Prepared in cooperation with the Alaska Department of Natural Resources Division of Oil and Gas

# Geologic Map of the Cook Inlet Region, Alaska

**Including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak 1:250,000-scale quadrangles**

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Pamphlet to accompany
Scientific Investigations Map 3153

Aleutian Range mountains south of Chakachamna Lake made up of Tertiary to Cretaceous quartz diorite of the Alaska-Aleutian Range Batholith.

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**U.S. Department of the Interior**
**U.S. Geological Survey**

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## Conversion Factors

Inch/Pound to SI

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in.) | 2.54 | centimeter (cm) |
| inch (in.) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| mile, nautical (nmi) | 1.852 | kilometer (km) |
| yard (yd) | 0.9144 | meter (m) |
| | Area | |
| acre | 4,047 | square meter ($m^2$) |
| acre | 0.4047 | hectare (ha) |
| acre | 0.4047 | square hectometer ($hm^2$) |
| acre | 0.004047 | square kilometer ($km^2$) |
| square foot ($ft^2$) | 929.0 | square centimeter ($cm^2$) |
| square inch ($in^2$) | 0.09290 | square meter ($m^2$) |
| square foot ($ft^2$) | 6.452 | square centimeter ($cm^2$) |
| section (640 acres or 1 square mile) | 259.0 | square hectometer ($hm^2$) |
| square mile ($mi^2$) | 259.0 | hectare (ha) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |

## Introduction

In 1976, L.B. Magoon, W.L. Adkinson, and R.M. Egbert (Magoon and others, 1976) published a major geologic map of the Cook Inlet region, which has served well as a compilation of existing information and a guide for future research and mapping. The map in this report updates Magoon and others (1976) and incorporates new and additional mapping and interpretation. This map is also a revision of areas of overlap with the geologic map completed for central Alaska (Wilson and others, 1998). Text from that compilation remains appropriate and is summarized here; many compromises have been made in strongly held beliefs to allow construction of this compilation. Yet our willingness to make interpretations and compromises does not allow resolution of all mapping conflicts. More time and fieldwork may allow resolution of these conflicts. Nonetheless, we hope that geologists who have mapped in this region will recognize that in incorporating their work, our regional correlations may have required some generalization or lumping of map units (Wilson and others, 1998).

Many sources were used to produce this geologic map and in most cases, data from available maps were combined, without generalization, and new data added where available. Geology of the Mount Katmai and mainland part of the Afognak 1:250,000-scale quadrangles is derived from Riehle and others (1987; 1993) and Riehle and Detterman (1993); the island part of the Afognak quadrangle is from Wilson (in press). Geology of the Iliamna, Lake Clark, and western Kenai quadrangles was derived from Wilson and others (in press) which, in turn was based on Detterman and Reed (1980), Nelson and others (1983), and Magoon and others (1976). Geology of the eastern Kenai and Seldovia quadrangles was derived from Wilson and others (2008), largely based on Bradley and others (1999), Karlstrom (1964), Bradley and Wilson (2000), and Magoon and others (1976). The Tyonek quadrangle is based on Magoon and others (1976) and is highly modified by more recent mapping by Solie and others (1991) and compilation by H.R. Schmoll, and sampling and analysis by P.J. Haeussler and D.C. Bradley (USGS). Geology of the Talkeetna quadrangle is from Reed and Nelson (1980) with additions from Weber (1961); geology of the Talkeetna Mountains quadrangle is based on Csejtey and others (1978) and Werdon and others (2002) and is highly modified by J.M. Schmidt on the basis of more recent mapping and interpretation. Finally, Anchorage quadrangle bedrock geology is largely from Winkler (1992). Mapping surficial deposits at scales of 1:63,360 and 1:25,000 during the last several decades was compiled by H.R. Schmoll from the following sources: Daniels (1981a,b); Kopczynski (2008); Kopczynski, S.E., Reger, R.D., and Evenson, E.B., unpub. data, 2009; Reger (1981a,b,c,d); Reger and others (1994a,b,c,d); Schmoll and Dobrovolny (1972, 1993); Schmoll and Gardner (1982); Schmoll and Yehle (1987, 1992); Schmoll and others (1981, 1996, 1999); Trainer (1960); Trainer and Waller (1965); Updike and Ulery (1983); Updike and others (1988); Yehle and Schmoll (1987a,b, 1988, 1989, 1994); Yehle and others (1983a,b,c, 1990, 1991, 1992), as well as unpublished mapping by Schmoll and Dobrovolny (Anchorage and Seward) and Yehle, Schmoll, Gardner, and J.K. Odum [USGS] (Tyonek). Mapping at smaller scales to the north and south (Weber, 1961; Reed and Nelson, 1980; Karlstrom, 1964; Riehle and Emmel, 1980; F.H. Wilson, unpub. data, 2009; Detterman and Reed, 1973; Riehle and Detterman, 1993) was compiled by F.H. Wilson and C.P. Hults.

Rock unit descriptions are grouped as sedimentary, igneous, or metamorphic and listed in chronological order from youngest to oldest; upper and lower denote stratigraphic position, whereas early and late indicate age. Metamorphic rock units are listed in order of increasing age of their inferred or interpreted protolith age, which in many cases is subject to significant uncertainty. If we cannot interpret a protolith age, then we list the metamorphic units by increasing known or inferred age of metamorphism. All reported radiometric ages are listed in accompanying table 1. Unconsolidated units are subdivided by genetic origin; however, the boundaries are rarely sharp or regionally constant between units. The unconsolidated surficial deposits, undivided (unit Qs) contains a number of subunits that can be mapped only on a local basis, and are not shown separately here.

A preliminary version of this map was published as a U.S. Geological Survey Open-File Report (Wilson and others, 2009). The main differences between the versions concern revised mapping of surfical deposits in the northern and eastern parts of the map area. Minor error corrections have been made also.


## Acknowledgments

A compilation on this scale could only be done with the assistance of many geologists, far more knowledgeable about the geology of various regions of Alaska than we are. We thank Chris Nye, Emily Finzel, and Dwight Bradley for discussions and information that assisted our compilation effort. The Alaska Department of Natural Resources, Division of Oil and Gas provided strong encouragement and financial support to assist with the preparation of this map; its assistance was invaluable. Technical review of the manuscript by Les Magoon, Michael Fisher, and Richard Stanley and editorial review by Theresa Iki was greatly appreciated and helped to improve the text and map.


