Inferred from the description in Detterman and others (1976), unit consists of fluvial conglomeratic sandstone and conglomerate with minor interbeds of siltstone, shale, coal. Magoon and others (1976) did not distinguish the individual formations at this locality; Detterman and others (1976) assigned these rocks to the Hemlock Formation (now Hemlock Conglomerate)

Twf **West Foreland Formation (Tertiary, early Eocene and late Paleocene)**—Tan to light-yellow-brown cobble conglomerate interbedded with lesser sandstone, laminated siltstone, and silty shale (Detterman and Hartsock, 1966). Thin coal beds are interbedded with the siltstone and shale. The clasts in the conglomerate are mainly rounded to subrounded quartz diorite, volcanic rocks, argillite, sandstone, siltstone, quartzite, tuff, and coal fragments. Intrusive and volcanic rock fragments each make up about 35% of the clasts in the conglomerate. Medium- to coarse-grained arkosic sandstone forms the matrix of the conglomerate, as well as distinct lenticular beds. The siltstone and shale interbedded with the conglomerate is a very fine grained subarkosic equivalent of the sandstone. Originally mapped as the Kenai Formation by Detterman and Hartsock (1966), Calderwood and Fackler (1972) subdivided the redefined Kenai Group into a number of units and these rocks were assigned to the West Foreland Formation. The West Foreland Formation was assigned to the Oligocene by Kirschner and Lyon (1973) and later to an early Eocene and late Paleocene age (Magoon and others, 1976). Recent dating of zircon from an included tuff north of the map area yielded 43 Ma (middle Eocene; P.J. Haeussler and D.W. Bradley, oral commun., 2005). The West Foreland was removed from the Kenai Group because a major unconformity separates West Foreland from the overlying Hemlock Conglomerate (see Magoon and Egbert, 1986). The lower contact was described as an angular unconformity with the Upper Jurassic Naknek Formation (Detterman and Hartsock, 1966); subsequent work by Magoon and others (1980) showed there to be a nonmarine Upper

Cretaceous sedimentary unit between the rocks of the West Foreland and Naknek Formations. Those nonmarine Upper Cretaceous rocks are shown here as unit Ksm

Tcl **Copper Lake Formation, undivided (Tertiary, Eocene and Paleocene(?))**—Thick clastic nonmarine sedimentary rock unit consisting of an upper and lower conglomerate member bounding a middle sandstone and siltstone member (Detterman and Reed, 1980; Detterman and others, 1996) at the east end of Iliamna Lake. Upper conglomerate unit consists of red-weathering pebble-cobble conglomerate consisting mainly of volcanic rock clasts and containing minor tuff. Member may be agglomerate rather than conglomerate; ranges from 50 to 100% fresh-appearing volcanic rock. Clasts of quartzite, schist, greenstone, rose quartz, limestone, and granitic rocks are present in lower parts of upper member. Sandstone and siltstone middle member is chiefly fine- to medium-grained, medium-gray to greenish-gray lithic graywacke containing locally abundant tuffaceous and carbonaceous material. Grains in the sandstone include abundant quartz, schist, volcanic, and granitic rock fragments. Interbedded siltstone is similar in color and composition to the sandy facies, whereas claystone interbeds are mainly micaeous clay containing a small amount of montmorillonite. Lower conglomerate member is red-weathering, pebble-cobble conglomerate consisting mainly of volcanic rock clasts and containing minor tuff. Volcanic clasts constitute about 25% and appear to be derived from the Talkeetna Formation and not from the fresher appearing Tertiary volcanic units. Age control is from a fossil megaflora collected from within the middle member indicating early Eocene (Detterman and others, 1996). Detterman and others (1996) correlate the Copper Lake Formation with the Tolstoi Formation of the southwestern Alaska Peninsula, where an early Eocene megaflora was collected from a sandstone and siltstone section that overlies a basal conglomerate containing a late Paleocene flora and underlies beds containing a middle Eocene flora. By analogy, Paleocene(?) to early Eocene was assigned to the Copper Lake Formation by Detterman and others (1996)

Ksm **Saddle Mountain section of Magoon and others (1980) (Upper Cretaceous, Maastrichtian)**—Nonmarine sandstone, conglomerate, and minor siltstone and coal found in the northeast of Chinitna Bay in a section 83 m thick (Magoon and others, 1980). Consists predominantly of fine- to medium-grained sandstone that fines upward and is generally massive with some crossbedded units. Sandstone is soft and friable except where calcite cemented. Conglomerate contains volcanic and plutonic rock boulders as much as 30 cm in diameter in a sandy matrix. Coal beds, which tend to occur in the upper part of the section, are as much as 2.7 m thick and locally have underclay (“undersoils”, Magoon and others, 1980). Siltstone is most abundant in the middle part of the section. Sporomorphs indicate Maastrichtian. This unit was included in the Kaguyak Formation by Bradley and others (1999) but is separated here because of its distinct difference in lithology and depositional environment from the Kaguyak Formation. This map unit overlies the Jurassic with angular unconformity and is in turn overlain by rocks of the West Foreland Formation with angular unconformity

Kkg **Kaguyak Formation (Upper Cretaceous, Maastrichtian and Campanian)**—Consists of a measured thickness of more than 1,200 m of dark-gray to pale-brown, typically thin bedded shale, siltstone, and fine-grained sandstone (Detterman and others, 1996). However, only a small area of outcrop occurs within the map area on the south side of Kamishak Bay. Proportion of sandstone in unit increases up-section. Load and flute casts are common; in upper part of unit, graywacke is graded with numerous rip-up clasts. Overall depositional environment of formation is near midfan within multi-channeled system; however, uppermost part of unit may have been deposited in upper-fan regime (Detterman and others, 1996). In general, fossils are sparse; however, in lower part of unit, fossils are locally abundant. Ammonites are most common and may range in size to as much as 1 m across. Fossils allow age assignment of latest Campanian and early Maastrichtian. Within the map area, the Kaguyak Formation unconformably overlies rocks of the Naknek Formation; no units overlie the Kaguyak within the map area. South of the map area, the Kaguyak Formation is unconformably overlain by rocks of the Copper Lake Formation or younger units

KJkr **Koksetna River sequence of Wallace and others (1989) (Lower Cretaceous, Valanginian, to Upper Jurassic, Kimmeridgian)**—Complexly deformed volcanic-lithic turbidites. Consists of a thick monotonous sequence of thin (<4 cm) sandstone beds interbedded with pelagic shale. Locally, fining-upward sequences of sandstone beds up to 1.5 m thick have scoured bases and rippled or contorted tops (Wallace and others, 1989). Westward and northeastward, the proportion of sandstone decreases and most of the unit is siltstone, shale, and thin sandstone interbeds. Paleocurrent indicators suggest transport to the northeast; interpretation of depositional environments suggests regional sediment transport was to the north or northwest (Wallace and others, 1989). Coarse, unsorted and chaotic matrix-supported conglomerate occurs sporadically in the unit. Provenance was a magmatic arc province consisting dominantly of “volcanic rocks, but with local exposures of plutonic rocks, fine-grained clastic rocks, dynamothermally metamorphosed rocks, and contact-metamorphosed rocks.” (Wallace and others, 1989, p. 1,393). Age control is limited for this map unit; Wallace and others (1989) reported four fossil localities containing *Buchia*, specifically Late Jurassic (late Kimmeridgian), *Buchia mosquensis*, and Early Cretaceous (Valanginian) *Buchia sublaevis*. In the northeastern Dillingham quadrangle, the unit contains rare fragmentary fossils; a sample collected in 2001 yielded fragments of *Buchia*, suggesting Late Jurassic or Early Cretaceous (R.B. Blodgett, unpub. data, 2002). An unpublished report indicating Jurassic(?) fossils found by Unocal in 1959 in the northeastern Dillingham quadrangle seems to have erroneous sample locations; the sample description suggests that the samples may have actually come from the southeastern Taylor Mountains quadrangle. Within the map area, unit may be a partial stratigraphic and lithologic equivalent of unit Jkw, Middle and Upper Jurassic graywacke of Kulukak Bay of Hoare and Coonrad (1978), and unit KJvs, the Jurassic to Cretaceous volcanic and sedimentary rock sequence also mapped by Hoare and Coonrad (1978). Both units, Jkw and KJvs, were tentatively extended as far east as the east boundary of the Dillingham quadrangle (Wilson and others, 2003) but are assigned to unit KJkr on this map. Distinction between these three units, KJkr, KJvs, and Jkw will have to be resolved by future study

Jn **Naknek Formation (Upper Jurassic, Tithonian to Oxfordian)**—Originally named Naknek Series by Spurr (1900, p. 169–171, 179, 181) for exposures at Naknek Lake on the Alaska Peninsula south of the map area. Largely consists of sandstone, conglomerate, and siltstone having a primarily plutonic provenance. This rock unit is widespread in southern Alaska, ranging in a long belt from south-central Alaska (Wilson and others, 1998) to the southwest end of the Alaska Peninsula (Wilson and others, 1999), about 1,150 km (Detterman and others, 1996). The aggregate thickness of the unit members exceeds 3,000 m, though the average thickness of the formation is more typically 1,700 to 2,000 m (Detterman and others, 1996). Megafossils, particularly the pelecypod *Buchia* (Detterman and Reed, 1980, p. B38; J.W. Miller, written commun., 1982–88), are common, and the fauna, which also includes ammonites, indicate an age range of Oxfordian to late Tithonian (Late Jurassic). Detterman and others (1996; see also, Detterman and Hartsock, 1966; Martin and Katz, 1912) have subdivided unit into six members, five of which are in the map area: Pomeroy Arkose (Jnp), Indecision Creek Sandstone (Jni), Snug Harbor Siltstone (Jnst), Northeast Creek Sandstone (Jnn), and the Chisik Conglomerate (Jnc) Members, which are described below as units Jnp, Jni, Jnst, Jnn, and Jnc

Jnp **Pomeroy Arkose Member (Upper Jurassic, Kimmeridgian and Oxfordian(?))**—Massive, light-gray, medium- to coarse-grained arkose containing many interbedded thin beds of dark-gray to brownish siltstone and pebble conglomerate (Detterman and Hartsock, 1966). The sandstone is rich in quartz (40–45%) and sodic feldspar (30–35%) and also contains 15–20% hornblende and tourmaline. Volcanic lithic fragments make up 2–3% of the rock. Grains are subangular to subrounded. The matrix is generally clay but is locally tuffaceous. The siltstone is mineralogically distinctive from the arkose and resembles the graywacke of older units according to Detterman and Hartsock (1966); we interpret this to indicate it contains a higher proportion of volcanic- and sedimentary-sourced components. Detterman and Hartsock (1966) indicated that most sections of the Pomeroy Arkose Member have a 70- to 350-ft-thick (21- to 113-m-thick), gray, medium-bedded to massive, arenaceous siltstone horizon, usually in the lower part of the member. Unit is sparsely fossiliferous, containing *Lytoceras*, *Phylloceras*, and *Buchia concentrica*, suggesting an age no younger than early Kimmeridgian. Detterman and Hartsock (1966) suggested that the nearby Jurassic part of the Alaska-Aleutian Range batholith was the source for this unit, and the subangular character of the easy-to-destroy grains of hornblende, tourmaline, and feldspar indicates short transport and rapid burial

Jni **Indecision Creek Sandstone Member (Upper Jurassic, Kimmeridgian and Oxfordian(?))**—Consists of medium-gray, fine- to medium-grained arkosic sandstone and siltstone. Thin-bedded to massive; where bedded, is locally crossbedded. Stratigraphically equivalent to the Pomeroy Arkose Member (Jnp), the Indecision Creek Sandstone Member is exposed in the southern part of the map area on the Alaska Peninsula. Unit is abundantly fossiliferous; however, fossils are restricted almost exclusively to pelecypods of genus *Buchia*. Shallow-water shelf to inner neritic depositional environment (Detterman and others, 1996). Lower contact is conformable and slightly gradational with Snug Harbor Siltstone Member (Jnst). Upper contact is unconformity with overlying Late Cretaceous or Tertiary strata, except where conformably and gradationally overlain by Staniukovich Formation or, in Mount Katmai region, Katolinat Conglomerate Member (Detterman and others, 1996). Unit is most widely exposed member of Naknek Formation and occurs throughout Alaska Peninsula south of the map area. Fresh biotite and hornblende are minor but important components of sandstone, as they are interpreted to indicate first-cycle erosion from Alaska-Aleutian Range batholith

Jnst **Snug Harbor Siltstone Member (Upper Jurassic, Kimmeridgian and Oxfordian)**—Dominantly massive to thin-bedded, dark-gray to black siltstone; calcareous gray sandstone beds are minor part of the unit (Detterman and Hartsock, 1966). Hard, gray limestone concretions and lenses are locally abundant; rare thin layers of volcanic ash and tuff are found locally (Detterman and Hartsock, 1966). Deposited in moderately deep water, well below wave base and above carbonate compensation depth, in a basin having restricted circulation (Detterman and others, 1996). It is the lowest abundantly fossiliferous member of the Naknek Formation; most common fossils are *Buchia*, including *Buchia concentrica* and the ammonites *Amoeboceras*, *Phylloceras*, and *Perisphinctes*

Jnn **Northeast Creek Sandstone Member (Upper Jurassic, Oxfordian)**—Arkosic sandstone and graywacke. Called the "lower sandstone member" by Detterman and Hartsock (1966), they considered this unit to have only local significance. Later work on the Alaska Peninsula (Detterman and others, 1996) showed that the lateral equivalent of this unit, the Northeast Creek Sandstone Member, is present along the entire length of the Alaska Peninsula. The member is light-gray, thin-bedded to massive arkosic sandstone, graywacke, and siltstone. According to Detterman and Hartsock (1966), some beds have a tuffaceous matrix and zones of small pebbles, as well as thin beds of arenaceous siltstone. Fossils are most common in the lower part of this unit and include ammonites, particularly *Cardioceras*, but also include *Phyllocreas* and *Lytoceras*. Detterman and Hartsock (1966) assigned an uppermost Callovian and lower Oxfordian age to this unit based on the presence of *Cardioceras martini* in the lower part of the member and its association with *Cardioceras distans*, without which *Cardioceras martini* continues to the top of the member. Detterman and others (1996) assigned only an Oxfordian age to the unit. Pelecypods including *Pleuromya*, *Quenstedtia*, *Oxytoma*, *Thracia*, and *Astarte*, as well as gastropods, echinoids, and belemnites, are present but not common (Detterman and Hartsock, 1966). Lower contact intertongues with the Chisik Conglomerate Member. Contact with the overlying Snug Harbor Siltstone Member is gradational

Jnc **Chisik Conglomerate Member (Upper Jurassic, Oxfordian)**—Consists of massive to thick-bedded conglomerate and interbedded, crossbedded, quartzose sandstone. Clasts as large as 2 m are mainly granitic rocks, but as much as 20% metamorphic and volcanic rocks are present (Detterman and others, 1996). The unit is mainly restricted to the area adjacent to Iniskin Bay and Tuxedni Bay in the map area. A quartz diorite cobble yielded a protolith age of 156.6 Ma (Detterman and others, 1965; table 1 herein)

Chinitna Formation (Middle Jurassic, Callovian)—Massive, gray, arenaceous siltstone. Unit is best exposed along the west coast of Cook Inlet. Subdivided into two members: the upper Paveloff Siltstone Member and the lower Tonnie Siltstone Member (Detterman and Hartsock, 1966). Unit is a partial age equivalent of the Shelikof Formation of the Alaska Peninsula (Detterman and others, 1996). Subdivided into the following: Jcp and Jct

Jcp **Paveloff Siltstone Member**—Consists of massive, dark-gray, arenaceous siltstone in the upper part and a thick sandstone unit at its base (Detterman and Hartsock, 1966). Large ellipsoidal concretions and lenticular beds of limestone occur throughout the unit, and thin interbeds of sandstone occur in the siltstone. A few siltstone beds contain abundant finely disseminated pyrite, causing the beds to weather rusty brown. The siltstone is well indurated and the uppermost part is thin bedded and fractures into angular fragments. The graywacke sandstone of the lower unit is "thin bedded to massive, locally lenticularly bedded, fine to coarse grained, gray to greenish gray" (Detterman and Hartsock, 1966, p. 43). Limestone concretions and interbeds are common and, on fresh surfaces, are very dark gray but weather buff to cream colored. Locally the limestone is bioclastic (Detterman and Hartsock, 1966). Many nondiagnostic pelecypods and gastropods have been collected from the lower sandstone (Detterman and Hartsock, 1966), whereas higher in the section a wide variety of ammonites have been collected from the siltstone and limestone concretions. Many genera of ammonites, including *Cadoceras*, *Stenocadoceras*, *Pseudocadoceras*, *Kepplerites*, *Kheraiceras*, and *Lilloettia*, have been collected from the unit (Detterman and Hartsock, 1966), indicating a Callovian age, although the uppermost zone of the Callovian has not been identified. The Paveloff Siltstone Member is the age equivalent of the Shelikof Formation of the Alaska Peninsula; the Shelikof contains a higher proportion of coarse volcanic debris (Detterman and others, 1996)