## Physiographic Setting

The map area borders the northern part of the Gulf of Alaska, a region heavily glaciated during Quaternary time. From west to east, the region extends from high glaciated mountains of the Aleutian Range through coastal lowlands of the Cook Inlet basin to glaciated coastal mountains on the west side of Prince William Sound. From north to south, the region extends from the Talkeetna Mountains and southern Alaska Range to the northern islands of the Kodiak Island archipelago. Throughout the mapped region, relief is generally high except for the lowlands of the Susitna River valley and the western Kenai Peninsula. Volcanoes on the west side of Cook Inlet, notably Mount Spurr (3,383 m), Redoubt Volcano (3,108 m), Iliamna Volcano (3,053 m), and Mount Douglas (2,140 m) are prominent physiographic features, as is Augustine Volcano (or Mount Saint Augustine) (1,227 m), an active volcano on Augustine Island in Cook Inlet. Relief on the east side of Cook Inlet is somewhat less, only locally exceeding 2,000 m. The mountains on the west side of the map area are part of the Alaska and Aleutian Ranges; the transition in name between these two mountain ranges is approximately at Chakachamna Lake, and in common usage, the mountains along the west side of Cook Inlet are called the Alaska-Aleutian Range. The Talkeetna Mountains, part of the Alaska Range, form the eastern boundary of the map area north of the Matanuska River. To the south of the Matanuska River, the map area is bounded on the east by the Chugach and Kenai Mountains, generally considered part of the "Coast" Range. The higher peaks in the region are presently glaciated; the Harding Icefield is a major center of glaciation in the Kenai Mountains, and a number of other areas of ice accumulation are found on the west side of Cook Inlet. Comparison between mid-1950's aerial photographs and 2006 satellite imagery of ice-covered areas west of Cook Inlet indicates approximately 13 percent loss of surface area of glaciers in the 50-year time period (Wilson and Labay, unpub. data, 2007).

## Regional Framework

Cook Inlet fills a largely Tertiary basin lying between two accreted belts of Mesozoic and younger rocks along the southern Alaska margin. Partially filling the basin and exposed on the east and west sides of the basin is a sequence of largely continental Tertiary sedimentary rocks as much as 7,000 m thick (Kirschner and Lyon, 1973; Fisher and Magoon, 1978). These Tertiary rocks are important oil and gas reservoirs for petroleum thought to be sourced from the underlying Jurassic and Triassic rocks (Magoon and Claypool, 1981). Bounding the western, and to a lesser extent, the northern side of the basin are the Mesozoic and Cenozoic plutonic rocks of the Alaska-Aleutian Range batholith; the associated volcanic rocks of the Early Jurassic Talkeetna magmatic arc; and sedimentary rocks, largely of Jurassic age, derived from erosion of the arc and Jurassic portion of the batholith. Emplaced through and overlying these Mesozoic and Cenozoic rocks are the volcanic rocks of the modern Aleutian magmatic arc. The eastern and southern sides of the Cook Inlet basin are bounded by Late Cretaceous accretionary flysch and associated mélange. Also on the eastern side of the basin is a narrow belt of early Mesozoic igneous and metamorphic rocks.

A prominent feature of the western part of the map area is the Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972, 1973). The batholith is a multiphase intrusive rock complex of Jurassic, Cretaceous, and Tertiary ages. The Lake Clark Fault system bifurcates the batholith and no Jurassic intrusive bodies are present north or west of the fault. However, Cretaceous and Tertiary rocks are found on both sides of the fault. Jurassic rocks that are lithologically and chronologically equivalent to the Alaska-Aleutian Range batholith occur in the Talkeetna Mountains of the northeast part of the map, north of the Castle Mountain Fault system.

Late Triassic and Early Jurassic plutonic rocks of similar composition to the Alaska-Aleutian Range batholith, but of slightly older age occur between the Border Ranges Fault system and Castle Mountain-Caribou Fault system in the Matanuska Valley; these plutons continue southward parallel to the Border Ranges Fault on the east side of Cook Inlet, extending to the Triassic Afognak pluton of Roeske and others (1989) on Afognak Island. Plutons of Triassic age are unknown on the Alaska Peninsula.

Two units closely associated with the Late Triassic and Early Jurassic plutons are the informally named Port Graham and Pogibshi formations of Kelley (1980). These two rock units have commonly been correlated with the Kamishak and Talkeetna Formations; however, the Port Graham formation of Kelley (1980) is lithologically distinct from the equivalent age Kamishak Formation, and the Pogibshi formation of Kelley (1980) is older than the lithologically equivalent Talkeetna Formation. Additionally, rock units tectonically associated with these units are distinctly different from rock units on the west side of Cook Inlet or in the Talkeetna Mountains. Amongst the distinctive units are the Seldovia metamorphic complex of Bradley and others (1999) and similar metamorphic complexes such as the Raspberry Schist of Roeske and others (1989), in the Kodiak Island archipelago, and the Schist of Iceberg Lake and Schist of Liberty Creek of Winkler and others (1981), in south central Alaska. These metamorphic rock assemblages were interpreted by Roeske and others (1989) to be part of a Late Triassic to Early Jurassic primitive island arc. Each of the metamorphic complexes is spatially associated with the Border Ranges Fault system and shows evidence of blueschist facies metamorphism, whereas rocks typical of the Alaska Peninsula on the west side of Cook Inlet rarely show evidence of metamorphism. The Triassic plutons are uniquely associated with the Port Graham and Pogibshi formations of Kelley (1980) and the blueschist facies metamorphic complexes.

A number of major fault systems bound or cross-cut the Cook Inlet region (fig. 1). The Border Ranges Fault system (in the past, called the Knik Fault; Magoon and others, 1976) lies on the eastern side of the Cook Inlet basin and separates the Late Cretaceous flysch and mélange from the older Mesozoic rocks on the east side of Cook Inlet and Shelikof Strait. The Border Ranges Fault system is exposed northeast of the Anchorage area (Winkler, 1992), on the southeast part of the map near Seldovia (Bradley and others, 1999), and on Afognak Island (Wilson, in press). Recent analysis of aeromagnetic data (R.W. Saltus, USGS, oral commun., 9/22/2010) suggests that along the Kenai Peninsula, the Border Ranges Fault system dips eastward, under the rocks of the McHugh Complex (KMm), whereas elsewhere it is generally considered a vertical feature. The Castle Mountain Fault system cuts across the Susitna River valley north of Cook Inlet and continues through the Matanuska River valley (Magoon and others, 1976; Winkler, 1992). The eastern part of the Castle Mountain-Caribou Fault system separates rocks, equivalent to those on the Alaska Peninsula, on the north from Mesozoic and younger rocks lying within and south of the fault. The western part of the Castle Mountain-Caribou Fault system transitions to the Lake Clark Fault system west of where the Bruin Bay Fault system is thought to splay off. Here, south


**Figure 1.** Major faults in the map area.

of the Lake Clark Fault system lie rocks of the Alaska Peninsula; north of the Lake Clark Fault system are younger rocks, of different character. Haeussler and Saltus (2005) suggested 26 km of right-lateral strike-slip offset along the Lake Clark Fault since Eocene time southwest of the map area; whereas Plafker and others (1975) reported 5 km of right-lateral offset in the same region. Detterman and others (1976) reported that near the Chulitna River, the fault has vertical offset in a reverse sense of 500 to 1,000 m and they could demonstrate no horizontal offset along the fault. Hults and Wilson (2009) postulated that an older strand of the Castle Mountain-Caribou Fault system extends from the Matanuska River valley through the Chakachamna Lake area. This strand may be an early Tertiary fault that dextrally offset the Alaska-Aleutian Range batholith and associated Mesozoic sedimentary rocks 160 to 190 kilometers. The West Foreland and Arkose Ridge Formations may be deposits filling a trans-tensional basin associated with motion along the Chakachamna-Castle Mountain Fault system.

The Bruin Bay Fault system splays southward from the Castle Mountain Fault system on the west side of the Cook Inlet. The Bruin Bay Fault system cuts rocks of the Alaska Peninsula into a western pluton-dominated block and an eastern sedimentary rock-dominated block. The western block served as a source terrain for the eastern sedimentary rock-block during Jurassic and Cretaceous time. During an early part of the development of the Bruin Bay Fault system, the fault was a normal(?) growth fault bounding the Jurassic depositional basin; during Tertiary time the fault was reactivated having thrust and possibly strike-slip motion, which is most apparent along its northern sections. Fisher and Magoon (1978) and Magoon and Claypool (1981) show in cross sections an inferred fault through Cook Inlet that separates the older Mesozoic rocks of the Kenai and Alaska Peninsulas.

Quaternary deposits of the Cook Inlet Basin are reported as nearly 1,300 m thick in the lower Susitna River valley (Freethey and Scully, 1980), but elsewhere, maximum thicknesses of 200 m to 300 m are more common (Trainer and Waller, 1965; Schmoll and Barnwell, 1984; W.W. Barnwell, USGS, unpub. data, 1984); the deposits record a history dominated by repeated glaciation as well as important estuarine, lacustrine, and alluvial deposits (Karlstrom, 1964; Schmoll and Yehle, 1986; Reger and others, 2007). Unconsolidated deposits at the surface were mainly derived from retreating glaciers that had advanced into the basin from surrounding mountains in the late Pleistocene, perhaps at times, filling the basin with ice. During glacial retreat, an ancestral Cook Inlet estuary invaded the basin as sea level rose, interacting with the glacial deposits and the glaciers themselves to form a central basin complex or terrain, the details of which are as yet incompletely understood. An excellent detailed discussion of the Quaternary history of the Municipality of Anchorage as it relates to Cook Inlet can be found in Schmoll and others (1999). The Quaternary unconsolidated deposits occur in four terrains that occur mainly at different levels, and generally decrease in age:

1. <u>High-level terrain</u> includes thin glacial drift at scattered localities on mountain ridges and glacially planed surfaces;
2. <u>Basin-margin terrain</u> includes the principal well-developed moraines and associated features that extend basinward from the adjacent mountains and stand plateau-like above the lower basin;
3. <u>Central-basin terrain</u> includes the glacioestuarine Bootlegger Cove Formation and related deposits that form a relatively flat platform with low hills that lies at intermediate level;
4. <u>Low-level terrain</u> includes mainly Holocene deposits in valleys and estuarine embayments graded to present sea level.

Quaternary volcanic rocks and deposits, prominent on the west side of the basin, occur as tephra throughout the region (Riehle, 1985).

The 1964 Great Alaska Earthquake had intense local impact and generated far-ranging tsunamis in the Pacific Basin. A brief summary of the effects of the earthquake in Alaska by Stover and Coffman (1993, p. 55) described "vertical displacement over an area of about 520,000 square kilometers. The major area of uplift trended northeast from the offshore of southern Kodiak Island to Prince William Sound and then trended east across the Prince William Sound. Vertical displacements ranged from about 11.5 meters of uplift to 2.3 meters of subsidence relative to sea level. Off the southwest end of Montague Island, there was absolute vertical displacement of about 13–15 meters. *** The zone of subsidence covered about 285,000 square kilometers, including the northern and western parts of Prince William Sound, the western part of the Chugach Mountains, most of Kenai Peninsula, and almost all the Kodiak Island group." Much more extensive reports on the effects of the earthquake can be found in Wood (1967), Leopold (1969), Eckel (1970), and Committee on the Alaska Earthquake of the Division of Earth Sciences National Research Council (1971), and related volumes. Within the city of Anchorage, significant damage to structures occurred as a result of liquefaction of fine-grained sediments of the Bootlegger Cove Formation along exposed faces (Hansen, 1965). Studies in Turnagain Arm, on Middleton Island, east of the map area and in Kenai Fjords National Park, southeast of the map area (Plafker and Rubin, 1978, Bartsch-Winkler and Schmoll, 1992; Combellick, 1991a,b, 1994; Scott and others, 1998; Crowell and Mann, 1998) have suggested a recurrence interval of 900 to 1,000 years for similar great earthquakes in this region.

# DESCRIPTION OF MAP UNITS

## UNCONSOLIDATED DEPOSITS

Qs **Surficial deposits, undivided (Quaternary)**—Unconsolidated silt, sand, and gravel of fluvial, glacial, colluvial, and other origins. Mainly unsorted boulders, cobbles, gravel, sand, and silt produced, deposited, and reworked by action of wind, water, glaciers, frost (including solifluction), and gravity. Includes deposits of present streams, colluvial and alluvial fans; glaciofluvial, glaciolacustrine, and deltaic deposits; unsorted material of morainal deposits; glacial-lake silt, clay, and muskeg deposits; and locally interstratified beach gravel, sand, and clay. In the vicinity of the Drift River delta (Kenai quadrangle), unit contains a significant proportion of volcanic debris derived from air fall, mudflows, and lahars from Redoubt Volcano and Iliamna Volcano (Till and others, 1993; Waythomas and Miller, 1999; F.H. Wilson, unpub. data, 2007). Includes artificial fill at the Drift River and West Foreland oil production facilities on the west side of Cook Inlet (Riehle and Emmel, 1980; Till and others, 1993). Unit also includes older, semi-consolidated deposits exposed in sea bluffs and below bluffs where deposits are visible only at lowest tides. At Goose Bay, about 16 km northwest of Anchorage (Anchorage quadrangle), older deposits are mainly gravel underlying peat; peat contains interbedded tephra dated at 378±0.67 ka by $^{40}Ar/^{39}Ar$ (Reger and others, 1995). Below sea level, at Goose Bay, deposits are mainly slightly indurated silt and clay with some comminuted shells and other organic material, as well as minor sand and gravel; Karlstrom (1964) also reported diamicton. Karlstrom's (1964) correlation of shells in this unit with those of the Bootlegger Cove Formation is no longer valid. Deposits similar to those at Goose Bay also occur at Eagle Bay (Anchorage quadrangle) and at Point Woronzof, but shells were lacking. In the bluffs at Granite Point (southern Tyonek quadrangle), the informal Kaloa deposits of Schmoll and others (1984), included here as part of this map unit, consist mainly of diamicton. These Koloa deposits contain numerous horizons of cobble-sized clasts that may be lag deposits (stone lines) and at least one prominent bed of probably transported coal debris that constitute gently dipping bedding surfaces; an apparent thickness of about 150 m is exposed. Reger (2009) considers the Kaloa deposits of subestuarine mass-movement origin, and late Pleistocene rather than older age. In the Eklutna valley (Anchorage quadrangle), somewhat oxidized poorly sorted gravel and sand are exposed in bluffs. These deposits served as the type deposits of the Eklutna Glaciation of Karlstrom (1964), but no reliable connection to the Eklutna moraines mapped elsewhere can be made. Similar deposits are thought to occur at Point Possession (Tyonek quadrangle) and perhaps elsewhere on the Kenai Peninsula (Schmoll and Yehle, 1986). Commonly subdivided into the following:

Qat **Alluvium along major rivers and in terraces (Holocene)**—Chiefly gravel and sand, well bedded and sorted within beds. Occurs (1) as actively reworked deposits in bars and very low terraces that are subject to continual reworking by streams and generally lack vegetation; thickness may be only a few meters; includes outwash from present-day glaciers where thickness may be 5–10 m; (2) in low to higher terraces where thickness may be 5–10 m; and (3) in small alluvial fans where thickness may be less than 5 m. Rarely preserved natural levee deposits on deltaic or fan delta deposits occur on the west side of Cook Inlet (F.H. Wilson, unpub. data, 2007)

Qtf **Modern tidal flat and estuarine deposits (Holocene)**—Well-sorted, subtidal, stratified silt and some sand and local gravel deposited in shallow embayments. Deposits reworked daily by tides in lower part, only during highest tides or extreme storms in upper part. Largely mapped from topographic maps

Qes **Estuarine deposits (Holocene)**—Chiefly silt and fine sand; somewhat coarser near tidal channels. Well bedded and sorted. Loose, commonly water saturated. Above zone of tidal activity but commonly marshy or occupied by numerous lakes. Locally includes thin beds of peat, driftwood, and other organic material, and some windblown material. Thickness of a few meters to a few tens of meters. Includes salt-marsh deposits of Detterman and Hartsock (1966) and grades into tidal flat deposits (Riehle and Emmel, 1980; F.H. Wilson, unpub. data, 2007). Also includes marine terrace deposits on the west side of Cook Inlet (F.H. Wilson, unpub. data, 2007). In upper Turnagain Arm area (Seward quadrangle) includes Placer River Silt (Ovenshine and others, 1976) deposited immediately following the 1964 earthquake. Homer Spit (Seldovia quadrangle) was shown as "elevated tidal silt and beach deposits" by Karlstrom (1964); however, his text described it as a subaqueous end moraine that he attributed to a late Skilak advance of the Naptowne glaciation. He described it as being deposited in deep water and subsequently being wave-reworked upon emergence

Qaf **Alluvial fan deposits (Holocene and Upper Pleistocene)**—Poorly sorted to well-sorted silt to boulders in alluvial fans, cones, and coalesced cones. May grade into colluvial deposits or talus. Some large fans graded to or may interfinger with glacioestuarine deposits

Qdf **Debris-flow deposits (Holocene)**—Debris-flow deposits from Redoubt Volcano in the Crescent River valley (Kenai quadrangle); includes several small (older?) deposits in the upper valley and a 3,500-year-old debris flow (Riehle and others, 1981) in the lower valley. Older deposits reflect multiple debris flows off west and southwest flanks of Redoubt Volcano. Oldest(?) deposit is derived from west flank of Redoubt Volcano. Next oldest deposit appears derived from a presently glaciated valley draining to southwest off Redoubt. Deposits are of relatively limited extent and may have dammed North Fork of the Crescent River, creating a temporary lake in the valley. Deposits of youngest, most extensive, and probably most fluid debris flow were derived from southwest flank of Redoubt Volcano. Flow was apparently derived from the only presently glacier free valley draining south from Redoubt; debris flow is young enough to possibly explain lack of glaciers in the source valley, as all surrounding valleys have extensive glaciers and glacial deposits. Flow extended to coast of Cook Inlet and flowed back up the main fork of the Crescent River, creating Crescent Lake. Map unit also includes a deposit in upper Crescent River valley that may be a debris flow deposit. Includes Holocene mudflow deposits in Drift River valley draining north and east from Redoubt Volcano (Till and others, 1993); many of which are historic, including 1966 and later flows

Qlc **Landslide and colluvial deposits (Holocene and Upper Pleistocene)**—Irregularly mixed fragments of various sizes and types derived by gravity processes, commonly in fast-moving events but also in slower downslope movement. Includes relatively large masses as well as deposits of smaller fragments of bedrock, diamicton, gravelly silt and sand, and relatively minor amounts of clay, boulders, and organic material. Only largest landslides mapped, developed mainly on Tertiary sedimentary rocks or lateral moraines on mountain slopes; some may have formed shortly after withdrawal of glacier ice. Most of those shown at Anchorage conceal Bootlegger Cove Formation and formed during the 1964 earthquake; others are older but proably of similar origin. Colluvial deposits shown mainly in small valleys where deposits occupy most of the area and where alluvium in valley bottoms is narrow. Includes angular rock debris and mud in slumps, earth-debris flows, block glides, and debris avalanches, and poorly sorted to well-sorted silt to boulders in alluvial fans and cones, and unsorted rock talus (Riehle and Emmel, 1980; Waythomas and Miller, 1999; F.H. Wilson, unpub. data, 2007); also includes remnants of lateral moraines and other glacial and unconsolidated deposits too small to map. In the vicinity of Redoubt Volcano and Iliamna Volcano, may include some volcanic mudflow (lahar) deposits (Riehle and Emmel, 1980). On the west side of Cook Inlet, solifluction deposits of poorly sorted sand, silt, and clay thought to be derived from local upslope bedrock sources are associated with plutonic rocks of the Alaska-Aleutian Range batholith (F.H. Wilson, unpub. data, 2007)

Qb **Beach deposits (Holocene)**—Sand, gravel, and cobbles of present and former beaches, beach ridges, spits, and tidal flats (Detterman and Hartsock, 1966; Riehle and Emmel, 1980; F.H. Wilson, unpub. data, 2007)

Qsl **Lacustrine, swamp, and fine silt deposits (Holocene and Upper Pleistocene)**—Chiefly silt, clay, fine sand, peat, and other organic material generally of lacustrine origin (Riehle and Emmel, 1980; F.H. Wilson, unpub. data, 2007). Includes deposits in peat bogs where mapped separately; may be underlain by permafrost

Qd **Eolian deposits (Holocene)**—Dunes consisting of well-sorted, fine-grained sand and silt. Includes cliff-head dunes adjacent to the mouth of Turnagain Arm southeast of Point Possession and Point Campbell, and on the southeast side of Fire Island (join area of Tyonek, Anchorage, Kenai, and Seward quadrangles). As mapped (Karlstrom, 1964), includes bluff exposures of underlying deposits, best seen on Fire Island

Qdl **Deltaic deposits (Holocene and Upper Pleistocene)**—Deltaic deposits, including outwash and alluvial deposits (F.H. Wilson, unpub. data, 2007); include deposits in hanging deltas marginal to glacial lakes and the ancestral Cook Inlet glacial-estuary

**Glacial deposits**—Range from clay to boulders, including till, consisting of gravelly sandy silt and variable amounts of clay. Chiefly unsorted, but locally moderately sorted as discontinuous lenses of sand and sandy pebbly gravel. Variably compact. May or may not show stratification or bedding. Forms end- and lateral-moraine ridges, hummocky ground moraine, and some relatively smooth ground-moraine plains. Also includes some glaciolacustrine, glacioalluvial, outwash, and other glacially related deposits. Thickness variable, as much as 25 m in some ridges, 10 m in hummocky terrain, and probably less than 7 m in plains (Karlstrom, 1964; Riehle and Emmel, 1980; Schmoll and Yehle, 1986, 1987, 1992; Yehle and Schmoll, 1987a,b, 1988, 1989, 1994; H.R Schmoll and L.A. Yehle, unpub. data, 2009; and F.H. Wilson, unpub. data, 2007). Unit ranges in age throughout the Quaternary. Locally subdivided into the following:

Qhg **Young moraine deposits (Holocene)**—Occurs mainly in prominent ridges within a few kilometers of large glaciers (late Holocene) and in well-developed to fragmentary ridges about 10 km downstream from large glaciers (early Holocene). Also occurs as a series of small ridges in some mountain valleys that head in small glaciers or valleys that no longer contain glaciers. Includes deposits of the Tunnel and Tustumena Stades (Karlstrom, 1964; Detterman and Hartsock, 1966); Tunnel Stade moraines are barren deposits as much as 1.6 km in front of present glaciers. Tustumena Stade deposits consist of partially dissected spruce- and brush-covered moraine 1.6 to 10 km in front of present glaciers (Detterman and Hartsock, 1966). On Kenai Peninsula, includes unmodified moraine deposits, which may be mantled by loess, generally 2 to 6 ft thick (Karlstrom, 1964). As shown also includes active and recently active rock glaciers consisting chiefly of rubble and coarse rock debris (F.H. Wilson, unpub. data, 2007) as well as fresh, poorly sorted debris on surfaces of glaciers (Detterman and Hartsock, 1966). In vicinity of Redoubt Volcano and Iliamna Volcano, may include a significant component of ash and other air-fall debris from eruptions (F.H. Wilson, unpub. data, 2007)

Qho **Younger outwash deposits (Holocene)**—Chiefly gravel and sand, well-bedded and sorted within beds, in terraces, and plains higher than modern streams near and down valley from present-day glaciers (Detterman and Hartsock, 1966; Riehle and Emmel, 1980; H.R. Schmoll and L.A. Yehle, 1986, 1987, 1992). Thickness probably 5–10 m (Karlstrom, 1964; F.H. Wilson, unpub. data, 2007)

Qgl **Glaciolacustrine deposits (Holocene and Upper Pleistocene)**—Chiefly well-sorted, well-stratified, laminated to massive silt and clay, with some sand and pebbly sand, especially near margins of ephemeral glacial and postglacial lakes. Deposits of small lakes marginal to glaciers may include diamicton. Near Beluga and Tustumena Lakes, deposits reflect higher level ancestral lakes. These deposits are thought to be typically covered by several feet of muck and peat (F.H. Wilson, unpub. data, 2007). Thickness is as much as 10 m, with some glaciolacustrine deltaic deposits as much as 50 m thick. In Talachulitna River valley (about 50 km north-northwest of Tyonek), includes by inference, deposits of ancestral glacial Lake Talachulitna (Karlstrom, 1964). Includes thin stratified and locally foreset-bedded sand and gravel over Hemlock Conglomerate of the Kenai Group sedimentary rocks (unit Tkh) that occur below 125 m elevation on West Foreland and from Katchin Creek to Redoubt Point; Riehle and Emmel (1980) inferred these deposits may be probable emerged delta and glaciolacustrine deposits. Includes active outwash fans (Riehle and Emmel, 1980)

Qm **Major moraine and kame deposits (Upper Pleistocene)**—Diamicton widespread in northern part of Cook Inlet basin and along margins of the basin farther south, produced by glaciers that originated in the adjacent mountains. Prominent end and lateral moraines indicated on map by blue line symbol. Most moraines represent glacier readvances during the general retreat from maximum positions in the central basin. Lakes, ponds, areas of peat deposits, and narrow channels are common locally. Kame fields, prominent locally, consist of irregularly shaped and relatively sharply defined hills as well as a few narrow and sinuous eskers that mainly consist of well-bedded to poorly bedded and sorted gravel and sand; some kame deposits and eskers might contain cores of diamicton. Especially between Big Lake and the Little Susitna River (Anchorage quadrangle), includes extensive esker fields (Kopczynski, 2008) and an area of ribbed (“Rogen”) moraines (Reger and Updike, 1983) reinterpreted as subaqueous dunes resulting from a catastrophic outburst from glacial Lake Atna far up the Matanuska Valley (Wiedmer and others, 2010). Moderately weathered, heavily spruce- and brush-covered moraine along Cook Inlet shoreline; (Detterman and Hartsock, 1966; F.H. Wilson, unpub. data, 2007). Internal contacts on west side of Cook Inlet reflect subdivisions of the Brooks Lake Glaciation; Iliuk, Newhalen, and Iliamna advances. Includes stratified and locally foreset-bedded sand and gravel that occur below about 60 m elevation on West Foreland and from Katchin Creek to Redoubt Point; deposits are probable emerged delta and glaciolacustrine deposits (Riehle and Emmel, 1980). Includes active outwash fans (Riehle and Emmel, 1980). On the east side of Cook Inlet, unit includes deposits of Naptowne Glaciation, mantled by 2 to 6 ft of loess (Karlstrom, 1964). Includes areas of bedrock covered by thin or discontinuous glacial deposits

Qgm **Modified glacial deposits (Upper Pleistocene)**—Consist of glacial deposits modified by estuarine or lacustrine processes. Deposits originally most likely associated with Last Glacial Maximum (Naptowne?) and (or) Knik glacial advances; however, includes terraced deposits mapped by Karlstrom (1964) as Eklutna in age. Well-defined morainal morphology either not developed due to deposition in water or has been modified by later submergence. Deposits consist of a variety of interbedded materials including diamicton, gravel, stony silt,

silt, fine-grained sand, and some clay and that generally have much fine-grained material. Winnowing of diamicton clasts and a cover of better sorted materials observed, especially in the Anchorage area (Karlstrom, 1964; Schmoll and others, 1999). Deposits are transitional between deposits of unit Qgm and map units Qge, Qbc, and minor other map units. Includes deposits of both units gm and mg of Schmoll and Dobrovolny (1972). Includes the Fire Island deposits of Schmoll and Gardner (1982) and Schmoll and others (1984), thought to have formed subaqueously in the glacioestuarine environment, perhaps in close proximity to glaciers

Qgc **Glacioalluvium (Upper Pleistocene)—**Gravel and sand that may be overlain by peat deposits; locally more than 1 m thick in channels within moraines. In some places, deposits may be lacking, and channel floored by diamicton of the enclosing moraine. Thickness generally less than 5 m. Includes abandoned channel deposits in outwash above modern floodplains or underfit stream channels, inferred to be relict glacial melt water channels; may include some glacial deposits (Detterman and Hartsock, 1966; Riehle and Emmel, 1980; Till and others, 1993; F.H. Wilson, unpub. data, 2007)

Qgo **Outwash in plains, valley trains, and fans (Upper Pleistocene)**—Outwash extending directly from moraines in plains and in downstream valley trains in channels not related to present-day streams. Fans, more distantly related to glacier sources, commonly graded to or may interfinger with glacioestuarine deposits. Chiefly well-bedded and sorted gravel and sand within beds, but may be finer grained, mainly sand or gravelly sand near toes of fans. Thickness 5–10 m, thinner toward fan toes. Extends from moraines of Naptowne age on Kenai Peninsula (Karlstrom, 1964) and to Brooks Lake age moraines on west side of Cook Inlet (F.H. Wilson, unpub. data, 2007)