Jct **Tonnie Siltstone Member**—Massive, dark-gray to brownish-gray, arenaceous siltstone, which weathers brownish gray to red brown (Detterman and Hartsock, 1966). Numerous small yellowish-brown-weathering limestone concretions occur in parallel bands and also randomly throughout the section. Thin, fine-grained, greenish-gray sandstone interbeds occur in the siltstone, and a more massive sandstone unit is found at the base of the section. The limestone concretions are generally ovoid and as much as 12–13 cm in diameter. They are extremely hard and commonly fossiliferous (Detterman and Hartsock, 1966). The sandstone interbeds are compositionally similar to the siltstone, just coarser grained. The thick (6–30 m) sandstone bed at the base of the unit is medium bedded to massive, fine to medium grained and grayish brown. On Chisik Island, a thick (65 m) channel conglomerate that consists mainly of volcanic rock cobbles and boulders is present at the base of the section. "The Chisik Island section also contains numerous thin beds of volcanic ash (Detterman and Hartsock, 1966, p. 41)." The Tonnie Siltstone is abundantly fossiliferous, containing many mollusks, particularly the ammonites *Paracadocreas*, *Pseudocadoceras*, *Phyllocreas*, *Lilloettia*, *Kheraiceras*, *Kepplerites*, and *Xenocephilites*. Also found are numerous pelecypods and rare belemnites, gastropods, and brachiopods (Detterman and Hartsock, 1966), all of which indicate an early Callovian age

Tuxedni Group (Middle Jurassic, Callovian to Bajocian)—Light- to dark-gray and green graywacke, conglomerate, siltstone, and shale (Detterman and Hartsock, 1966). Graywacke ranges from feldspathic to lithic; conglomerate is composed mainly of volcanic clasts in a graywacke matrix. Unit is subdivided into the Red Glacier

Formation, Gaikema Sandstone, Fitz Creek Siltstone, Cynthia Falls Sandstone, Twist Creek Siltstone, and Bowser Formation, whose descriptions below are derived from Detterman and Hartsock (1966): Jtb, Jtt, Jtc, Jtf, Jtg, and Jtrg

Jtb **Bowser Formation (Middle Jurassic, Callovian and Bathonian)**—Heterogeneous assemblage of sandstone, conglomerate, shale, and siltstone characterized by rapid facies changes (Detterman and Hartsock, 1966). Massive, light- to dark-gray sandstone and conglomerate are the dominant lithologic types on the Iniskin Peninsula. Sandstone and conglomerate matrix are coarse grained and composed of angular fragments of feldspar and quartz, having biotite, augite, and magnetite as common accessory minerals. Light-gray sandstones are interbedded with dark-gray sandstone and are commonly calcareous and contain numerous coquina beds composed almost entirely of pelecypods *Inoceramus* and *Trigonia*. Clasts in the conglomerate are dominantly felsic volcanic rocks and basalt but include about 10% granitic rocks. Siltstone as much as 100 m thick is interbedded with the conglomerate and sandstone. North of Chinitna Bay, siltstone occurs in beds as much as 250 m thick, where it forms the dominant lithology in the Bowser Formation. Siltstone is massive to thin bedded, medium to coarse grained, and dark brownish gray, weathering to light brown. Lenticular limestone concretions containing ammonites are common north of Chinitna Bay. Unit ranges in overall thickness from 380 to 560 m. Abundantly fossiliferous, containing ammonites and pelecypods, this formation can be divided into two faunal zones that occur on either side of the break between Callovian and Bathonian. Lower faunal zone immediately overlies the unconformity with Twist Creek Siltstone and contains Bathonian *Cranocephalites*, *Arctocephalites*, *Siemiradzkia*, *Cobbanites*, and *Parareineckia* ammonites. Upper faunal zone contains the Callovian ammonites, *Xenocephalites*, *Kheraiceras*, and *Kepplerites*

Jtt **Twist Creek Siltstone (Middle Jurassic, Bajocian)**—Soft, poorly consolidated, thin-bedded to massive siltstone and silty shale as much as 125 m thick (Detterman and Hartsock, 1966). Siltstone is dark gray, weathers to dark rusty brown, and contains many thin beds of volcanic ash that weathers bright orange. Small limestone concretions commonly fossiliferous and are common throughout the unit. An abundant ammonite fauna, restricted to the limestone concretions, includes *Oppelia* (*Liroxyites*), *Megasphaerceras*, *Leptoshinctes*, *Lissoceras*, and *Normannites* (*Dettermanites*)

Jtc **Cynthia Falls Sandstone (Middle Jurassic, Bajocian(?))**—Massive to thick-bedded graywacke sandstone and pebble conglomerate about 200 m thick (Detterman and Hartsock, 1966). Sandstone is medium to coarse grained and greenish gray to dark green, weathering mottled light gray due to zeolites, and has graded bedding. Sandstone consists mainly of angular fragments of feldspar and volcanic rocks in a compositionally similar silt-size matrix. Pebble conglomerate occurs in thin lenticular beds within the sandstone and is well sorted within individual beds. Clasts consist of “red and green felsitic volcanic rocks, aphanitic igneous rocks, and a few metasedimentary rocks that are primarily dark-gray quartzite” (Detterman and Hartsock, 1966, p. 32). Coarse-grained siltstone is interbedded with the sandstone and the siltstone may contain a few limestone concretions. Siltstone may make up 10–15% of the formation. Like the underlying Fitz Creek Siltstone and Gaikema Sandstone, the Cynthia Falls Sandstone is coarsest grained in the vicinity of Gaikema Creek (a small creek on the southwest side of Chinitna Bay) and finer grained away from this area. Fossils are relatively uncommon in this unit, thought in part due to rapid deposition in a nearshore environment; sparse fauna includes *Chondroceras* and *Stephanoceras* ammonites as well as *Inoceramus* sp. and *Mytilus* sp. pelecypods

Jtf **Fitz Creek Siltstone (Middle Jurassic, middle Bajocian)**—Thick sequence (as much as 400 m thick) of massive, bluish-dark-gray, arenaceous, coarse- to fine-grained siltstone that commonly weathers rusty orange and contains many small limestone concretions (Detterman and Hartsock, 1966). Interbedded, fine-grained sandstone and, locally, interbedded conglomerate. In the upper part of the unit the siltstone could possibly be called silty shale. Unit is coarsest in the vicinity of Gaikema Creek and rapidly becomes finer grained in all directions away from the Gaikema Creek section. Unit is abundantly fossiliferous and is the first unit of the Tuxedni Group where ammonites are more numerous than pelecypods. A few non-diagnostic brachiopods are also present. Ammonites include *Normannites*, *Teloceras*, and *Chondroceras* and many other genera; pelecypods include *Inoceramus* and *Pleuromya*, both forms distinctly different than lower part of the Tuxedni Group. The *Inoceramus* is specifically identified as *I. ambiguus* Eichwald, different from the common *Inoceramus* of the older rocks

Jtg **Gaikema Sandstone (Middle Jurassic, lower middle Bajocian)**—Resistant, cliff-forming, massive to thin-bedded graywacke sandstone and cobble conglomerate having graded bedding in 150- to 260-m-thick units (Detterman and Hartsock, 1966). Conglomerate is confined to the Iniskin Peninsula; clasts consist of “red and green felsitic volcanic rocks, aphanitic igneous rocks, and minor metasedimentary rocks” (Detterman and Hartsock, 1966, p. 26), all thought to be derived from the Talkeetna Formation. Rare granitic clasts are the first appearance in the Middle Jurassic of rocks presumably derived from the Alaska-Aleutian Range batholith. Siltstone constitutes generally less than 10% of the unit, mainly as thin interbeds in sandstone. Siltstone is thin-bedded to massive, generally coarse grained to sandy, gray to olive gray, and weathers brownish to rusty brown. Locally, siltstone can constitute as much as 40% of the formation, though it apparently is not found in close proximity to the conglomeratic parts of the formation. Fossiliferous throughout, unit contains pelecypods *Meleagrinella*, *Trigonia*, and *Inoceramus* and ammonites *Witchellia(?)*, *Stephanceras*, and, locally, *Sonninia* (*Papilliceras*), *Lissoceras*, and *Emileia*

Jtrg **Red Glacier Formation (Middle Jurassic, lower middle Bajocian to lower Bajocian)**—Thin-bedded to massive, red-brown, weathering dark-gray to moderate olive-gray siltstone is concentrated in the upper part of the unit and makes up about 40% of the Formation (Detterman and Hartsock, 1966). Siltstone is highly arenaceous and locally contains lenticular interbeds and concretions of reddish-gray, dense limestone and very minor coal seams. Underlying the siltstone is light-tan to buff arkosic sandstone making up about 25% of the unit; a thick, black, silty to arenaceous, very fissile shale constitutes the rest of the unit. Overall thickness ranges from 600 to 2,000 m. Unit is most abundantly fossiliferous in its upper parts; no fossils are known from the lower 600 m of the unit. Pelecypods include *Meleagrinella*, *Trigonia*, *Inoceramus*, *Camptonectes*, and *Pleuromya*. Ammonites occur in two distinct faunal assemblages. The lower assemblage includes *Erycites*, *Tmetoceras*, and *Pseudolioceras* and this faunal zone is 450 to 1,400 m below the top of the formation. The upper assemblage includes *Soninia*, *Emiliea*, and *Parabigottes* in the upper 400 m of the formation and includes *Papilliceras*, *Strigoceras*, *Lissoceras*, *Stephanoceras*, *Stemmatoceras*, and *Skirroceras* in the uppermost 150 m

Jtk **Talkeetna Formation, undivided (Lower Jurassic)**—Bedded volcanic rocks widely distributed in the Iliamna, Lake Clark, and Kenai quadrangles. Where undivided, unit consists of flows, breccia, tuff, and agglomerate and minor sandstone and shale, often somewhat hydrothermally altered or metamorphosed (Detterman and Hartsock, 1966; Detterman and Reed, 1980). In the map area, locally subdivided into three members: Horn Mountain Tuff (Jtkh), Portage Creek Agglomerate (Jtkp), and Marsh Creek Breccia (Jtkm) Members:

Jtkh **Horn Mountain Tuff Member**—Bedded tuff and tuffaceous feldspathic sandstone, locally containing porphyritic andesite flows. Bedded tuff occurs in thin-bedded to massive beds that are fine to coarse grained and tan, red, green, purple, or mottled (Detterman and Hartsock, 1966). Locally, tree stumps occur within the tuff beds, suggesting subaerial deposition. However, thin-bedded laminated units having graded bedding and containing rare belemnite fragments indicate some parts of unit are marine. Measured thickness is as much as 870 m (Detterman and Hartsock, 1966). Belemnites and plant fragments occur near the top of the unit; the fossils are not age diagnostic. In the Talkeetna Mountains, which is north of the map area, fossils in the upper part of the Talkeetna Formation, which is considered correlative to the rocks of the Horn Mountain Tuff Member, indicate a late Pliensbachian and Toarcian (Early Jurassic) age (Arthur Grantz, oral commun., 1963, cited in Detterman and Hartsock, 1966)

Jtkp **Portage Creek Agglomerate Member**—Reddish, fragmental volcanic debris, primarily rounded volcanic bomb-like fragments and lapilli tuff (Detterman and Hartsock, 1966). In contrast to the Marsh Creek Breccia Member, this unit grades northward to fine-grained tuff, clastic sedimentary rocks, and flows. Interbedded flows, tuff, and sedimentary rocks are thicker than in the underlying Marsh Creek Breccia Member, suggesting to Detterman and Hartsock (1966) a decrease in violent volcanism in the source area. These rocks are generally more felsic, although commonly described as andesitic (Detterman and Hartsock, 1966), than those of the Marsh Creek Member, and their distribution suggests a separate source (Detterman and Hartsock, 1966). Thickness estimated between 685 and 870 m; fossil control is unknown for this map unit

Jtkm **Marsh Creek Breccia Member**—Massive, dark-green to green volcanic breccia having a tuff matrix (Detterman and Hartsock, 1966). Consists of angular fragments of aphanitic, pink and green volcanic rocks ranging in size from 1 cm to nearly 1 m. Interbedded flows of andesite and basalt (Detterman and Reed, 1980), thought to be partly submarine (Detterman and Hartsock, 1966), are common and increase in abundance and thickness southward; coarse breccia decreases southward. This member has an estimated minimum overall thickness of 1,000 m; no complete section has been measured and the measured section is cut by faulting. No fossils are known from this unit in the map area and its inferred age is based on correlations with rocks in the Talkeetna Mountains type area

Ŧk **Kamishak Formation, undivided (Upper Triassic, Norian)**—Limestone, chert, porcellanite, and minor tuff divided by Detterman and Reed (1980) into three formal members, in descending order: Ursus Member, an unnamed middle member, and Bruin Limestone Member. Originally named the Kamishak Chert by Martin and Katz (1912) and renamed the Kamishak Formation by Kellum (1945, as cited in Detterman and Reed, 1980). Unit primarily found along west side of Cook Inlet, east of southern Alaska Range and northern Aleutian Range crest. Fossils found within the unnamed middle and Bruin Limestone members of the Kamishak Formation yield a Norian age (Detterman and Reed, 1980; C.D. Blome, U.S. Geological Survey, oral commun., 1981). As mapped, unit includes a small area of Triassic limestone and chert associated with the Chilikadrotna Greenstone in the central Lake Clark quadrangle. Cut by abundant dikes and sills related either to the Cottonwood Bay

Greenstone or the Talkeetna Formation. Locally subdivided into Ursus, middle, and Bruin Limestone Members: TRku, TRkm, and TRkb

TRku **Ursus Member**—Thin-bedded, light-gray limestone, locally dolomitic, minor interbedded gray chert and porcellanite, and minor tuff. Limestone is fine-grained biomicrite. Depositional environment was moderate to high-energy, shallow water

TRkm **Middle member**—Thin- to medium-bedded, dark-gray to black limestone and calcilutite, locally dolomitic, and minor black chert and gray tuff. Limestone is fine-grained microsparite. Calcite is locally altered to chert, suggesting a deep-basin environment

TRkb **Bruin Limestone Member**—Massive to thin-bedded, light- to dark-gray limestone; coral and echinoid bioherms, banded green and white chert. Environment was apparently high-energy, shallow water

TRsh **Gray shale and gray volcaniclastic sandstone (Triassic)**—Gray shale and gray volcaniclastic sandstone. Unit shown by Eakins and others (1978) in central Lake Clark quadrangle in close proximity to outcrops of the Chilikadrotna Greenstone. Originally thought to be of Silurian age on the basis of an erroneous fossil determination in associated limestone (R.B. Blodgett, unpub. data, 2004)

STRUCTURAL ASSEMBLAGES

JPk **Kakhonak and Tlikakila Complexes (Jurassic, Triassic, and Permian(?) or older(?))**—The Kakhonak Complex, defined by Detterman and Reed (1980), and the Tlikakila Complex, defined by Carlson and Wallace (1983), are lithologically diverse and complex assemblages of metamorphosed mafic plutonic, volcanic, and sedimentary rocks. Detterman and Reed (1980) described the unit as largely consisting of roof pendants within the Alaska-Aleutian Range batholith and suggested that the Kakhonak Complex represents, in part, the metamorphic equivalent of Upper Triassic and Lower Jurassic rocks of the vicinity. However, quartzite and quartz-mica schist occurring within the Kakhonak Complex have no direct equivalent within the sedimentary rocks of the vicinity, indicating other protoliths may have contributed to the complex. A possible Paleozoic age was not excluded by Detterman and Reed (1980), because Permian rocks were known from Puale Bay south of the map area. Internal contacts are typically faults, resulting in a tectonic mix of lithologies. The essentially equivalent Tlikakila Complex is lithologically similar. The Kakhonak Complex is defined from the southeastern part of the map area as roof pendants or closely associated with the batholith; whereas the Tlikakila Complex is exposed largely west of the batholith but still closely associated with it in the northern part of the map area. Although most of the rocks of these complexes are at greenschist facies, the rocks range from nonmetamorphosed to granulite facies. Age control on the protolith is limited in the Tlikakila Complex to Late Triassic megafossils and conodonts in the included limestone (Wallace and others, 1989), whereas no age control is known from the Kakhonak Complex. Bogar and others (2003) reported ^{40}Ar/^{39}Ar ages ranging from 176.3 to 178.2 Ma on biotite from metasedimentary rocks in the Tlikakila Complex indicating Middle Jurassic metamorphism, coeval with the emplacement of plutonic rocks of the Alaska-Aleutian Range batholith (see table 1). Detterman and Reed (1980) also mapped a migmatite unit on the east side of the Jurassic batholith at Bruin Bay; we have included the migmatite with unit JPk on the present map