Qge **Glacioestuarine deposits (Upper Pleistocene)**—Chiefly well-bedded and sorted, medium to coarse sand, includes some interbeds of fine gravel. Probably deposited as a cover sand during waning phases of glacioestuarine environment in which underlying Bootlegger Cove Formation was deposited. Includes Hood Lake deposits of Schmoll and others (1999). Commonly overlain by peat that may be more than 1 m thick over large areas. Thickness of deposits is as much as 10 m, but locally much thinner or even absent where surface peat directly overlies Bootlegger Cove Formation. Includes some abandoned beach ridges that rise a few meters above surrounding plain

Qbc **Bootlegger Cove Formation (Upper Pleistocene)—**Silty clay and clayey silt containing minor interbedded silt, fine to medium sand, and thin beds of diamicton, and containing scattered pebbles and cobbles in widely varying concentrations (Updike and others, 1988). Miller and Dobrovolny (1959) defined the unit as the Bootlegger Cove Clay and considered the deposit of glaciolacustrine origin, as did Karlstrom (1964) except for one shell-bearing marine horizon. Established as glacioestuarine in origin throughout the exposed formation by Schmidt (1963). Radiocarbon ages of 14,000 to 16,500 years B.P. reported from shells at Anchorage by Schmoll and others (1972) and by Reger and others (1995) from shells near Kenai. Thickness as much as 35 m at type area in Anchorage (Updike and others, 1988), but poorly known in the Susitna River and Yentna River region (Tyonek quadrangle) where only small outcrops along those rivers have been observed and along Turnagain Arm where scattered evidence has been found. However, thought to be widely extensive beneath cover sand deposits (Qge). Includes deposits near Point Campbell and near Girdwood that might be younger than and discrete from other deposits of unit

Qig **Intermediate age glacial deposits (Upper Pleistocene)**—Prominent, but modified morainal deposits of Knik Glaciation of Karlstrom (1964) widely exposed north of Homer on Kenai Peninsula (Karlstrom, 1964). Occurs on relatively flat lying to sloping surfaces on some lower mountains where diamicton may be somewhat weathered and subjected to minor gravitational reworking. On Kenai Peninsula, moraines of this age are terraced below approximately 228 m (750 ft), reflecting deposition in proglacial lakes; these deposits are included in unit Qgm. In the vicinity of Tustumena Lake, Reger (1995) suggests that the innermost area of these deposits may more properly be assigned to the Moosehorn advance of the Naptowne Glaciation (Last Glacial Maximum). However, this would require extending the Moosehorn advance a significant distance beyond the defined type area

Qog **Older glacial deposits (Middle or Lower Pleistocene)**—Prominent, but modified morainal deposits of Eklutna Glaciations of Karlstrom (1964). Occur on relatively flat lying to sloping surfaces on some lower mountains where diamicton may be somewhat weathered and subjected to minor gravitational reworking. Includes drift of the Caribou Hills glaciation on Kenai Peninsula (Karlstrom, 1964). Probably no more than a few meters to 10 m thick. Flat surfaces containing bedrock rubble and scattered glacial erratics, chiefly cobbles and small boulders, occur at highest elevations, notably on Mount Susitna. On Kenai Peninsula, moraines of Eklutna age are terraced below approximately 228 m (750 ft), reflecting modification in proglacial lakes. Includes pebble- and boulder-bearing diamicton observed at one upland location at West Foreland and in sea cliffs along West Foreland and from Katchin Creek south to near Redoubt Point (Riehle and Emmel, 1980). Drift of the Caribou Hills of Karlstrom (1964) is highly modified in Caribou Hills and exposed as remnant deposits elsewhere on Kenai Peninsula; deposits are terraced below elevations of about 305 m (1,000 ft) and discontinuously mantled by proglacial lake sediment deposits also reflecting modification in proglacial lakes (Karlstrom, 1964)

## SEDIMENTARY ROCKS

Tsu **Sedimentary rocks, undivided (Tertiary)**—Clastic sedimentary rocks in Talkeetna Mountains quadrangle described as fluviatile conglomerate, sandstone, and claystone with a few interbeds of lignitic coal. Sequence is greater than 160 m thick; lithologically resembles Chickaloon Formation but lacks fossil evidence for definitive correlation (Csejtey and others, 1978)

Tkn **Kenai Group, undivided (Pliocene to Oligocene)**—Coal-bearing clastic unit (in Seldovia, Kenai, and Tyonek quadrangles) consisting of, in descending order: Sterling, Beluga, and Tyonek Formations, and Hemlock Conglomerate in vicinity of Cook Inlet. According to Calderwood and Fackler (1972), unit is at least 8,000 m thick in the subsurface of Cook Inlet. Units are typically estuarine and nonmarine clastic sedimentary rocks. Calderwood and Fackler (1972) included West Foreland Formation within the Kenai Group; however, it was separated as a distinct unit by Magoon and others (1976). Swenson (1997) has proposed an alternative stratigraphic column for Cook Inlet basin that recognizes the time-transgressive nature of the units, wherein all units of Kenai Group and West Foreland Formation somewhat overlap in age. Dallegge and Layer (2004) suggested that the age range of the stratigraphic units be revised based on new $^{40}Ar/^{39}Ar$ dating of tephra from within Kenai Group. In particular, they document the time-transgressive nature of the formations and that Tyonek Formation may be as old as 49 Ma or early Eocene (Ypresian) in Matanuska River valley (see below), making its lower part age equivalent with Hemlock Conglomerate and West Foreland Formation. According to R.G. Stanley (USGS, written commun., 2009) the type sections for West Foreland Formation and the subdivisions of Kenai Group are not in outcrop but rather in the subsurface located in several different wells, both onshore and offshore. These wells, in turn, are located many miles from each other in an area of complicated structure and lateral facies changes; therefore, correlation of these subsurface type sections with the surface outcrops is poorly documented, difficult, and controversial. Subdivided into the following:

Tks **Sterling Formation (Pliocene and Miocene)**—Weakly lithified massive sandstone, conglomeratic sandstone and interbedded siltstone and claystone (in Kenai and Seldovia quadrangles); includes interbedded lignitic coals typically less than 1 m thick in upper part of unit, but may be as much as 3 m thick in lower part of unit (Calderwood and Fackler, 1972). According to Flores and others (1997, cited in Bradley and others, 1999), sandstone grades upward from coarse grained to very fine grained in trough crossbedded sequences; siltstone is typically ripple laminated and contains roots or burrows. Bradley and others (1999) indicated that only the lowest 700 m of the more than 3,000-m-thick Sterling Formation is exposed at the surface, consisting of sandstone, siltstone, mudstone, carbonaceous shale, lignite coal, and minor volcanic ash. Magoon and others (1976) tabulated plant fossil localities that provide the primary age control for Sterling Formation. Triplehorn and others (1977), Turner and others (1980), and Dallegge and Layer (2004) reported K-Ar, $^{40}Ar/^{39}Ar$, and fission-track age determinations from ash partings within coal beds within Sterling Formation (table 1). Dates range from 3.17±1.58 to 9.23±0.97 Ma; some older reported ages were interpreted to be contaminated by detrital material (Turner and others, 1980), or contain excess argon or xenocrystic material (Dallegge and Layer, 2004)