IGNEOUS ROCKS

Qv **Volcanic rocks, undivided (Quaternary)**—Andesite, dacite, and basalt lava flows, volcanic breccia, lahar deposits, and debris-flow deposits. Includes air-fall tuff, volcanic dome deposits, block-and-ash-flow deposits, ash-flow tuffs, volcanic-rubble flows, debris flows, and hot-blast avalanche deposits. Lava flows and clasts in other volcanic deposits of unit are porphyritic, typically glassy, gray to black, and commonly vesicular. Andesite is dominant composition and probably constitutes 60% or more of rocks. Unit typically forms volcanic edifices. Rocks of this unit mapped at Augustine and Iliamna Volcanoes include Holocene rocks. Locally subdivided into volcanic rocks (Qhv), debris-flow deposits (Qdf), volcanic rubble and mudflows (Qmf), and andesite and dacite domes (Qamp):

Qhv **Volcanic rocks (Quaternary, Holocene)**—Andesite and basalt lava flows, and sills. These primarily extrusive rocks typically form the present-day edifices of Iliamna and Redoubt Volcanoes. They cap ridges and include massive lava flows, agglomerate, and lahar deposits, primarily associated with Redoubt Volcano and flows from Iliamna Volcano and associated satellite volcanic centers

Qdf **Debris-flow deposits (Quaternary, Holocene)**—Debris-flow deposits from Redoubt Volcano in the Crescent River valley. Includes several small (older?) deposits in the upper valley and a 3,500-year-old debris flow in the lower valley. The older deposits are multiple debris flows off the west and southwest flanks Redoubt Volcano. Oldest(?) deposit is derived from west flank of Redoubt. Next oldest deposit is probably derived from presently glaciated valley draining to the southwest off Redoubt. These deposits have relatively limited extent and may have dammed the North Fork of the Crescent River, creating a temporary lake in the valley. Deposits of the youngest, most extensive, and probably most fluid debris flow are derived from southwest flank of Redoubt Volcano. Flow was apparently derived from the only presently glacier free valley draining south from Redoubt. This debris flow has been dated at 3,500 yrs B.P. (Riehle and others, 1981), young enough to possibly explain lack of glaciers in the source valley, as all surrounding valleys have extensive glaciers and glacial deposits. This debris flow extends to coast of Cook Inlet and back-flowed up the main fork of the Crescent River, creating Crescent Lake. Map unit also includes an apparent debris-flow deposit in the upper Crescent River valley. These unusual deposits emanate from valley on east side of Crescent River valley. Source valley is along extension of northeast-trending normal fault having apparent Holocene movement. These deposits have not been examined on the ground and probably are non-volcanogenic

Qmf **Volcanic rubble and mudflows (Quaternary, Holocene)**—Volcanic rubble and mudflows on Augustine Volcano (Detterman and Reed, 1980), as well as mudflows in the Drift River valley draining Redoubt Volcano (Till and others, 1993). Deposits are Holocene and many are historic, including the 1963 mudflows on Augustine and the 1966 and later flows from Redoubt

Qamp **Andesite and dacite domes**—Composite dome complex of Double Glacier Volcano, consisting of medium-porphyritic to coarsely porphyritic hornblende andesite and dacite. Three K-Ar whole-rock ages were determined: two are considered minimum ages at 627 and 763 ka and one yielded 887 ka (table 1). Unit also includes the Johnson Glacier dome complex of Iliamna Volcano (Waythomas and Miller, 1999)

QTv **Volcanic rocks, undivided (Quaternary, Pleistocene, or Tertiary, Pliocene)**—Detterman and Reed (1980) mapped two eruptive centers within the Jurassic part of the Alaska-Aleutian Range batholith in the Iliamna quadrangle. Only one of the sites was briefly examined by Detterman and Reed (1980). Scoriaceous olivine basalt at Seven Sisters is thought to represent a volcanic neck and feeder-dike system. The second site, at West Glacier Creek, is thought to consist largely of andesitic tuff and breccia having a smooth to gently rounded topographic expression. No age control exists for either center. Detterman and Reed (1980) suggested the olivine basalt of the Seven Sisters is most closely related to the Intricate Basalt of possible Pliocene age, whereas the andesite(?) at West Glacier Creek seems more similar to Augustine and Iliamna Volcano products. Unit also includes basaltic andesite porphyry dikes and sills intruding the Jurassic sedimentary rocks between Chinitna and Iniskin Bays

Alaska-Aleutian Range batholith of Reed and Lanphere (1969)

Ti **Intrusive rocks, undivided (Tertiary)**—Generally consists of fine- to medium-grained granodiorite and quartz diorite, but also includes granite (Nelson and others, 1983). Typically surrounded by well-developed hornfels zones and sporadic hydrothermal alteration in country rocks; includes volcanic necks, sills, and dikes. Dikes, sills, and stock-like masses of felsic to mafic composition; includes a wide variety of granitic rocks in the Lake Clark quadrangle. These rocks and subdivisions are part of the Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972). Locally divided into the following units: Tig, Tpgr, Tign, Togd, Teg, Tipg, and Tigd

Tig **Granite and aplite (Tertiary, Oligocene(?) and younger)**—In the Lake Clark quadrangle (Nelson and others, 1983), unit includes a variety of granite bodies. Includes a multiphase, hypabyssal, leucocratic, grayish-pink biotite granite exposed north of the Lake Clark Fault system (Ti13, Nelson and others, 1983), a small pluton consisting of fractured biotite granite containing as much as 40% potassium-feldspar (Ti18, Nelson and others, 1983), and a light-gray, fine-grained xenomorphic granular aplite stock (Ti19, Nelson and others, 1983)

Tpgr **Peralkaline granite**—Mostly medium-grained, hypidiomorphic granular granite containing subhedral to euhedral perthite (Nelson and others, 1983). Only peralkaline granite that is associated with Alaska-Aleutian Range batholith and probably is not related to calc-alkaline rocks of the batholith. Unit may correlate with other peralkaline granite bodies in the Dillingham quadrangle (units TKgr and TKgs) that generally yielded 60–64 Ma ages

Tign **Gabbronorite**—Small, coarse-grained stock of hornblende and biotite-bearing olivine gabbronorite cutting Mesozoic sedimentary rocks (Nelson and others, 1983). According to Nelson and others, this pluton is most likely related to nearby Tertiary volcanic rocks

Togd **Granodiorite and quartz monzodiorite (Tertiary, Oligocene and late Eocene)**—A compositionally variable suite of medium-grained, slightly foliated rocks ranging from tonalite to monzodiorite, including quartz diorite and granodiorite (Detterman and Reed, 1980; Nelson and others, 1983). Also, heterogeneous, intensely sheared and locally altered, medium- to fine-grained rocks ranging from tonalite to monzodiorite, as well as medium-gray, medium-grained hypidiomorphic-granular biotite-hornblende granodiorite (Ti16, Nelson and others, 1983) that Reed and Lanphere (1972) had assigned to the Merrill Pass sequence, but, as a result of additional work, Nelson and others (1983) indicated this was no longer a proper assignment. K-Ar ages range from 31.9±0.9 to 39.6 Ma (table 1)

Teg **Granite (Tertiary, late Eocene)**—Largely granite, but includes lesser granodiorite and quartz monzodiorite phases (Nelson and others, 1983). Unit includes biotite granite, biotite-hornblende granite, and granodiorite in the northeastern part of the Lake Clark quadrangle. Unit becomes more heterogeneous to the south. Available K-Ar ages range from 34.6±1.3 to 41.9±1.3 Ma (table 1)

Tipg **Older granite (Tertiary, Paleocene)**—Medium-grained composite pluton of granite and granodiorite that forms west border of Alaska-Aleutian Range batholith from Little Lake Clark southwestward into the Iliamna quadrangle. Age inferred; however, a single K-Ar age (Reed and Lanphere, 1972; table 1 herein) yielded 43.9 Ma on biotite. The biotite was very low in potassium (Reed and Lanphere, 1972, sample 66Ale 23), possibly indicating alteration

Tigd **Granodiorite (Tertiary, Paleocene)**—Medium- to fine-grained, equigranular, hornblende-biotite granodiorite plutons, but ranges from granite to quartz monzodiorite (Nelson and others, 1983). Intrudes Jurassic and Cretaceous rocks of Alaska-Aleutian Range batholith. Concordant K-Ar ages of 61.0 and 62.8 Ma (Reed and Lanphere, 1969, 1972; Nelson and others, 1983; table 1 herein)

KJg **Mafic granitic rocks (Cretaceous and (or) Jurassic)**—Medium-gray, medium-grained, hypidiomorphic granular hornblende-biotite quartz monzodiorite containing variable amounts of clinopyroxene. Flow structures locally present and hornblende and plagioclase are aligned north-northeast. Two samples yielded strongly discordant K-Ar biotite and hornblende ages between 58.8 and 97.5 Ma (Nelson and others, 1983; table 1 herein). Part of the Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972)

Jtr **Trondhjemite (Late Jurassic)**—Medium- to coarse-grained, seriate, leucocratic trondhjemite containing 10% muscovite and about 5% interstitial, perthitic potassium feldspar. This is a large body in the central part of the batholith west of Chinitna Bay. A single K-Ar age on muscovite was 148 Ma (Reed and Lanphere, 1972; table 1 herein)

Jla **Lamprophyre and basalt dikes (Jurassic)**—Shown only locally in the join area between the Iliamna and Kenai quadrangles (Detterman and Hartsock, 1966); dikes intrude map unit Jqd

Jqm **Granodiorite and quartz monzonite (Jurassic)**—Whitish-gray, medium-grained, biotite granodiorite, minor hornblende, and accessory primary muscovite. Medium-grained, light-gray with a pinkish cast quartz monzonite, locally may include quartz diorite and trondhjemite. Unit is largely exposed only on the east margin of the Jurassic batholith. Detterman and Reed (1980) reported ages of 170±4.0 and 174±4.0 Ma (table 1 herein), which were replicates of a single sample

Jqd **Quartz diorite, tonalite, and diorite (Jurassic)**—Medium-grained quartz diorite and tonalite, which are locally foliated. This is by far the dominant map unit of the Alaska-Aleutian Range batholith. Hornblende is the dominant mafic mineral; biotite increases in proportion to the presence of quartz and potassium feldspar. Detterman and Reed (1980) reported that the rocks of this unit grade to diorite, but they did not observe it grading into granodiorite or quartz monzonite. Potassium-argon ages generally range from 146±4.3 to 183 Ma; a number of samples yielded younger ages, which were considered suspect or reset by younger plutonism (table 1). Two small exposures of gabbro and diorite in the Iliamna quadrangle included in unit

Jmu **Mafic and ultramafic plutonic rocks (Early Jurassic)**—Small areas of gabbro, hornblende gabbro, hornblendite, and pyroxenite in the Jurassic batholith of Detterman and Reed (1980). K-Ar ages of 160 and 183 Ma reported (Reed and Lanphere, 1972; table 1 herein)

Ꞧc **Cottonwood Bay and Chilikadrotna Greenstones (Triassic)**—Largely dark gray to dark green porphyritic to amygdaloidal basaltic flows altered to greenstone (Detterman and Reed, 1980; Nelson and others, 1983; Wallace and others, 1989). Locally includes andesite, chert, limestone, and tuffaceous sedimentary rock, all weakly metamorphosed. About 60% of unit is metabasalt. In the Iliamna quadrangle, the Cottonwood Bay Greenstone occurs either as roof pendants of or east of the Alaska-Aleutian Range batholith. In the Lake Clark quadrangle, the Chilikadrotna Greenstone occurs well west of the batholith. In the Dillingham quadrangle, an area of fine-grained, mildly altered basaltic volcanic rocks is included in this unit; however this is mainly based on an inferred lithologic correlation (Wallace and others, 1989). Basal beds of the Bruin Limestone Member of the Kamishak Formation contain volcanic rocks similar to the Cottonwood Bay Greenstone and, with this evidence, Detterman and Reed (1980) assigned a Late Triassic age to Cottonwood Bay Greenstone. As the Kamishak Formation is Norian, Detterman and Reed (1980) stated that the Cottonwood Bay Greenstone is probably older than Norian. Eakins and others (1978) described dark-gray limestone associated with the Chilikadrotna Greenstone. Originally, the fossils in this limestone were identified as Silurian (Eakins and others, 1978; Nelson and others, 1983); re-collection indicated the limestone was Triassic (Wallace and others, 1989); the limestone is shown as Kamishak Formation on this map

METAMORPHIC ROCKS

MzPzb **Metamorphosed mafic volcanic and sedimentary rocks (Mesozoic and (or) Paleozoic)**—Metamorphosed mafic volcanic rocks, phyllite, schist, quartzite, marble, calc-silicate rocks, serpentinite, gabbro, and chert

(Nelson and others, 1983). Mixed unit of varying affinity, protolith, and metamorphic age. Dominantly metamorphosed mafic volcanic rock that may be stratigraphically equivalent to the Chilikadrotna Greenstone or the Talkeetna Formation. Unit also includes nonmetamorphosed siltstone and sandstone near west margin of map unit, which Wallace and others (1989) assigned to their Koksetna River sequence. A K-Ar date on biotite from schist near the west margin of this unit yielded a date of 63.2±1.9 Ma (Wallace and others, 1989; table 1 herein). Wallace and others (1989) considered this schist to be the metamorphosed equivalent of their Koksetna River sequence; however, the abundance of metamorphosed mafic volcanic rocks indicates the significant inclusion of another protolith. Also includes biotite-feldspar-quartz schist; locally, actinolite-felspar-quartz schist or garnet-feldspar-quartz schist mapped by Eakins and others (1978) west of Lake Clark

IGNEOUS ROCKS, ALL PROVINCES

[Although many of the igneous rock units under this heading are primarily exposed in the Alaska-Aleutian Range province, representatives of each unit occur throughout the map area]

Tvu **Volcanic rocks, undivided (Tertiary)**—Andesite, basalt, and dacite lava flows, tuff, lahar deposits, volcanic breccia, and hypabyssal intrusions. Widely scattered throughout the map area; most apparent in the Lake Clark quadrangle, where they are a subdivision of unit Tvf of Nelson and others (1983). In part, mapped by air-photo correlation with areas of known volcanic rocks of unit Tv of Detterman and Reed (1980), having similar outcrop and erosion patterns. Locally subdivided into the following units: Tb, Tpg, and Tvr

Tb **Basaltic volcanic rocks (late Tertiary)**—Olivine basalt lava flows as much as 10 m thick and locally diabasic intrusive rocks in the northwest corner of the Taylor Mountains quadrangle. These columnar-jointed flows, which form a large tilted plateau, yielded K-Ar ages of 4.62±0.14 and 4.72±0.10 Ma (Reifenstuhl and others, 1985a; table 1, herein). Map unit also includes the Intricate Basalt of Detterman and Reed (1980), a glassy to porphyritic, black to dark-green olivine-augite basalt, largely in the vicinity of Intricate Bay, but also occurring south of Gibraltar Lake. In the Iliamna quadrangle (Detterman and Reed, 1980), unit includes mafic dikes not shown here. Detterman and Reed (1980) reported K-Ar ages of 4.4±0.5 and 5.1±1.0 Ma on an olivine basalt dike that cuts the Naknek Formation. An outcrop of olivine basalt at Kazik Hill in the northeast Taylor Mountains quadrangle is undated

Tpg **Gibraltar Lake Tuff (Tertiary, Pliocene(?) to Oligocene(?))**—Defined by Detterman and Reed (1980), unit is divided into a lower welded member and an upper nonwelded member. The upper member consists of light-gray to white, crystal ash-flow tuff having a maximum thickness of 152 to 182 m; locally capped by basalt flows of the Intricate Basalt. Lower member consists of light- to medium-gray and tan, rhyolitic, crystal and lithic welded tuff and is at least 300 m thick; locally, includes interbedded porphyritic rhyolite flows. Unit unconformably overlies older Tertiary basalt and andesite. Detterman and Reed (1980), on the basis of geomorphology and comparison with other Tertiary age units, suggested that the age was more likely Pliocene than Oligocene

Tvr **Felsic volcanic rocks**—Rhyolitic breccia, ash-flow tuff, flows, and intrusive rocks and subordinate mafic and intermediate flows. Unit is thought to encompass entire Tertiary and may include Jurassic rocks of the Talkeetna Formation. Much of this unit was included in map unit Tv of Nelson and others (1983), however, those rocks that we believe correspond in age with the Oligocene to Eocene Meshik Arc (Wilson, 1985) are included within map unit Tmv here. In the Dillingham quadrangle, unit Tvr includes the larger of scattered occurrences of felsic hypabyssal rocks, which occur as dikes and small plugs. In the Taylor Mountains quadrangle, includes felsic porphyritic rocks in the northwest corner and along the southeast margin

Tmv **Volcanic rocks, undivided (Tertiary, Oligocene and Eocene)**—Ranges from rhyolitic breccia, ash-flow tuff, and flows to dark-gray to green, coarse andesitic and basaltic volcanic rubble, lahar deposits, and glassy to porphyritic basaltic andesite and andesite lava flows. Includes minor volcaniclastic sedimentary rocks and hypabyssal felsic porphyry. As described by Detterman and Reed (1980), in many cases eruptive centers can be identified as volcanic necks of eroded volcanoes or as caldera complexes. Limited age determinations for the unit and subdivisions range from approximately 41 to 54 Ma; dates reported by Thrupp (1987) were 31.3±0.9 and 33.8±6.8 Ma (table 1). Inferred to represent the northern extension of the Meshik Arc of the Alaska Peninsula (Wilson, 1985). Most likely correlative, in part, with volcanic rock units Tmf and Tmba. As mapped in the Lake Clark quadrangle by Nelson and others (1983), unit Tmv may also include rocks of the Talkeetna Formation. Locally subdivided into the following units: Tmf and Tmba

Tmf **Tuffaceous felsic volcanic rocks**—Cream, light-gray, green, and purple, bedded, lithic-, crystal-, and vitric-tuff; light-gray to tan, welded crystal and lithic tuff most common (Detterman and Reed, 1980). Also includes distinctive light-colored horizons of felsic tuff interlayered with olivine basalt in the northeastern Dillingham quadrangle (Wilson and others, 2003) and is largely altered glass and very fresh phenocrysts of plagioclase in layers approximately 10 to 30 m thick. A ^{40}Ar/^{39}Ar age determination yielded 45.1±0.19 Ma (sample 01AWs 67B, table 1). A sample from this unit collected by J.H. Curran (U.S. Geological Survey) along the Alagnak River in the southern Dillingham quadrangle yielded a ^{40}Ar/^{39}Ar age of 41.62±0.18 Ma (sample AL00, table 1); both ages are consistent with the Meshik Arc (Wilson, 1985). However, these ages are not necessarily applicable to all the tuffs within this map unit

Tmba **Basalt and andesite**—Dark-gray to green, glassy to porphyritic basaltic andesite and andesite lava flows. Also includes andesite to basalt plugs, volcanic rubble, and breccia, including some agglomerate; may include deposits of lahars (Detterman and Reed, 1980). Includes two areas of massive, columnar-jointed olivine basalt flows in the northeastern Dillingham quadrangle (Wilson and others, 2003). The younger flows range from 3 to 10 m thick, interbedded with felsic tuff of map unit Tvf, and yield a ^{40}Ar/^{39}Ar age of 44.47±0.41 Ma (sample 01AWs 67, table 1). The older olivine basalt may, in part, be a sill because it is locally overlain by contact-metamorphosed rocks of unit KJvs; olivine basalt yields a ^{40}Ar/^{39}Ar isochron age of 53.71±0.61 Ma (sample 01AWs 55, table 1). Many of the rocks of this map unit are associated with eruptive centers. An isolated andesitic plug in northeastern Dillingham quadrangle yielded a ^{40}Ar/^{39}Ar isochron age of 47.95±1.39 Ma (sample 01AWs 49, table 1). Overall, unit ranges from 29.5±1.4 to 53.71±0.61 Ma

Tvig **Ignimbrite (Tertiary, Paleocene)**—Crystal tuff containing variable amounts of biotite and feldspar crystals in a tuffaceous matrix (Wilson and others, 2003). Unit is widespread in the Stuyahok Hills in the northeastern Dillingham quadrangle and varies in general appearance from crystal tuff to porphyritic plutonic rock. However, in all cases, the groundmass is tuff. The proportion of tuff seems to decrease east to west. Wallace and others (1989) reported K-Ar ages of 57.9±1.7 (hornblende) and 58.6±1.8 (biotite, table 1). New ^{40}Ar/^{39}Ar age determinations on biotite indicate a tight age range from 59.25±0.05 to 59.69±0.05 Ma (Iriondo and others, 2003; table 1 herein)

TKv **Volcanic rocks (Tertiary and (or) Cretaceous)**—Volcanic rocks including tuff, tuff breccia, and breccia. Age and compositional data are not available (Eakins and others, 1978; W.K. Wallace, written commun., 2002). Subdivided into the following units: TKr and TKb

TKr **Rhyolite and dacite flows, tuff, dikes, and sills**—Rhyolite and dacite flows and tuff cut by dikes or sills, which locally contain phenocrysts of sanidine and high-temperature quartz. These rocks primarily occur in the valley of the Mulchatna River in the Lake Clark quadrangle and are spatially associated with rocks of the Koksetna River sequence of Wallace and others (1989). An additional area of exposure is in the northeastern Dillingham quadrangle, where unit consists of porphyritic, quartz-eye and feldspar phenocrystic felsic rocks that are variably hydrothermally altered (Wilson and others, 2003). In general, unit appears to represent the roof area of plutons of the immediate area. Only the larger of scattered occurrences of felsic hypabyssal rocks are shown on the map. Eakins and others (1978) reported two K-Ar dates: 59.5±1.8 Ma on biotite from dacite and 62.7±1.9 Ma on biotite from andesite included within a dacite map unit (their unit TKd)

TKb **Basalt flows**—Scattered occurrences west of Lake Clark. No further lithologic description available (Eakins and others, 1978). Thrupp (1987) reported two K-Ar dates from this map unit, both whole-rock K-Ar determinations: 44.4±1.7 and 65.8±13.2 Ma (table 1, herein). Eakins and others (1978) indicated 56.2±1.7 Ma on rocks mapped within this unit but described the rock as “hornblende-biotite granodiorite,” which suggests either a map or sample location error

TKg **Granitic rocks, undivided (Tertiary and (or) Cretaceous)**—Fine-, medium- and coarse-grained, light- to dark-gray, rarely pink, granitic rocks widely present west of the southern Alaska Range and northern Aleutian Range crest. Chiefly granite, quartz monzonite, and quartz monzodiorite; however, many of the individual plutons include a range of lithologies. Biotite and hornblende are locally common; muscovite is uncommon. Common in the western Dillingham quadrangle (Wilson, 1977) and many are unusual in that they tend to have biotite and pyroxene, often orthopyroxene, as their mafic minerals, regardless of the overall pluton composition (see Wilson, 1977). Unit also includes fine-, medium-, and coarse-grained, light- to dark-gray, plutonic granitic rocks mixed with felsic dikes and contact metamorphosed volcanic or sedimentary rocks in the northeastern Dillingham quadrangle. In the northeastern Dillingham quadrangle, alkali content (F.H. Wilson, unpub. data, 2003) is high relative to normal for their SiO_2 content (LeMaitre, 1976). Throughout the map area, K-Ar and ^{40}Ar/^{39}Ar ages range from 54 to 72.5 Ma (table 1). Subdivided into the following units: TKgr, TKgs, TKqm, TKgd, and TKqd

TKgr **Granite and alaskite**—Ranges from very leucocratic alaskite to highly potassic, peralkaline monzogranite; widely distributed in the map area. In the Dillingham quadrangle, Wilson and others (2003) mapped a large (7 km in diameter) coarse- to fine-grained, white to off-white alaskite (alkali-feldspar granite) consisting of white feldspar and smoky quartz. Mafic minerals and mica are exceedingly sparse in this alaskite body; where present, biotite appears to be late or secondary, rare sodic amphibole, which is locally cyan-blue pleochroic. Smoky quartz and pegmatitic zones are common throughout unit. SiO_2 content is high, ranging from 74.8 to 75.4%.

Also, a large medium- to coarse-grained, light-gray to pinkish biotite monzogranite is exposed in the eastern part of the Dillingham quadrangle. It contains large (2 cm) phenocrysts of potassium feldspar (orthoclase), with biotite as the dominant mafic mineral; the biotite to hornblende ratio is approximately 3:1. Based on multiple chemical analyses (F.H. Wilson, unpub. data, 2006), rocks of this pluton cluster about the intersection of the quartz monzonite, monzogranite, granodiorite, and quartz monzodiorite fields of Streckeisen (1975); however, visually estimated modes place the rock unit primarily in the monzogranite field. The Tikchik Lake and Akuluktuk plutons of Wilson (1977) are also assigned to this map unit. Another relatively large granite pluton is exposed in the central Lake Clark quadrangle; biotite and hornblende are in sub-equal proportions (Nelson and others, 1983). Other granite bodies are widely scattered in the Dillingham and Taylor Mountains quadrangles. Available K-Ar and ^{40}Ar/^{39}Ar ages for this unit range from a minimum age on hornblende of 54.5±1.6 Ma (Wallace and others, 1989; table 1 herein) to 69.6±2.1 on a discordant biotite (74 B 57, Hoare and Coonrad, 1978; table 1 herein)

TKgs **Syenitic rocks**—Medium-grained biotite monzogranite to syenogranite found in the mountains immediately south of the Koktuli River (Wilson and others, 2003). Biotite is the only mafic mineral and orthoclase has moderate development of string perthite. SiO$_2$ of analyzed samples has a narrow range of 65.5–65.7% and relatively high K$_2$O (>4.80%; F.H. Wilson, unpub. data, 2003). ^{40}Ar/^{39}Ar ages range from 65.50±0.05 to 66.24±0.08 Ma on biotite (Iriondo and others, 2003; table 1 herein). Rocks of syenitic affinity are restricted largely to the northern Dillingham and southern Taylor Mountains quadrangles. The largest representative of this map unit is the so-called “northern pluton” of Wilson and others (2003)

TKqm **Quartz monzonite and quartz monzodiorite**—Medium- to coarse-grained, light-gray monzogranite or quartz monzodiorite, may contain biotite, hornblende, sodic amphibole, and (or) clinopyroxene and orthopyroxene. Locally contains large phenocrysts of orthoclase; biotite to hornblende ratio is variable but generally sub-equal although a few plutons do not contain biotite. Locally there is minor development of string perthite texture in orthoclase. These plutons are the most common of the Tertiary and (or) Cretaceous plutons of the map area, occurring in the Lake Clark, Taylor Mountains, and Dillingham quadrangles. K-Ar and ^{40}Ar/^{39}Ar ages range from 60.5±1.8 to 71.3±2.1 Ma (table 1)

TKgd **Granodiorite**—Medium-grained, hypidiomorphic granular, seriate granodiorite. Biotite tends to more abundant than hornblende. Common in the Lake Clark and Kenai quadrangles (Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976). K-Ar ages range from 65.1±1.9 to 70.5±2.0 Ma (table 1)

TKqd **Monzodiorite and quartz diorite**—Largely fine to medium grained monzodioritic and dioritic rocks, but locally includes diorite and gabbro. Rocks typically have sparse biotite and abundant amphibole and clinopyroxene, and locally show evidence of contact metamorphism. Generally located in the central Lake Clark quadrangle and northeastern Dillingham quadrangle. A 64.42±0.04 Ma ^{40}Ar/^{39}Ar age was determined on biotite from a pluton in the Dillingham quadrangle (Iriondo and others, 2003; table 1 herein), whereas a 69.4±2.1 Ma K-Ar age on hornblende was determined on a pluton in the Lake Clark quadrangle (Eakins and others, 1978; table 1 herein). One of the plutons included in this unit, which crops out near Upper Tazimina Lake in the Lake Clark quadrangle, may be as old as Jurassic (map unit TKi1 of Nelson and others, 1983)

Kg **Plutonic rocks, undivided (Cretaceous)**—No description available beyond granodiorite, quartz diorite, and diorite (Magoon and others, 1976; Reed and others, 1992), but assumed to include representatives of the Cretaceous granitic rocks described below. Primarily located in the northeastern part of the map area, east of the Lake Clark Fault, these rocks were mapped as Tertiary or Cretaceous by Magoon and others (1976). Based on K-Ar dates ranging from 67.2±1.9 to 74.4±2.2 Ma (Reed and Lanphere, 1972; table 1 herein), rocks are shown as Cretaceous. Subdivided into the following units: Kqms, Klgd, Kgr, Kgd, and Kqd

Kqms **Quartz monzonite and syenite (Late Cretaceous)**—Massive, coarse-grained, light-gray porphyritic quartz monzonite (Detterman and Reed, 1980; Nelson and others, 1983). Includes plutons in the Iliamna and Lake Clark quadrangles and the pluton of the Okstukuk Hills in the Dillingham quadrangle (Wilson, 1977), which consists of biotite granite or syenite having very coarse feldspar laths, medium-grained very fresh biotite, and fine-grained clinopyroxene. K-Ar ages range from 75.6 to 85.5 Ma (Reed and Lanphere, 1972; table 1 herein) and a ^{40}Ar/^{39}Ar age on biotite yielded 84.49±0.05 Ma in the Okstukuk Hills (Iriondo and others, 2003; table 1 herein)

Klgd **Granodiorite (Late Cretaceous)**—Isolated porphyritic granodiorite body having phenocrysts of quartz, plagioclase, biotite, and glomeroporphyritic clusters of pale-green amphibole in a groundmass of quartz and mostly potassic feldspar in the south-central Lake Clark quadrangle (Nelson and others, 1983) and a small granodiorite pluton in the eastern Taylor Mountains quadrangle (F.H. Wilson, unpub. data, 2001). Reported K-Ar age for the Lake Clark pluton on biotite is “Late Cretaceous” (Nelson and others, 1983); a ^{40}Ar/^{39}Ar age on hornblende from the Taylor Mountains pluton is 75.22±0.32 Ma (Iriondo and others, 2003; table 1 herein)

Kgr **Granite**—Coarse-grained, light-pink, biotite granite (Detterman and Reed, 1980; Nelson and others, 1983). Exposed on the south margin of the Lake Clark quadrangle and northern Iliamna quadrangle. No age control available

Kgd **Granodiorite**—Granodiorite and quartz monzodiorite bodies mapped by Nelson and others (1983) in the eastern Lake Clark quadrangle, as well as plutons surrounding the Pebble Copper deposit approximately 25 km northwest of Iliamna (Bouley and others, 1995). The rocks are medium- to coarse-grained, light- to medium-gray, contain hornblende and biotite and rarely muscovite and locally have cataclastic textures. Although mapped as separate plutons by Nelson and others (1983), a number of the plutons are thought to be fault-offset extensions of each other. Age control shows a wide range of K-Ar ages, ranging from discordant biotite and hornblende yielding 63.1±1.8 and 69.0±2.0 Ma on one sample (Reed and Lanphere, 1972; table 1 herein) to 99.8±5.0 Ma on potassium feldspar (Bouley and others, 1995; table 1 herein). Bouley and others also report 89.2±0.2 Ma on zircon from a tonalite. One of the plutons (Ki13 of Nelson and others, 1983) intrudes rocks of apparent Late Cretaceous age

Kqd **Quartz diorite, tonalite, and diorite**—Locally foliated, largely medium-grained hornblende-biotite quartz diorite, but includes hornblende-pyroxene gabbro and diorite, quartz diorite, tonalite, and minor granodiorite (Nelson and others, 1983). Occurs only in the Lake Clark quadrangle. Reed and Lanphere (1972) reported a K-Ar age on one pluton as 65.6±1.8 Ma on biotite and 68.7±2.0 Ma on hornblende (table 1)

Mzmi **Mafic igneous rocks (Mesozoic(?))**—Predominantly diabase, probably intrusive. Isolated outcrops in the north-central Dillingham quadrangle. Intrudes rocks provisionally assigned to map unit KTRag, suggesting age may be Triassic or younger. Farther northeast in the quadrangle, volcanic rock outcrops were inferred to be Triassic by Wallace and others (1989); in neither case does true age control exist. To the west, the buried mafic and ultramafic rocks of the Kemuk prospect (ARDF record DI003, Hudson, 2001) have been dated by ^{40}Ar/^{39}Ar at 86.05±0.08 Ma on biotite (Iriondo and others, 2003; table 1 herein)

References Cited

Babcock, L.E., and Blodgett, R.B., 1992, Biogeographic and paleogeographic significance of Middle Cambrian trilobites of Siberian aspect from southwestern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 4.