Tkb **Beluga Formation (Miocene)**—Nonmarine, interbedded, weakly lithified sandstone, siltstone, mudstone, carbonaceous shale, coal, and minor volcanic ash (Bradley and others, 1999) in Kenai and Seldovia quadrangles. Calderwood and Fackler (1972) reported a distinctive feature of Beluga Formation is its lack of massive sandstone beds and massive coal seams that characterize the underlying Tyonek Formation; however, lignitic to subbituminous coal seams can be as much as 4 m thick in the upper part of Beluga Formation. The contact between Beluga and overlying Sterling Formation may be an unconformity (Calderwood and Fackler, 1972), but in any case can be difficult to pinpoint (Calderwood and Fackler, 1972; Turner and others, 1980). Magoon and others (1976) tabulated plant fossil localities that provide the primary age control for Beluga Formation. Triplehorn and others (1977), Turner and others (1980), and Dallegge and Layer (2004) reported a number of K-Ar, $^{40}Ar/^{39}Ar$, and fission-track age determinations from ash partings within coal beds in this unit ranging from 4.57±0.72 to 12.9±5.1 Ma (table 1)

Tkt **Tyonek Formation (Miocene and Oligocene)**—Carbonaceous nonmarine conglomerate and subordinate sandstone, siltstone, and coal (Winkler, 1992; Bradley and others, 1999) in Tyonek, Talkeetna, and Anchorage quadrangles. Tyonek Formation is identified by massive sandstone beds and lignitic to subbituminous coal beds as much as 9 m thick (Calderwood and Fackler, 1972). Contact with overlying Beluga Formation is believed to be a disconformity where sandstone beds and coal beds become markedly thinner (Calderwood and Fackler, 1972). Reed and Nelson (1980) locally divided unit into two members: a sandstone member consisting of about 80 percent tan to light-gray sandstone, 20 percent light- to medium-gray siltstone and claystone, and less than 1 percent conglomerate, coal, and volcanic ash; and a conglomerate member consisting of 40 percent conglomerate, 20 percent sandstone, and less than 40 percent siltstone, claystone, and coal. Plant fossils comprising the Seldovian Stage of early and late Miocene age as well as plants representing the Angoonian Stage of Oligocene age provide age control (Wolfe and Tanai, 1980). Dallegge and Layer (2004) reported a $^{40}Ar/^{39}Ar$ age of 48.65±2.31 Ma on glass from a tephra sample collected from a well core; sample came from a depth of 593.8 m in the Matanuska River valley. According to Dallegge and Layer (2004), Smith (1995) considered this interval to represent the Tyonek Formation; however, there is no mention in Smith (1995) to suggest this correlation, which can only be inferred on the basis of an isopach map shown as figure 8 in Smith (1995). However, correlation of the dated sample with Tyonek Formation is considered doubtful according to D.L. LePain (Alaska Division of Geological and Geophysical Surveys, oral commun., March 3, 2008)

Tkh **Hemlock Conglomerate, undivided (Oligocene)**—Sandstone, conglomerate, and siltstone in the vicinity of Harriet Point in Kenai quadrangle on west side of Cook Inlet and in Mount Katmai and Afognak quadrangles (Calderwood and Fackler, 1972); original description suggests unit may be about 170 m thick. On the basis of the description in Detterman and others (1976), rocks consist of fluvial conglomeratic sandstone and conglomerate containing minor interbeds of siltstone, shale, and coal. Magoon and others (1976) mapped these rocks in a unit consisting of combined Tyonek Formation and Hemlock Conglomerate, whereas Detterman and others (1976) assigned these rocks to the Hemlock Conglomerate. Hemlock Conglomerate is lithologically transitional with Tyonek Formation, leading to some confusion; Hemlock Conglomerate is best known from the subsurface. Plant fossils indicate Oligocene age; Wolfe and Tanai (1980) suggested early Oligocene, and Wolfe (cited in Detterman and others, 1996) suggested late Oligocene in southern portion of map area, although he could not rule out an earliest Miocene(?) age. Wolfe and Tanai (1980) suggested the rocks at Harriett Point may be isochronous with beds considered typical of Tyonek Formation

Tts **Tsadaka Formation (Miocene or Oligocene)**—Poorly sorted cobble to boulder conglomerate, interbedded with lenses of feldspathic sandstone, siltstone, and shale (Winkler, 1992) at least 200 m thick. Unit is terrestrial and of local provenance, showing rapid lateral lithologic and thickness changes; deposited on alluvial fans and in braided streams from a northerly source (Winkler, 1992). Clasts in the conglomerate are largely plutonic in contrast to the underlying Wishbone Formation (Winkler, 1992). Age considered Oligocene in Anchorage quadrangle (Winkler, 1992) on the basis of plant fossils described by Wolfe (1977)

Tvs **Volcaniclastic sedimentary rocks (Eocene or younger)**—Light-green to gray, bedded volcaniclastic sedimentary rocks; some beds contain volcanic breccia clasts. Volcanic rock clasts are light green. LA-ICPMS detrital zircon dates have youngest grain ages of 55–58 Ma (D.C. Bradley, USGS, written commun., 2008). Unit outcrops along western margin of Tyonek quadrangle at approximately latitude 61° 30’ N.

Tw **Wishbone Formation (Eocene)**—Fluviatile conglomerate having thick interbeds of sandstone, siltstone, and claystone and containing local partings of volcanic ash (Winkler, 1992); maximum thickness of about 560 m (Barnes and Payne, 1956). Deposited in a similar environment as overlying Tsadaka Formation; however, source terrain was largely volcanic, most likely the Talkeetna Formation (Winkler, 1992)

Twf **West Foreland Formation (Eocene and Paleocene)**—Exposed only on west side of Cook Inlet, unit consists of 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. Detterman and Hartsock (1966) also describe a lenticular bed of carbonaceous ashstone breccia that may have been referred to as obsidian by Martin and Katz (1912). However, Detterman and Hartsock (1966) indicate that along with quartz and feldspar grains and probably glass shards, the bed also contains plant fragments and is clearly of sedimentary origin. Conglomerate clasts are mainly rounded to subrounded quartz diorite, volcanic rock, argillite, sandstone, siltstone, quartzite, tuff, and coal fragments. Intrusive and volcanic rock fragments each make up about 35 percent of the clasts in conglomerate. Medium- to coarse-grained arkosic sandstone forms the conglomerate matrix and forms distinct lenticular beds. Siltstone and shale interbedded with conglomerate is a very fine-grained subarkosic equivalent of the sandstone. Originally mapped as Kenai Formation by Detterman and Hartsock (1966); Calderwood and Fackler (1972) redefined Kenai Group and subdivided it into a number of formations. The rocks here were assigned to West Foreland Formation on the basis of correlation with the type section in a well (Pan American Petroleum Corp. West Foreland No. 1 well; Calderwood and Fackler, 1972) where the unit is about 275 m thick. West Foreland was assigned Oligocene age by Kirschner and Lyon (1973) and later reassigned early Eocene and late Paleocene age by Magoon and others (1976), presumably on the basis of plant fossils. Recent dating of zircon from an interbedded tuff about 1 m thick yielded a 43 Ma age (middle Eocene) (P.J. Haeussler, USGS, written commun., 2008). West Foreland Formation was removed from Kenai Group because it was separated by a major unconformity from the overlying Hemlock Conglomerate (Magoon and Egbert, 1986). Unit may be equivalent to Arkose Ridge Formation described below. Lower contact was described by Detterman and Hartsock (1966) as an angular unconformity with Upper Jurassic Naknek Formation; subsequent work by Magoon and others (1980) showed there to be a nonmarine Upper Cretaceous sedimentary unit between rocks of West Foreland and Naknek Formations. Those Cretaceous rocks are shown here as unit Ksm