Babcock, L.E., Blodgett, R.B., and St. John, James, 1993, Proterozoic and Cambrian stratigraphy and paleontology of the Nixon Fork terrane, southwestern Alaska: Guanajuato, Mexico, Proceedings of the First Circum-Pacific and Circum-Atlantic Terrane Conference, November 5–22, 1993, p. 5–7.

Babcock, L.E., Blodgett, R.B., and St. John, James, 1994, New late(?) Proterozoic age formations in the vicinity of Lone Mountain, McGrath quadrangle, west-central Alaska, *in* Till, A.B. and Moore, T.E., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1993: U.S. Geological Survey Bulletin 2107, p. 143–155.

Beikman, H.M., 1980, Geology of Alaska: U.S. Geological Survey, scale 1:2,500,000.

Berry, A.L., Dalrymple, G.B., Lanphere, M.A., Von Essen, J.C., and others, eds., 1976, Summary of miscellaneous potassium-argon age measurements, U.S. Geological Survey, Menlo Park, Calif., for the years 1972–74: U.S. Geological Survey Circular 727, 13 p.

Blodgett, R.B., 1998, Emsian (late Early Devonian) fossils indicate a Siberian origin for the Farewell terrane, *in* Clough, J.G., and Larson, F., eds., Short notes on Alaskan geology 1997: Alaska Division of Geological and Geophysical Surveys Professional Report 118, p. 53–61.

Blodgett, R.B., and Clough, J.G., 1985, The Nixon Fork terrane; part of an in place peninsular extension of the North American Paleozoic continent [abs.]: Geological Society of America Abstracts with Programs, v. 17, p. 342.

Blodgett, R.B., Clough, J.G., and Sandy, M.R., 2002, Biogeographic and stratigraphic evidence for the Siberian origins of the Arctic Alaska Plate [abs.]: American Association of Petroleum Geologists Bulletin, v. 86, no. 6, p. 1137.

Blodgett, R.B., Sullivan, Ray, Clough, J.G., and LePain, D.L., 1999, Paleozoic paleontology of the Holitna Lowland, southwest Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 31, no. 6, p. A–39.

Blodgett, R.B, and Wilson, F.H., 2001, Reconnaissance geology north of the Hoholitna River, Taylor Mountains D–1 1:63,360-scale quadrangle, southwestern Alaska, *in* Gough, L.P., and Wilson, F.H., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1999: U.S. Geological Survey Professional Paper 1633, p. 73–82.

Blodgett, R.B., Wilson, F.H., Stanley, G.D., Jr., McRoberts, C.A., and Sandy, M.R., 2000, Upper Triassic stratigraphy and fauna of the Taylor Mountains D–2 and D–3 quadrangles (SW part of the Farewell terrane), southwest Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 32, no. 6, p. A–4.

Bogar, M.J., Amato, J.M., Farmer, G.L., and McIntosh, W.C., 2003, The origin and metamorphism of the Tlikakila Complex, Lake Clark National Park, Alaska—Implications for the collision of the Talkeetna Arc/Peninsular terrane with Alaska during the Middle Jurassic [abs.]: Geological Society of America Abstracts with Programs, v. 35, no. 4, p. 69.

Bouley, B.A., St. George, Phil, and Wetherbee, P.K., 1995, Geology and discovery at Pebble Copper, a copper-gold porphyry system in southwest Alaska, *in* Porphyry deposits of the northwest Cordillera of North America: Canadian

Institute of Mining, Metallurgy, and Petroleum Special Volume 46, p. 422–435.

Box, S.E., 1985, Mesozoic tectonic evolution of the northern Bristol Bay region, southwestern Alaska: Santa Cruz, University of California, Ph.D. dissertation, 163 p., 2 pls., 21 figs.

Box, S.E., and Elder, W.P., 1992, Depositional and biostratigraphic framework of the Upper Cretaceous Kuskokwim Group, southwestern Alaska, *in* Bradley, D.C., and Ford, A.B., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1990: U.S. Geological Survey Professional Paper 1999, p. 8–16.

Box, S.E., Moll-Stalcup, E.J., Frost, T.P., and Murphy, J.M., 1993, Preliminary geologic map of the Bethel and southern Russian Mission quadrangles, southwestern Alaska: U.S. Geological Survey Miscellaneous Field Studies Map 2226–A, scale 1:250,000.

Bradley, D.C., Kusky, T.M., Haeussler, P.J., Karl, S.M., and Donley, D.T., 1999, Geologic map of the Seldovia quadrangle, south-central Alaska: U.S. Geological Survey Open-File Report 99–18, scale 1:250,000, http://geopubs.wr.usgs.gov/open-file/of 99-18/.

Burleigh, R.E., 1991, Evaluation of the tin-tungsten greisen mineralization and associated granite at Sleitat Mountain, southwestern Alaska: U.S. Bureau of Mines Open-File Report 35–91, 41 p.

Cady, W.M., Wallace, R.E., Hoare, J.M., and Webber, E.J., 1955, The central Kuskokwim region, Alaska: U.S. Geological Survey Professional Paper 268, 132 p., 9 plates including 1 map, scale about 1:500,000.

Calderwood, K.W., and Fackler, W.C., 1972, Proposed stratigraphic nomenclature for Kenai Group, Cook Inlet basin, Alaska: American Association of Petroleum Geologists Bulletin, v. 56, no. 4, p. 739–754.

Carlson, Christine, and Wallace, W.K., 1983, The Tlikakila Complex, a disrupted terrane in the southwestern Alaska Range [abs.]: Geological Society of America Abstracts with Programs 1983, v. 15, no. 5, p. 406.

Case, J.E., and Nelson, W.H., 1986, Maps showing aeromagnetic survey and geologic interpretation of the Lake Clark quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map 1114–E, 2 plates.

Chapman, R.M., and Patton, W.W., Jr., 1979, Two upper Paleozoic rock units identified in the southwestern part of the Ruby quadrangle, *in* Johnson, K.M., and Williams, J.R., eds., The United States Geological Survey in Alaska—Accomplishments during 1978: U.S. Geological Survey Circular 804–B, p. B59–B61.

Clark, A.L., Condon, W.H., Hoare, J.M., and Sorg, D.H., 1970a, Analyses of rock and stream-sediment samples from the Taylor Mountains A–6 and the southern part of Taylor Mountains B–6 quadrangles, Alaska: U.S. Geological Survey Open-File Report 70–78, 94 p., 1 sheet, scale 1:63,360.

Clark, A.L., Condon, W.H., Hoare, J.M., and Sorg, D.H., 1970b, Analyses of rock and stream-sediment samples from the northern part of the Taylor Mountains B–6 quadrangle, Alaska: U.S. Geological Survey Open-File Report 70–79, 89 p., 1 sheet, scale 1:63,360.

Clark, A.L., Condon, W.H., Hoare, J.M., and Sorg, D.H., 1970c, Analyses of rock and stream-sediment samples from the Taylor Mountains C–8 quadrangle, Alaska: U.S. Geological Survey Open-File Report 70–80, 110 p., 1 sheet, scale 1:63,360.

Clark, A.L., Condon, W.H., Hoare, J.M., and Sorg, D.H., 1971, Analyses of stream-sediment samples from the Taylor Mountains D–8 quadrangle, Alaska: U.S. Geological Survey Open-File Report 71–68, 60 p., 1 sheet, scale 1:63,360.

Coats, R.R., 1950, Volcanic activity in the Aleutian Arc, *in* Contributions to general geology: U.S. Geological Survey Bulletin 974–B, p. 35–47, 1 plate.

Decker, John, Bergman, S.C., Blodgett, R.B., Box, S.E., Bundtzen, T.K., Clough, J.G., Coonrad, W.L., Gilbert, W.G., Miller, M.L., Murphy, J.M., Robinson, M.S., and Wallace, W.K., 1994, Geology of southwestern Alaska, *in* Plafker, George, and Berg, H.C., eds., The geology of Alaska: Boulder, Colo., Geological Society of America, The geology of North America, v. G–1, p. 285–310.

Decker, John, Reifenstuhl, R.R., and Coonrad, W.L., 1985, Compilation of geologic data from the Taylor Mountains D–7 quadrangle, southwestern Alaska: Alaska Department of Geological and Geophysical Surveys Report of Investigations 85–3, scale 1:63,360, 1 sheet.

Decker, J.E., Reifenstuhl, R.R., Robinson, M.S., Waythomas, C.F., and Clough, J.G., 1995, Geology of the Sleetmute A–5, A–6, B–5, and B–6 quadrangles, southwestern Alaska: Alaska Division of Geological and Geophysical Surveys, Professional Report 99, 16 p., 2 oversize sheets, map scale 1:63,360.

Detterman, R.L., and Hartsock, J.K., 1966, Geology of the Iniskin-Tuxedni region, Alaska: U.S. Geological Survey Professional Paper 512, 78 p., 6 plates.

Detterman, R.L., Hudson, Travis, Plafker, George, Tysdal, R.G., and Hoare, J.M., 1976, Reconnaissance geologic map along Bruin Bay and Lake Clark Faults in Kenai and Tyonek quadrangles, Alaska: U.S. Geological Survey Open-File Report 76–477, scale 1:250,000.

Detterman, R.L., Miller, J.W., Case, J.E., Wilson, F.H., and Yount, M.E., 1996, Stratigraphic framework of the Alaska Peninsula: U.S. Geological Survey Bulletin 1969–A, 74 p.

Detterman, R.L., and Reed, B.L., 1973, Surficial deposits of the Iliamna quadrangle, Alaska: U.S. Geological Survey Bulletin 1368–A, 64 p., 1 sheet, scale 1:250,000.

Detterman, R.L., and Reed, B.L., 1980, Stratigraphy, structure, and economic geology of the Iliamna quadrangle, Alaska: U.S. Geological Survey Bulletin 1368–B, 86 p., 1 sheet, scale 1:250,000.

Detterman, R.L., Reed, B.L., and Lanphere, M.A., 1965, Jurassic plutonism in the Cook Inlet region, Alaska: U.S. Geological Survey Professional Paper 525–D, p. D16–D21.

Dumoulin, J.A., Harris, A.G., Gagiev, Mussa, Bradley, D.C., and Repetski, J.E., 2002, Lithostratigraphic, conodont, and other faunal links between lower Paleozoic strata in northern and central Alaska and northeastern Russia, *in* Miller, E.L., Grantz, Arthur, and Klemperer, S.L., eds., Tectonic evolution of the Bering Shelf-Chukchi Sea-Arctic margin and adjacent landmasses: Geological Society of America Special Paper 360, p. 291–312.

Dutro, J.T., Jr., and Patton, W.W., Jr., 1982, New Paleozoic formations in the northern Kuskokwim Mountains, west-central Alaska: U.S. Geological Survey Bulletin 1529–H, p. H13–H22.

Eakins, G.R., Gilbert, W.G., and Bundtzen, T.K., 1978, Preliminary bedrock geology and mineral resource potential of west-central Lake Clark quadrangle, Alaska: Alaska Division of Geological and Geophysical Surveys Open-File Report 118, 15 p., 2 sheets, scale 1:125,000.

Elder, W.P., and Box, S.E., 1992, Late Cretaceous Inoceramid bivalves of the Kuskokwim basin, southwestern Alaska, and their implications on basin evolution: The Paleontological Society Memoir 26, 39 p.

Fritschen, M.M., 1995, Quaternary glacier fluctuations in the Chigmit Mountains, Alaska: University of Alaska Fairbanks, M.S. thesis, 98 p.

Gilbert, W.G., 1981, Preliminary geologic map and geochemical data, Cheeneetnuk River area, Alaska: Alaska Division of Geological and Geophysical Surveys Open-File Report 153, 10 p., 2 sheets, scale 1:63,360.

Haeussler, P.J., and Saltus, R.W., 2005, 26 km of offset on the Lake Clark Fault since late Eocene time, *in* Haeussler, P.J., and Galloway, J.P., eds., Studies by the U.S. Geological Survey in Alaska, 2004: U.S. Geological Survey Professional Paper 1709–A, 4 p.

Hoare, J.M., and Coonrad, W.L., 1959a, Geology of the Bethel quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I–285, scale 1:250,000.

Hoare, J.M., and Coonrad, W.L., 1959b, Geology of the Russian Mission quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Series Map I–292, scale 1:250,000.

Hoare, J.M., and Coonrad, W.L., 1961, Geologic map of Goodnews quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I–339, scale 1:250,000. [Quadrangle subsequently renamed Goodnews Bay]

Hoare, J.M, and Coonrad, W.L, 1978, Geologic map of the Goodnews and Hagemeister Island quadrangles region, southwestern Alaska: U.S. Geological Survey Open-File Report 78–9–B, scale 1:250,000, 2 sheets.

Hoare, J.M., Coonrad, W.L., Detterman, R.L., and Jones, D.L., 1975, Preliminary geologic map of the Goodnews A–3 quadrangle and parts of the A–2 and B–2 quadrangles, Alaska: U.S. Geological Survey Open-File Report 75–308, 16 p.

Hoare, J.M., and Jones, D.L., 1981, Lower Paleozoic radiolarian chert and associated rocks in the Tikchik Lakes area, southwestern Alaska, *in* Albert, N.R.D., and Hudson, Travis, eds., The U.S. Geological Survey in Alaska—Accomplishments during 1979: U.S. Geological Survey Circular 823–B, p. 44–45.

Hudson, Travis, 2001, Alaska resource data file, Dillingham quadrangle: U.S. Geological Survey Open-File Report 01–192, 24 p., http://ardf.wr.usgs.gov/ardf_data/Dillingham.pdf.

Iriondo, Alexander, Kunk, M.J., and Wilson, F.H., 2003, ^{40}Ar/^{39}Ar geochronology of igneous rocks in the Taylor Mountains and Dillingham quadrangles in southwest Alaska: U.S. Geological Survey Open-File Report 03–421, 32 p.

Jones, D.L., Silberling, N.J., and Hillhouse, John, 1977, Wrangellia—A displaced terrane in northwestern North America: Canadian Journal of Earth Sciences, v. 14, no. 11, p. 2565–2577.

Kellum, L.B., 1945, Jurassic stratigraphy of Alaska and petroleum exploration in northwestern America: New York Academy of Sciences Transactions, ser. 2, v. 7, no. 8, p. 201–209.

Kingsbury, S.A., 1998, Biogeography and paleogeographic implications of some upper Lower Cambrian–lower Middle Cambrian(?) trilobites from the Farewell terrane, southwestern Alaska: Columbus, Ohio State University, M.S. thesis, 52 p.

Kingsbury, S.A., and Babcock, L.E., 1998, Biogeography and paleogeographic implications of early Middle Cambrian trilobites and enigmatic fossils from the Farewell terrane, southwestern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 30, no. 2, p. 27.

Kingsbury, S.A., Babcock, L.E., and Blodgett, R.B., 2003, Cambrian trilobites of Siberian biogeographic aspect from southwestern Alaska—Implications for understanding the Provenance of the Farewell Terrane [abs.]: Geological Society of America Abstracts with Programs, v. 35, no. 4, p. 25.

Kirschner, C.E., and Lyon, C.A., 1973, Stratigraphic and tectonic development of Cook Inlet petroleum province, *in* Pitcher, M.G., ed., Arctic geology: American Association of Petroleum Geologists Memoir 19, p. 396–407.

LeMaitre, R.W., 1976, The chemical variability of some common igneous rocks: Journal of Petrology, v. 17, pt. 4, p. 589–637.

LePain, D.L., Blodgett, R.B., Clough, J.G., Ryherd, T.J., and Smith, T.N., 2000, Generalized stratigraphy and petroleum potential of the Holitna region, southwest Alaska: Alaska Division of Geological and Geophysical Surveys Preliminary Interpretive Report 2000–1, 34 p., 1 sheet, 1:250,000.

Magoon L.B., Adkison, W.L., and Egbert, R.M., 1976, Map showing geology, wildcat wells, Tertiary plant localities, K-Ar age dates, and petroleum operations, Cook Inlet area, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I–1019, scale 1:250,000, 3 sheets.

Magoon, L.B., and Egbert, R.M., 1986, Framework geology and sandstone composition, *in* Magoon, L.B., ed., Geologic studies of the Lower Cook Inlet COST No. 1 Well, Alaska Outer Continental Shelf: U.S. Geological Survey Bulletin 1596, p. 65–90.

Magoon, L.B., Griesbach, F.B., and Egbert, R.M., 1980, Nonmarine Upper Cretaceous rocks, Cook Inlet, Alaska: American Association of Petroleum Geologists Bulletin, v. 64, no. 8, p. 1259–1266.

Martin, G.C., and Katz, F.J., 1912, A geologic reconnaissance of the Iliamna region, Alaska: U.S. Geological Survey Bulletin 485, 138 p.

McRoberts, C.A., and Blodgett, R.B., 2002, Upper Triassic (Norian) mollusks from the Taylor Mountains quadrangle, southwest Alaska, *in* Wilson, F.H., and Galloway, J.P., eds., Geologic studies in Alaska by the U.S. Geological Survey, 2000: U.S. Geological Survey Professional Paper 1662, p. 55–75.

Mertie, J.B., Jr., 1938, The Nushagak District, Alaska: U.S. Geological Survey Bulletin 903, 96 p., 2 plates in pocket.

Miller, M.L., Bradley, Dwight, Bundtzen, T.K., Blodgett, R.B., Pessagno, E.A., Tucker, Robert,, and Harris, A.G, 2005, Age and provenance of the restricted Gemuk Group (Triassic to Lower Cretaceous), southwest Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 37, no. 7, p. 81.

Miller, M.L, and Bundtzen, T.K., 1994, Generalized geologic map of the Iditarod quadrangle, Alaska, showing potassium-argon, major-oxide, trace-element, fossil, paleocurrent, and archaeological sample localities: U.S. Geological Survey Miscellaneous Field Studies Map 2219–A, scale 1:250,000, 48 p.

Mohadjer, Solmaz, Wilson, F.H., and Saltus, R.W., 2006, Geologic and aeromagnetic views of the Mulchatna lineament of southwest Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 38, no. 5, p. 17.

Nelson, W.H., Carlson, Christine, and Case, J.E., 1983, Geologic map of the Lake Clark quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map 1114–A, scale 1:250,000.

Nicholson, S.W., Dicken, C.L., Horton, J.D., Labay, K.A., Foose, M.P., and Mueller, J.A.L., 2005, Preliminary integrated geologic map databases for the United States: Kentucky, Ohio, Tennessee, and West Virginia: U.S. Geological Survey Open-File Report 2005–1324, http://pubs.usgs.gov/of/2005/1324/.

Palmer, A.R., Egbert, R.M., Sullivan, R., and Knoth, J.S., 1985, Cambrian trilobites with Siberian affinities, southwestern Alaska [abs.]: American Association of Petroleum Geologists Bulletin, v. 69, p. 295.

Patton, W.W., Jr., Moll, E.J., Dutro, J.T., Jr., Silberman, M.L., and Chapman, R.M., 1980, Preliminary geologic map of the Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80–811A, 1 sheet, scale 1:250,000.

Patton, W.W., Jr., Wilson, F.H., Labay, K.A., and Shew, Nora, 2009, Geologic map of the Yukon-Koyukuk basin, Alaska: U.S. Geological Survey Scientific Investigations Map 2909, pamphlet 26 p., 2 sheets, scale 1:500,000.

Péwé, T.L., 1975, Quaternary geology of Alaska: U.S. Geological Survey Professional Paper 835, 145 p., 3 plates.

Plafker, George, Moore, J.C., and Winkler, G.R., 1994, Geology of the southern Alaska margin, *in* Plafker, George, and Berg, H.C., eds., The geology of Alaska: Boulder, Colo., Geological Society of America, The Geology of North America, v. G–1, p. 389–449.

Reed, B.L., and Lanphere, M.A., 1969, Age and chemistry of Mesozoic and Tertiary plutonic rocks in south-central Alaska: Geological Society of America Bulletin, v. 80, p. 23–44.

Reed, B.L., and Lanphere, M.A., 1972, Generalized geologic map of the Alaska-Aleutian Range batholith showing K/Ar ages of the plutonic rocks: U.S. Geological Survey Miscellaneous Field Studies Map 372, scale 1:1,000,000.

Reed B.L., and Lanphere, M.A., 1973, Alaska-Aleutian Range batholith—Geochronology, chemistry, and relation to circum-Pacific plutonism: Geological Society of America Bulletin, v. 84, p. 2583–2610.

Reed, B.L., Lanphere, M.A., and Miller, T.P., 1992, Double Glacier volcano, a ‘new’ Quaternary volcano in the eastern Aleutian volcanic arc: Bulletin of Volcanology, v. 54, p. 631–637.

Reifenstuhl, R.R., Decker, John, and Coonrad, W.L., 1985a, Compilation of geologic data from the Taylor Mountains D–8 quadrangle, southwestern Alaska: Alaska Department of Geological and Geophysical Surveys Report of Investigations 85–4, scale 1:63,360, 1 sheet.

Reifenstuhl, R.R., Decker, John, and Coonrad, W.L., 1985b, Compilation of geologic data from the Taylor Mountains D–4 quadrangle, southwestern Alaska: Alaska Department of Geological and Geophysical Surveys Report of Investigations 85–2, scale 1:63,360, 1 sheet.

Riehle, J.R., Kienle, Juergen, and Emmel, K.S., 1981, Lahars in Crescent River valley, lower Cook Inlet, Alaska: Alaska Division of Geological and Geophysical Surveys Geologic Report 53, 10 p.

Rigby, J.K., Nitecki, M.H., Soja, C.M., and Blodgett, R.B., 1994, Silurian aphrosalpingid sphinctozoans from Alaska and Russia: Acta Palaeontologica Polonica, v. 39, no. 4, p. 341–391.

Rombach, C.S., 2000, Genesis and mineralization of the Shotgun deposit, southwestern Alaska, *in* Tucker, T.L., and Smith, M.T., The Tintina gold belt—Concepts, exploration, and discoveries: Vancouver, B.C., Canada, British Columbia and Yukon Chamber of Mines, Special Volume 2, p. 181–196.

Sainsbury, C.L., and MacKevett, E.M., Jr., 1965, Quicksilver deposits of southwestern Alaska: U.S. Geological Survey Bulletin 1187, 89 p., 8 plates.

Saltus, R.W., and Milicevic, B., 2004, Preliminary grid data and maps for an aeromagnetic survey of the Taylor Mountains quadrangle and a portion of the Bethel quadrangle, Alaska: U.S. Geological Survey Open-File Report 2004–1293, 6 p., http://pubs.usgs.gov/of/2004/1293/.

St. John, J.M., 1994, Systematics and biogeography of some upper Middle Cambrian trilobites from the Holitna basin, southwestern Alaska: Columbus, Ohio State University, M.S. thesis, 90 p.

St. John, James, and Babcock, L.E., 1994, Biogeographic and paleogeographic implications of Middle Cambrian trilobites of extra-Laurentian aspect from a native terrane in southwestern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 26, no. 5, p. 63.

St. John, J.M., and Babcock, L.E., 1997, Late Middle Cambrian trilobites of Siberian aspect from the Farewell terrane, southwestern Alaska, *in* Dumoulin, J.A., and Gray, J.E., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1995: U.S. Geological Survey Professional Paper 1574, p. 269–281.

Spurr, J.E., 1900, A reconnaissance in southwestern Alaska in 1898: U.S. Geological Survey 20th Annual Report, pt. 7, p. 31–264.

Steiger, R.H., and Jager, E., 1977, Subcommission on geochronology—Convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359–362.

Stoeser, D.B., Green, G.N., Morath, L.C., Heran, W.D., Wilson, A.B., Moore, D.W., and Van Gosen, B.S., 2005, Preliminary integrated geologic map databases for the United States central states—Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas, and Louisiana: U.S. Geological Survey Open-File Report 2005–1351, http://pubs.usgs.gov/of/2005/1351/.

Streckeisen, A., 1975, To each plutonic rock its proper name: Earth-Science Reviews, v. 12, p. 1–33.

Till, A.B., Yount, M.E., and Riehle, J.R., 1993, Redoubt Volcano, southern Alaska—A hazard assessment based on eruptive activity through 1968: U.S. Geological Survey Bulletin 1996, 19 p., 1 plate, scale 1:125,000.

Thrupp, G.A., 1987, The paleomagnetism of Paleogene lava flows on the Alaska Peninsula, and the tectonics of southern Alaska: Santa Cruz, University of California, Ph.D. dissertation, p. 227–229.

U.S. Geological Survey, 2002, Aeromagnetic surveys in the Anchorage, Iliamna, and Tyonek quadrangles, Alaska; a website for the distribution of data: U.S. Geological Survey Open-File Report 02–0267, http://pubs.usgs.gov/of/2002/ofr-02-0267/.

Wallace, W.K., Hanks, C.L., and Rogers, J.F., 1989, The southern Kahiltna terrane—Implications for the tectonic evolution of southwestern Alaska: Geological Society of America Bulletin, v. 101, p. 1389–1407.

Waythomas, C.F., and Miller, T.P., 1999, Preliminary volcano-hazard assessment for Iliamna Volcano: U.S. Geological Survey Open-File Report 99–373, 31 p., 1 plate.

Wilson, F.H., 1977, Some plutonic rocks of southwestern Alaska, a data compilation: U.S. Geological Survey Open-File Report 77–501, 4 plates, 7 p.

Wilson, F.H., 1985, The Meshik arc—An Eocene to earliest Miocene magmatic arc on the Alaska Peninsula: Alaska Division of Geological and Geophysical Surveys Professional Report 88, 14 p.

Wilson, F.H., 2006, Ephemeral glacial lakes in southwestern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 38, no. 5, p. 30.

Wilson, F.H., and Coonrad, W.L., 2005, The Togiak-Tikchik Complex of southwest Alaska, a replacement for the Gemuk Group—Stratigraphic nomenclature that has outlived its time: U.S. Geological Survey Scientific Investigations Report 2005–5019, 12 p., http://pubs.usgs.gov/sir/2005/5019.

Wilson, F.H., Detterman, R.L., Case, J.E., 1985, The Alaska Peninsula terrane; a definition: U.S. Geological Survey Open-File Report 85–450, 17 p.

Wilson, F.H., Detterman, R.L., and DuBois, Gregory, 1999, Digital data for the geologic framework of the Alaska Peninsula, southwest Alaska, and the Alaska Peninsula terrane: U.S. Geological Survey Open-File Report 99–317, http://geopubs.wr.usgs.gov/open-file/of99-317/.

Wilson, F.H., Detterman, R.L., and DuBois, G.D., 2015, Geologic framework of the Alaska Peninsula: U.S. Geological Survey Bulletin 1969–B, scale 1:500,000, http://dx.doi.org/10.3133/b1969B.

Wilson, F.H., Dover, J.H., Bradley, D.C., Weber, F.R., Bundtzen, T.K., and Haeussler, P.J., 1998, Geologic map of central (interior) Alaska: U.S. Geological Survey Open-File Report 98–133, 3 sheets, scale 1:500,000, pamphlet 63 p., appendix 13 p.

Wilson, F.H., Hudson, T.L., Grybeck, Donald, Stoeser, D.B., Preller, C.C., Bickerstaff, Damon, Labay, Keith, and Miller, M.L., 2003, Preliminary geologic map of the northeast Dillingham quadrangle (D–1, D–2, C–1, and C–2), Alaska: U.S. Geological Survey Open-File Report 03–105, 13 p., scale 1:100,000, http://geopubs.wr.usgs.gov/open-file/of03-105/.

Wilson, F.H., Labay, K.A., Mohadjer, Solmaz, and Shew, Nora, 2005a, Digital data for the reconnaissance geologic map for the Kodiak Islands, Alaska: U.S. Geological Survey Open-File Report 2005–1340, http://pubs.usgs.gov/of/2005/1340/.

Wilson, F.H., Labay, K.A., Shew, Nora, and Mohadjer, Solmaz, 2005b, Digital data for the reconnaissance geologic map for the Yukon-Koyukuk Basin, Alaska: U.S. Geological Survey Open-File Report 2005–1341, http://pubs.usgs.gov/of/2005/1341/.

Wilson, F.H., Labay, K.A., Shew, N.B., Preller, C.C., and Mohadjer, Solmaz, 2005c, Digital data for the geology of Wrangell-Saint Elias National Park and Preserve, south-central Alaska: U.S. Geological Survey Open-File Report 2005–1342, http://pubs.usgs.gov/of/2005/1342/.

Wilson, F.H., and Preller, C.C., 2003, Surficial geologic map of the Lake Clark and western Kenai quadrangles, Alaska—A work in progress [abs.]: Alaska Geological Society 2003 Geology Symposium volume, April 25–26, 2003, p. 67.

Table 1. Radiometric ages from the northern Alaska Peninsula map area.

[Samples listed by map unit, in the order listed in the Description of Map Units and from north to south within a map unit]

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Kkv?	94ADw 59b	Taylor Mountains	60.972	158.4528	Basalt	40/39?	?	70.0	0.4	Basalt flow	J.R. Riehle, written commun., 2006
Jnc	62ALe 6e	Kenai	60.1133	152.5850	Quartz diorite	K-Ar	BI	156.6	n.a.	Rounded granitic boulders within the Chisik Conglomerate member of the Naknek Formation, RECAL	Detterman and others, 1965, Magoon and others, 1976
Qamp	78AR 290LT	Kenai	60.717	152.667	Andesite	K-Ar	WR	0.627	0.024	Light band in banded andesite, approximate location	Reed and others, 1992
Qamp	78AR 290DK	Kenai	60.717	152.667	Andesite	K-Ar	WR	0.763	0.017	Dark band in banded andesite, approximate location	Reed and others, 1992
Qamp	90AR 99	Kenai	60.77	152.7	Andesite	K-Ar	WR	0.887	0.015	Approximate location	Reed and others, 1992
Tb	82MR 322	Taylor Mountains	60.8833	158.8583	Basalt	K-Ar	WR	4.72	0.10		Reifenstuhl and others, 1985b
Tb	82MR 322	Taylor Mountains	60.8833	158.8583	Basalt	K-Ar	PL	4.62	0.14		Reifenstuhl and others, 1985b
Tb	6-27-1	Iliamna	59.0733	154.0417	Basalt	K-Ar	WR	4.4	0.5	Olivine basalt dike	Magoon and others, 1976; Detterman and Reed, 1980
Tb	6-27-1	Iliamna	59.0733	154.0417	Basalt	K-Ar	WR	5.1	1.0	Olivine basalt dike	Magoon and others, 1976; Detterman and Reed, 1980
Tmv	82-107J (GT4)	Iliamna	59.6400	154.4500	Andesite	K-Ar	PL	33.8	6.8	Southeast of Lake Iliamna	Thrupp, 1987
Tmv	83-108A (GT8)	Iliamna	59.11	154.94	Andesite	K-Ar	WR	31.3	0.9	North of Battle Lake	Thrupp, 1987
Tmf	01AWs 67B	Dillingham	59.6140	156.3110	Rhyolite	40/39 plateau age	PL	45.10	0.19	Dacite tuff	Iriondo and others, 2003
Tmf	AL00	Dillingham	59.0050	156.0440	Rhyolite	40/39 average age	PL	41.62	0.18	Maroon and white banded rhyodacite porphyry, fine-grained wholly crystalline. Phenocrysts plucked in thin-section, remnants appear fresh plagioclase	Iriondo and others, 2003
Tmba	82-76 (GT3)	Iliamna	59.95	155.16	Andesite	K-Ar	WR	38.5	1.2	Top of Groundhog Mountain	Thrupp, 1987

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Tmba	82-82 (GT1)	Iliamna	59.95	155.18	Andesite	K-Ar	WR	39.7	2.4	Base of Groundhog Mountain	Thrupp, 1987
Tmba	01AWs 55	Dillingham	59.7910	156.2980	Basalt	40/39 isochron	WR*	53.71	0.61	Columnar jointed basalt	Iriondo and others, 2003
Tmba	01AWs 49	Dillingham	59.7620	156.0110	Andesite	40/39 isochron	WR*	47.95	1.39	Basalt plug	Iriondo and others, 2003
Tmba	-- (GT13)	Iliamna	59.73	154.72	Andesite	K-Ar	WR	36.4	n.a.	Rabbit Island, Lake Iliamna	Thrupp, 1987
Tmba	01AWs 67	Dillingham	59.6140	156.3110	Basalt	40/39 isochron	WR*	44.47	0.41	Basalt flow—fresh, sparse olivine phenocrysts	Iriondo and others, 2003
Tmba	01AWs 60	Dillingham	59.6010	156.3230	Basalt	40/39 isochron	WR*	44.38	0.38	Incredibly fresh, columnar-jointed basalt flow	Iriondo and others, 2003
Tmba	GT14	Iliamna	59.393	155.11	Andesite	K-Ar	WR	35.0	n.a.	Peter's Plug	Thrupp, 1987
Tmba	83-118 (GT9)	Iliamna	59.31	154.62	Andesite	K-Ar	WR	29.5	1.4	Southwest Gibraltar, south of Lake Iliamna	Thrupp, 1987
Togd	68AR 244	Lake Clark	60.9467	153.5450	Granodiorite	K-Ar	BI	31.9	0.9	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976; Nelson and others, 1983
Togd	68AR 244	Lake Clark	60.9467	153.5450	Granodiorite	K-Ar	HO	36.3	1.8	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Nelson and others, 1983
Togd?	66ALe 25	Lake Clark	60.4150	153.6100	Quartz monzonite	K-Ar	BI	39.6	n.a.	Not mapped, unit assignment provisional, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976
Togd	66AR 1289	Iliamna	59.0533	154.6517	Quartz diorite	K-Ar	HO	37.0	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Togd	66AR 1289	Iliamna	59.0533	154.6583	Quartz diorite	K-Ar	BI	35.6	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon, and others, 1976; Detterman and Reed, 1980
Teg	68AR 245	Lake Clark	60.9300	153.3450	Quartz monzonite	K-Ar	BI	34.6	1.3	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
Teg	70AR 165	Lake Clark	60.8683	153.4150	Granodiorite	K-Ar	BI	37.5	1.0	RECAL	Reed and Lanphere, 1972, 1973, Magoon and others, 1976

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Teg	68AR 248	Lake Clark	60.8383	153.5817	Quartz monzonite	K-Ar	BI	38.6	1.1	RECAL	Reed and Lanphere, 1969, 1972, 1973, Magoon and others, 1976
Teg	70AR 181	Lake Clark	60.7683	153.3367	Granodiorite	K-Ar	BI	34.8	1.0	RECAL	Reed and Lanphere, 1969, 1972, 1973, Magoon and others, 1976
Teg	68AR 251	Lake Clark	60.7233	153.5383	Granodiorite	K-Ar	BI	39.4	1.1	RECAL	Reed and Lanphere, 1969, 1972, 1973, Magoon and others, 1976
Teg	68AR 251	Lake Clark	60.7233	153.5383	Granodiorite	K-Ar	HO	41.90	1.3	RECAL	Reed and Lanphere, 1969, 1972, 1973, Magoon and others, 1976
Teg	70AR 159	Lake Clark	60.7050	153.2800	Granodiorite	K-Ar	BI	38.6	1.1	RECAL	Reed and Lanphere, 1969, 1972, 1973, Magoon and others, 1976
Teg	70AR 159	Lake Clark	60.7050	153.2800	Granodiorite	K-Ar	HO	39.3	1.9	RECAL	Reed and Lanphere, 1969, 1972, 1973, Magoon and others, 1976
Tipg	66ALe 23	Lake Clark	60.0400	154.1700	Quartz monzonite	K-Ar	BI	43.9	n.a.	RECAL	Reed and Lanphere, 1969, 1972
Tigd	66AR 1393	Lake Clark	60.1383	154.0700	Granodiorite	K-Ar	BI	62.8	n.a.	RECAL	Reed and Lanphere, 1969, 1972; Nelson and others, 1983
Tigd	66AR 1393	Lake Clark	60.1383	154.0700	Granodiorite	K-Ar	HO	61.0	n.a.	RECAL	Reed and Lanphere, 1969, 1972; Nelson and others, 1983
Tvig	01AM 109A	Dillingham	59.6910	156.5310	Dacite tuff	40/39 total fusion age	BI	59.25	0.05	Rubble crop of fine- to medium-grained, biotite granodiorite. Biotite looks fresh, grain size about 1–3 mm	Iriondo and others, 2003
Tvig	00AWs 16	Dillingham	59.6750	156.6050	Dacite tuff	40/39 total fusion age	BI	59.69	0.05	Stuyahok Hills. Hornblende-biotite dacite porphyry. Contains excellent fresh biotite; hornblende fresh but loaded with biotite inclusions	Iriondo and others, 2003
Tvig	82BB422	Dillingham	59.642	156.45	Dacite	K-Ar	HO	57.9	1.7	Hornblende-biotite dacite, approximate location	Wallace and others, 1989

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Tvig	82BB422	Dillingham	59.642	154.45	Dacite	K-Ar	BI	58.6	1.8	Hornblende-biotite dacite, approximate location	Wallace and others, 1989
Tvig	01AWs 61	Dillingham	59.6080	156.3950	Dacite tuff	40/39 total fusion age	BI	59.34	0.03	Fine-grained porphyritic intrusive rock. Contains phenocrysts of very fresh biotite and feldspar in an aphanitic tuffaceous(?) matrix. Hypabyssal?	Iriondo and others, 2003
TKv in JPk	82BB289	Lake Clark	60.3833	153.88	Mafic dike	K-Ar	HO	79.6	2.4	Mafic dike cutting Tlikakila Complex, approximate location	Wallace and others, 1989
TKr	77E 216	Lake Clark	60.3700	155.2033	Dacite	K-Ar	BI	59.5	1.8	Biotite dacite	Eakins and others, 1978
TKr	K-Ar5	Lake Clark	60.2772	154.8378	Andesite	K-Ar	BI	62.7	1.9	Augite andesite porphyry	Eakins and others, 1978
TKb	83-133 (GT10)	Lake Clark	60.57	154.34	Basalt	K-Ar	WR	44.4	1.7	South of Snipe Lake, north of Lake Clark	Thrupp, 1987
TKb	K-Ar2	Lake Clark	60.3075	154.6433	Granodiorite	K-Ar	BI	56.2	1.7	Hornblende biotite granodiorite	Eakins and others, 1978
TKb	82-95 (GT2)	Lake Clark	60.2655	154.635	Basalt	K-Ar	WR	65.8	13.2	Top of "eastern mesa," north of Lake Clark	Thrupp, 1987
TKg	01AH 63	Dillingham	59.8680	156.1650	Hypabyssal dacite	40/39 total fusion age	BI	65.26	0.06	Biotite granodiorite, screens of metamorphic rocks locally, scattered xenoliths, and some fine-grained segregation within the granodiorite	Iriondo and others, 2003
TKg	00AWs 39	Dillingham	59.3860	156.5350	Granodiorite	40/39 isochron	BI	61.86	0.44	Isolated pluton containing excellent biotite and good hornblende, fair amount of K-feldspar	Iriondo and others, 2003
TKgr	82MR 309	Taylor Mountains	60.9383	157.3717	Granite	K-Ar	BI	65.3	2.0		Reifenstuhl and others, 1985a,b
TKgr	83MR 234C	Taylor Mountains	60.9333	157.3683	Granite	K-Ar	BI	67.6	2.0		Reifenstuhl and others, 1985a,b
TKgr	83MR 235C	Taylor Mountains	60.9333	157.3683	Granite	K-Ar	BI	65.0	2.0		Reifenstuhl and others, 1985a,b
TKgr	83MR 235C	Taylor Mountains	60.9333	157.3683	Granite	K-Ar	MI	64.5	1.9	White mica	Reifenstuhl and others, 1985a,b
TKgr	83MR 234C	Taylor Mountains	60.9333	157.3683	Granite	K-Ar	MI	65.5	2.0	White mica	Moll, written commun., 1986

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
TKgr	99AWs 17	Taylor Mountains	60.9260	156.7320	Monzodiorite	40/39 total fusion age	BI	67.69	0.04	Hoholitna pluton. Biotite granite or quartz monzonite intruding Kuskokwim Group. Fairly fresh biotite, hornblende secondary after clinopyroxene.	Iriondo and others, 2003
TKgr	83MR 233C	Taylor Mountains	60.9200	156.7217	Quartz monzonite	K-Ar	BI	67.0	2.0		Reifenstuhl, oral commun., 1984; Moll, written commun., 1986
TKgr	83MR 233C	Taylor Mountains	60.9200	156.7217	Quartz monzonite	K-Ar	AM	67.1	2.0		Reifenstuhl, oral commun., 1984; Moll, written commun., 1986
TKgr	01AH 83	Taylor Mountains	60.4100	156.0690	Muscovite granite	40/39 plateau age	MU	67.18	0.28	Probably >10-ft-wide, medium-grained, equigranular muscovite granite dike, euhedral muscovite	Iriondo and others, 2003
TKgr	98-07, 98-10	Taylor Mountains	60.41	158.12	Granite porphyry	40/39 plateau	BI	69.7	0.3	Shotgun deposit, mean plateau age of four samples	Rombach, 2000
TKgr	01AWs 41	Taylor Mountains	60.0450	157.0850	Granite	40/39 total fusion age	BI	60.41	0.06	Sleitat pluton, tin-bearing biotite granite	Iriondo and others, 2003
TKgr	--	Taylor Mountains	60.044	157.083	Muscovite veinlet in granite	K-Ar	MU	56.8	2.8	Dates late-stage hydrothermal event, approximate location	Burleigh, R.E., 1991
TKgr	01AH 70	Dillingham	59.8370	156.3510	Alaskite	40/39 average age	KF	58.40	0.20	Rubble crop of orange-weathering granite; interstitial graphic textures vuggy over most of area. Probably dueterically altered	Iriondo and others, 2003
TKgr	01AH 80	Dillingham	59.8050	156.3770	Alaskite	40/39 average age	KF	58.30	0.20	Aplitic granite with greenish tourmaline clots and vug fillings. Locally, vugs also have euhedral quartz and K-spar	Iriondo and others, 2003
TKgr	01AWs 39	Dillingham	59.7260	156.2040	Granodiorite	40/39 isochron	BI	60.93	0.65	Isolated knoll in Stuyahok River valley. Medium- to coarse-grained hornblende granodiorite	Iriondo and others, 2003

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
TKgr	01AWs 39	Dillingham	59.7260	156.2040	Granodiorite	40/39 plateau age	HO	60.07	0.25	Isolated knoll in Stuyahok River valley. Medium- to coarse-grained hornblende granodiorite	Iriondo and others, 2003
TKgr	00AWs 31A	Dillingham	59.7030	157.9870	Biotite granite	40/39 total fusion age	BI	64.45	0.11	Small cirque of northeast side of Kemuk Mountain. Medium-grained biotite granite, deep weathering rinds, slightly vuggy. Fresh biotite	Iriondo and others, 2003
TKgr	01AWs 80	Dillingham	59.6330	156.1930	Granite	40/39 total fusion age	BI	61.63	0.05	Stuyahok Hills pluton. Hornblende-biotite granodiorite with large 2–3 cm feldspar phenocrysts and common mafic xenoliths	Iriondo and others, 2003
TKgr	01AWs 64	Dillingham	59.6290	156.1960	Granite	40/39 plateau age	HO	64.20	0.27	Coarse- to medium-grained porphyry granite. Large K-spar phenocrysts to 2 cm	Iriondo and others, 2003
TKgr	74 B 57	Dillingham Goodnews Bay	59.6267	159.00	Granite	K-Ar	BI	69.6	2.1	Akuluktok Mountain pluton	Hoare and Coonrad, 1978
TKgr	74 B 57	Dillingham Goodnews Bay	59.6267	159.00	Granite	K-Ar	HO	63.4	1.9	Aluluktok Mountain pluton	Hoare and Coonrad, 1978
TKgr	01AWs 57	Dillingham	59.6180	156.1220	Granite	40/39 total fusion age	BI	61.57	0.06	Dark-colored, medium- to coarse-grained hornblende-biotite quartz monzonite or granodiorite, with large 2 cm K-spar phenocrysts	Iriondo and others, 2003
TKgr	01AWs 24	Dillingham	59.6070	156.3210	Granite	40/39 total fusion age	BI	61.70	0.06	Biotite-hornblende granodiorite with 2 cm K-spar phenocrysts. Good fresh mafic minerals. Local xenoliths	Iriondo and others, 2003

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
TKgr	00AWs 38	Dillingham	59.6060	156.1590	Granite	40/39 total fusion age	BI	61.15	0.04	Granite, biotite is fine-grained and fresh, also contains clinopyroxene and common K-feldspar. No hornblende	Iriondo and others, 2003
TKgr	01APc 18	Dillingham	59.6060	156.2230	Granite	40/39 total fusion age	BI	61.28	0.05	Pegmatitic biotite granite	Iriondo and others, 2003
TKgr	01APc 20	Dillingham	59.6040	156.2540	Granite	40/39 total fusion age	BI	61.30	0.05	Biotite granite	Iriondo and others, 2003
TKgr	82BB421	Dillingham	59.6	156.23	Granite	K-Ar	HB	54.50	1.6	Hornblende-biotite granite, approximate location	Wallace and others, 1989
TKgr	82BB421	Dillingham	59.6	156.23	Granite		Bi	61.15	1.8	Hornblende-biotite granite, approximate location	Wallace and others, 1989
TKgr	01APc 23	Dillingham	59.5890	156.2400	Granite	40/39 total fusion age	BI	61.64	0.05	Granite	Iriondo and others, 2003
TKgr	01AWs 59	Dillingham	59.5810	156.3320	Granite	40/39 total fusion age	BI	61.65	0.05	Yellowish biotite granite or quartz monzonite. Another mafic could be orthopyroxene	Iriondo and others, 2003
TKgr	01APc 25	Dillingham	59.5790	156.2400	Granite	40/39 total fusion age	BI	61.26	0.05	Hornblende biotite granite	Iriondo and others, 2003
TKgr	01AWs 78	Dillingham	59.5660	156.2630	Granite	40/39 total fusion age	BI	60.90	0.04	Stuyahok Hills pluton. Hornblende-biotite granodiorite with large 2–3 cm feldspar phenocrysts and common mafic xenoliths	Iriondo and others, 2003
TKgr	00AWs 15A	Dillingham	59.3290	158.3010	Biotite granite	40/39 total fusion age	BI	67.94	0.04	Main part, Muklung Hills. Nearly hypabyssal- appearing biotite granite having very fresh biotite and abundant K-feldspar. Fair to poor hornblende	Iriondo and others, 2003

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
TKgs	01AH 59	Dillingham	59.9140	156.1820	Quartz monzonite	40/39 total fusion age	BI	65.50	0.05	Outcrops of medium-grained, medium-light-gray, equigranular biotite granodiorite. Small disseminated euhedral biotite books	Iriondo and others, 2003
TKgs	01AH 62	Dillingham	59.9000	156.1980	High-potassium granodiorite	40/39 total fusion age	BI	65.75	0.03	Medium-grained, medium-light-gray seriate biotite granodiorite; small clean biotite crystals. Oxidized sulfides present?	Iriondo and others, 2003
TKgs	01AWs 46	Dillingham	59.8980	156.1930	Quartz monzonite	40/39 total fusion age	BI	66.24	0.08	Quartz monzonite to high-potassium granodiorite containing common chlorite, lesser epidote, and minor biotite	Iriondo and others, 2003
TKqm	77BT 217	Lake Clark	60.8300	153.5233	Quartz monzonite	K-Ar	BI	64.0	1.9		Eakins and others, 1978; Nelson and others, 1983
TKqm	69ACk 1008	Taylor Mountains	60.4917	158.0667	Granite	K-Ar	BI	67.3		RECAL	Berry and others, 1976
TKqm	77E 217	Lake Clark	60.4833	155.2183	Granodiorite	K-Ar	BI	71.3	2.1	Biotite pyroxene granodiorite	Eakins and others, 1978; Nelson and others, 1983
TKqm	77E 211	Lake Clark	60.3967	154.9033	Granodiorite	K-Ar	BI	61.6	1.8	Biotite granodiorite	Eakins and others, 1978
TKqm	K-Ar6	Lake Clark	60.405	154.5533	Granodiorite	K-Ar	BI	60.5	1.8	Hornblende biotite granodiorite	Eakins and others, 1978
TKqm	01AWs 2	Dillingham	59.8910	156.2510	Quartz diorite	40/39 plateau age	HO	63.77	0.27	Pike Creek. Massive, dark-gray, medium- to coarse-grained hornblende-bearing intermediate intrusive rock	Iriondo and others, 2003
TKqm	01AWs 48	Dillingham	59.8420	156.1710	Quartz monzonite	40/39 total fusion age	BI	65.72	0.04	Coarse-grained biotite-hornblende granodiorite	Iriondo and others, 2003
TKqm	01AH 64	Dillingham	59.8220	156.2010	Quartz monzonite	40/39 total fusion age	BI	66.49	0.07	Medium-grained, equigranular to seriate biotite granodiorite. Euhedral small biotite books	Iriondo and others, 2003

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
TKqm	01AH 69	Dillingham	59.8040	156.1550	Quartz diorite	40/39 total fusion age	BI	64.42	0.04	Fine- to medium-grained, equigranular hornblende-biotite granodiorite	Iriondo and others, 2003
TKqm	01AH 67	Dillingham	59.8020	156.0280	Quartz monzodiorite	40/39 plateau age	HO	61.30	0.20	Medium-dark-greenish-gray, fine- to medium-grained, seriate to porphyritic quartz diorite(?) or granodiorite. Few K-spar crystals to 2 cm long	Iriondo and others, 2003
TKqm	00AWs 37	Dillingham	59.7890	156.0880	Quartz monzonite	40/39 total fusion age	BI	63.09	0.05	Similar sample 00AWs 35a, however biotite not as fresh and secondary hornblende more common. Plagioclase is sericitized	Iriondo and others, 2003
TKqm	00AWs 35a	Dillingham	59.7780	156.1340	Quartz monzodiorite	40/39 total fusion age	BI	61.67	0.05	Large tor of biotite granite. Coarse, almost pegmatitic phase containing excellent biotite. Clinopyroxene is common and hornblende is alteration product from clinopyroxene	Iriondo and others, 2003
TKqm	01AWs 50	Dillingham	59.7690	156.1330	Quartz diorite?	40/39 total fusion age	BI	61.11	0.07	Biotite granite, south edge(?) of pluton	Iriondo and others, 2003
TKqm	00AWs 13A	Dillingham	59.3040	158.1210	Granodiorite	40/39 total fusion age	BI	65.81	0.06	East side Muklung Hills. Biotite-hornblende granodiorite containing abundant hornblende and biotite. Biotite slightly chloritized, hornblende shows minor alteration	Iriondo and others, 2003
TKgd	70AR 140	Kenai	60.9433	152.8617	Granodiorite	K-Ar	BI	65.1	1.9	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
TKgd	70AR 140	Kenai	60.9433	152.8617	Granodiorite	K-Ar	HO	70.5	2.0	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
TKgd	70AR 147	Kenai	60.8650	152.6800	Granodiorite	K-Ar	BI	65.4	1.8	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
TKgd	70AR 147	Kenai	60.8650	152.6800	Granodiorite	K-Ar	HO	67.6	2.0	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
TKgd	70AR 146	Kenai	60.7433	152.9583	Granodiorite	K-Ar	BI	68.2	1.0	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
TKgd	00AWs 22	Taylor Mountains	60.0410	156.8200	Granodiorite	40/39 total fusion age	BI	66.55	0.07	Northeast end of Sleitat Mountain ridge. Biotite-hornblende granodiorite(?) intruding Kuskokwim Fm. Excellent biotite, hornblende unsuitable for dating	Iriondo and others, 2003
TKqd	77BT 224	Lake Clark	60.6317	154.5783	Diorite	K-Ar	HO	69.4	2.1	Hornblende diorite	Eakins and others, 1978; Nelson and others, 1983
TKqd	01AH 65	Dillingham	59.7930	156.1430	Diorite	40/39 isochron	HO	60.60	0.30	Diorite complex. Fine- to medium-grained, greenish-gray diorite with some amphibole crystals to 1 cm long	Iriondo and others, 2003
Mzmi?	KEMUK	Dillingham	59.7200	157.7000	Pegmatitic ultramafic	40/39 total fusion age	BI	86.05	0.08	Kemuk iron-PGE (platinum-group element) prospect. Biotite book from core sample, drillhole number 6, depth 621 ft. Approx. location Sec. 24(?), T. 5 S., R. 50 W.	Iriondo and others, 2003
Kg	70AR 179	Kenai	60.9850	152.2800	Quartz diorite	K-Ar	BI	71.3	2.0	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Kg	70AR 179	Kenai	60.9850	152.2800	Quartz diorite	K-Ar	HO	70.6	2.1	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Kg	70AR 158	Kenai	60.8317	152.5817	Quartz diorite	K-Ar	BI	70.0	2.0	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Kg	70AR 158	Kenai	60.8317	152.5817	Quartz diorite	K-Ar	HO	74.4	2.2	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Kg	70AR 173	Kenai	60.7483	152.8117	Diorite	K-Ar	BI	67.2	1.9	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
Kg	70AR 173	Kenai	60.7483	152.8117	Diorite	K-Ar	HO	71.5	2.1	RECAL	Reed and Lanphere, 1972, 1973, Magoon and others, 1976
Kgd	70AR 169	Lake Clark	60.5983	153.4050	Granodiorite	K-Ar	BI	63.1	1.8	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
Kgd	70AR 169	Lake Clark	60.5983	153.4050	Granodiorite	K-Ar	HO	69.0	2.0	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
Kgd	--	Iliamna	59.898	155.296	Granodiorite	K-Ar	KF	99.8	5	Coarse, fresh K-feldspar from drillhole at northwest edge of Pebble Copper deposit, approximate location	Bouley and others, 1995
Kgd	--	Iliamna	59.898	155.296	Biotite pyroxenite	K-Ar	BI	96.1	4.8	Coarse, fresh biotite, approximate location	Bouley and others, 1995
Kgd	--	Iliamna	59.898	155.296	Granodiorite	K-Ar	KF	90.5	4.5	Secondary K-feldspar from hydrothermal alteration associated with Pebble Copper deposit, approximate location	Bouley and others, 1995
Kgd	--	Iliamna	59.8536	155.323	Tonalite	U-Pb	ZI	89.7	0.2	Tonalite from batholith associated with Sill (or 25 Gold) prospect, approximate location	Bouley and others, 1995
Kqd	70AR 168	Lake Clark	60.6417	153.1583	Quartz diorite	K-Ar	BI	65.6	1.8	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Kqd	70AR 168	Lake Clark	60.6417	153.1583	Quartz diorite	K-Ar	HO	68.7	2.0	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
Kqms	65AR 818	Iliamna	59.8467	153.8583	Quartz diorite	K-Ar	BI	79.8	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Kqms	65AR 910	Iliamna	59.8267	154.2067	Quartz diorite	K-Ar	BI	82.7	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Kqms	65AR 910	Iliamna	59.8267	154.2067	Quartz diorite	K-Ar	HO	85.5	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Kqms	65AR 1034	Iliamna	59.8050	154.2467	Quartz monzonite	K-Ar	HO	75.6	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Kqms	00AWs 12	Dillingham	59.4610	158.1990	Syenite	40/39 total fusion age	BI	84.49	0.05	Okstukuk Hills at VABM Kokwok. Biotite granite or syenite having very coarse feldspar laths, medium-grained, very fresh biotite and fine-grained clinopyroxene	Iriondo and others, 2003
Klgd	01AH 85A	Taylor Mountains	60.2790	156.0800	Granodiorite	40/39 average age	HO	75.22	0.32	Rubble crop of medium-grained, equigranular, medium-light-gray biotite hornblende granodiorite. Both biotite and hornblende are euhedral	Iriondo and others, 2003
KJg	68AR 261	Lake Clark	60.8867	153.0317	Granodiorite	K-Ar	BI	58.8	1.7	RECAL	Reed and Lanphere, 1969, 1973; Magoon and others, 1976; Nelson and others, 1983
KJg	68AR 261	Lake Clark	60.8867	153.0317	Granodiorite	K-Ar	HO	97.5	3.8	RECAL	Reed and Lanphere, 1969, 1973; Magoon and others, 1976; Nelson and others, 1983

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
KJg	70AR 184	Lake Clark	60.7367	153.1033	Quartz diorite	K-Ar	BI	72.4	2.0	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
KJg	70AR 184	Lake Clark	60.7367	153.1033	Quartz diorite	K-Ar	HO	95.8	2.8	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
Jtr	65AR 905	Iliamna	59.9200	153.6083	Trondhjemite	K-Ar	MU	148	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980; Nelson and others, 1983
Jqm	6-14-6	Iliamna	59.9217	153.285	Quartz monzonite	K-Ar	WR	170.0	4.0		Detterman and Reed, 1980
Jqm	6-14-6	Iliamna	59.9217	153.285	Quartz monzonite	K-Ar	WR	174.0	4.0		Detterman and Reed, 1980
Jqd	70AR 156	Kenai	60.8050	152.4917	Diorite	K-Ar	HO	146.0	4.3	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Jqd	66AR 1464	Kenai	60.8033	152.3550	Quartz monzonite	K-Ar	BI	159.0	n.a.	RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Jqd	70AR 178	Kenai	60.6767	152.4517	Granodiorite	K-Ar	BI	165.0	4.8	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Jqd	70AR 178	Kenai	60.6767	152.4517	Granodiorite	K-Ar	HO	162.0	4.8	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
Jqd	70AR 177	Kenai	60.6150	152.6283	Quartz diorite	K-Ar	BI	163.0	4.7	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Jqd	70AR 177	Kenai	60.6150	152.6283	Quartz diorite	K-Ar	HO	161.0	4.7	RECAL	Reed and Lanphere, 1972, 1973; Detterman and others, 1976; Magoon and others, 1976

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Jqd	70AR 175	Kenai	60.5900	152.7800	Granodiorite	K-Ar	BI	97.8	2.8	RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976
Jqd	62ALe 5	Kenai	60.2533	152.8860	Granodiorite	K-Ar	BI	174	n.a.	Alaska-Aleutian Range batholith, RECAL	Detterman and others, 1965; Reed and Lanphere, 1969, 1972, Magoon and others, 1976
Jqd	62ALe 5	Kenai	60.2533	152.8860	Granodiorite	K-Ar	HO	171.9	n.a.	Alaska-Aleutian Range batholith, RECAL	Detterman and others, 1965, 1976; Magoon and others, 1976; Reed and Lanphere, 1969, 1972
Jqd	65AR 906	Iliamna	59.8833	153.7450	Quartz diorite	K-Ar	BI	78.0	n.a.	Alaska-Aleutian Range batholith, RECAL, reset age?	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	65AR 906	Iliamna	59.8833	153.7450	Quartz diorite	K-Ar	HO	90.1	n.a.	Alaska-Aleutian Range batholith, RECAL, reset age?	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	65AR 827	Iliamna	59.7717	153.6450	Diorite	K-Ar	BI	161	n.a.	Alaska-Aleutian Range batholith, not RECAL	Detterman and others, 1965; Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	65AR 827	Iliamna	59.7717	153.6450	Diorite	K-Ar	HO	160	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	62ALe 2	Iliamna	59.7683	153.9150	Granodiorite	K-Ar	BI	87.1	n.a.	Alaska-Aleutian Range batholith, RECAL, too young?	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	62ALe 2	Iliamna	59.7683	153.9150	Granodiorite	K-Ar	HO	92.3	n.a.	Alaska-Aleutian Range batholith, RECAL, too young?	Reed and Lanphere, 1969, 1972; Detterman and Reed, 1980
Jqd	62ALe 1	Iliamna	59.7017	153.7000	Quartz diorite	K-Ar	BI	163	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Detterman and Reed, 1980

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Jqd	62ALe 1	Iliamna	59.7017	153.7000	Quartz diorite	K-Ar	HO	172	n.a.	Alaska-Aleutian Range batholith, RECAL	Detterman and others, 1965; Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	6-26-1	Iliamna	59.6083	153.5617	Quartz diorite	K-Ar	FD	155.0	3.0		Detterman and Reed, 1980
Jqd	66ALe 13	Iliamna	59.4217	154.4483	Quartz diorite	K-Ar	BI	156.0	4.6	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976
Jqd	66ALe 13	Iliamna	59.4217	154.4483	Quartz diorite	K-Ar	HO	157.0	4.6	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
Jqd	66ALe 22	Iliamna	59.4017	154.6333	Quartz diorite	K-Ar	BI	135.0	5.0	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1972; Magoon and others, 1976
Jqd	66ALe 22	Iliamna	59.4017	154.6333	Quartz diorite	K-Ar	HO	151.0	4.5	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
Jqd	64ADt 715	Iliamna	59.3967	154.3083	Quartz diorite	K-Ar	BI	156	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	64ADt 715	Iliamna	59.3967	154.3083	Quartz diorite	K-Ar	MU	164	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	66ALe 45	Iliamna	59.3767	154.3217	Quartz diorite	K-Ar	BI	158.0	4.6	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
Jqd	66ALe 45	Iliamna	59.3767	154.3217	Quartz diorite	K-Ar	MU	160.0	4.7	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1972, 1973; Magoon and others, 1976
Jqd	64ADt 420A	Iliamna	59.3750	154.4667	Quartz diorite	K-Ar	BI	158	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980

Table 1. Radiometric ages from the northern Alaska Peninsula map area.—Continued

Unit label	Sample number[1]	Quadrangle	Latitude (° N.)	Longitude (° W.)	Rock type, map unit	Method[2]	Mineral[3]	Age (MA)	Error[4] (m.y.)	Comment[5]	Sources
Jqd	64ADt 863	Iliamna	59.3417	154.4500	Quartz diorite	K-Ar	BI	161	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	64ADt 863	Iliamna	59.3417	154.4500	Quartz diorite	K-Ar	HO	159	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	64AR 612	Iliamna	59.3000	154.3050	Quartz diorite	K-Ar	BI	167	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jqd	64AR 612	Iliamna	59.3000	154.3050	Quartz diorite	K-Ar	HO	158	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jmu	65ADt 1084	Iliamna	59.7300	153.8483	Hornblendite	K-Ar	HO	160	n.a.	Alaska-Aleutian Range batholith, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
Jmu	64AE 98	Iliamna	59.2683	154.4900	Gabbro	K-Ar	HO	183	n.a.	Alaska-Aleutian Range batholith, hornblende gabbro, RECAL	Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980
MzPzb	82BB404A	Lake Clark	60.3	154.58	Schist	K-Ar	BI	63.2	1.9	Biotite schist, thought to be metamorphosed Koksetna River sequence of Wallace and others (1989), approximate location	Wallace and others, 1989
unit not known	--	Iliamna	59.8536	155.323	Latite	U-Pb	ZI	46.2	0.2	Latite near Sill (or 25 Gold) prospect, approximate location	Bouley and others, 1995

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[1] Sample collectors: ADt, R.L. Detterman; AH, T.L. Hudson; ALe, M.A. Lanphere; AM, M.L. Miller; APc, C.C. Preller-Schlenker; AR, B.L. Reed; AWs, F.H. Wilson; BT, T.K. Bundtzen; KEMUCK, sample from Kemuck iron-PGE prospect (no sample number); MR, M.S. Robinson; --, no sample number published.

[2] Methods used: K-Ar, conventional potassium-argon; 40/39, ^{40}Argon-^{39}Argon; U-Pb, Uranium-Lead.

[3] Minerals dated: AM, amphibole; BI, biotite; FD, feldspar; HO, hornblende; KF, potassium feldspar; MI, mica; MU, muscovite; PL, plagioclase; WR, whole-rock; WR*, whole rock, matrix only; ZI, zircon.

[4] Abbreviation: n.a., not applicable.

[5] RECAL indicates that originally reported ages have been recalculated using the constants of Steiger and Jager (1977)