Tar **Arkose Ridge Formation (lower Eocene and upper Paleocene)**—Fluviatile and alluvial feldspathic and biotitic sandstone, conglomerate, siltstone, and shale containing abundant plant fragments (Csejtey and others 1977; Winkler, 1992). Coarsening upward sequence was deposited on alluvial fans and by braided streams carrying sediment derived from rapid erosion of uplifted mountains to the north (Winkler, 1992). Thickness is as much as 700 m. Age control is largely based on late Paleocene fossil plants and radiometric ages on locally associated volcanic flows and dikes (Tvu). A pre-Tertiary age has been suggested for the part of the unit based on a questionable 67.5±2.4 K-Ar age determination on biotite from a metamorphosed part of the unit (Csejtey and others, 1977, 1978; sample 76ACy 19, table 1 here); otherwise the age is considered broadly coeval with Chickaloon Formation based on 46 to 56 Ma whole rock ages from volcanic rocks in lower part of formation and 46.1±2.8 Ma whole rock age of basalt dike from the middle of formation as well as late Paleocene plant fossils (Silberman and Grantz, 1984). Unit may be equivalent to West Foreland Formation, representing a transtensional basin along the Castle Mountain Fault system

Tch **Chickaloon Formation (lower Eocene and upper Paleocene)**—Predominantly fluviatile and alluvial carbonaceous mudstone, siltstone, conglomeratic sandstone, and polymictic conglomerate (Winkler, 1992). Locally, upper and middle parts of unit contain numerous beds of bituminous coal (Winkler, 1992). Lower part of unit largely conglomerate and lithic sandstone derived from erosion of the Talkeetna Formation (Winkler, 1992). A strongly deformed, "southerly derived, green-weathering, noncarbonaceous basal sequence of poorly sorted, massive to crudely stratified cobble and boulder conglomerate ***" grades "upward into well-stratified, thick-bedded sandstone and conglomerate ***" having a chloritic matrix (Winkler, 1992). Little (1988, 1990, cited in Winkler, 1992), interpreted this sequence to represent a prograding alluvial fan derived from uplift and erosion of the

Chugach accretionary complex (Chugach terrane) to the south (Winkler, 1992). Thickness is more than 1,500 m (Winkler, 1992). Age control derived from K-Ar and fission-track determinations on ash partings within coal beds ranging from 52 to 56 Ma (table 1) and the presence of Paleocene fossil leaves (Wolfe and others, 1966; Triplehorn and others, 1984)

Tcl **Copper Lake Formation, undivided (lower Eocene and Paleocene?)**—Thick clastic nonmarine sedimentary rock unit consisting of an upper and lower conglomerate member bounding a middle sandstone and siltstone member at the east end of Iliamna Lake (Detterman and Reed, 1980; Detterman and others, 1996). Detterman and others (1996) described a 1,025-m-thick section in the Mount Katmai area. In the Iliamna Lake region (Detterman and Reed, 1980), upper conglomerate unit consists of red-weathering pebble-cobble conglomerate consisting mainly of volcanic rock clasts and containing minor tuff. Member may be an agglomerate rather than conglomerate; clasts are 50 to 100 percent fresh-appearing volcanic rock. Clasts of quartzite, schist, greenstone, rose quartz, limestone, and granitic rocks are present in lower parts of this member. Sandstone and siltstone intervals of measured section vary from thin bedded to massive and are typically dark- to medium-gray; they are fine- to medium-grained lower in section and become medium- to coarse-grained toward top. Middle member is chiefly medium-gray to greenish-gray, lithic graywacke sandstone and siltstone. More fine-grained clastic parts of formation contain considerable carbonaceous debris and minor coaly 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 micaceous 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 percent and appear to be derived from the Talkeetna Formation and not fresher appearing Tertiary volcanic units. Copper Lake Formation was derived from erosion of Mesozoic source area and is terrestrial. In Mount Katmai and Iliamna quadrangle areas, this source area was underlain by Alaska-Aleutian Range batholith (Reed and Lanphere, 1973) and associated Mesozoic sedimentary and metamorphic rocks. Towards the north, Copper Lake Formation undergoes transition from rocks of Mesozoic provenance to fresh volcanic clasts of probable Tertiary age (Detterman and Reed, 1980, p. B47). Age of the Copper Lake Formation is poorly constrained; sparse megaflora in type section in Iliamna area and abundant megaflora on the Alaska Peninsula are restricted to sandstone and siltstone intervals in middle part of unit (Detterman and others, 1996). Detterman and others (1996) correlated the Copper Lake Formation with the Tolstoi Formation of the southwest Alaska Peninsula where an early Eocene megaflora was collected from a sandstone and siltstone section overlying a basal conglomerate containing a late Paleocene flora and underlying beds containing a middle Eocene flora. By analogy, a Paleocene(?) to early Eocene age was assigned to the Copper Lake Formation by Detterman and others (1996). Upper and lower contacts of the Copper Lake Formation are disconformities with Hemlock Conglomerate and Kaguyak Formation, respectively

Kyh **Graywacke of the Yenlo Hills (Cretaceous?)**—According to Reed and Nelson (1980), graywacke in the Yenlo Hills (Willow Mountain and Mount Yenlo) of the Talkeetna quadrangle differs significantly from other sedimentary rocks in the vicinity “in that extremely angular, and oscillatory zoned plagioclase, volcanic rock fragments, hornblende, epidote, and calcite grains are more abundant, suggesting that the sandstone may have been derived from the Jurassic magmatic arc (Reed and Lanphere, 1973) now covered by younger rocks in Cook Inlet basin. Contemporaneous volcanism is suggested by rare interbedded light tuffaceous sediments in the Yenlo Hills (Reed and Nelson, 1980).” We have separated these rocks because of their distinct lithologic differences with other rocks assigned to the Kahiltna flysch sequence (units KJs, Ksf, Kes)

Kkd **Kodiak Formation (Upper Cretaceous)**—Medium- to thick-bedded, graded-bed sequences that average 1 m thick, of arkosic wacke and shale and occasional beds of pebbly conglomerate, mostly known from Kodiak Island, south of the map area. Flute casts and complete Bouma sequences indicate deposition by turbidity currents. Unit crops out more extensively south of map area; crops out in a small area on northern end of Shuyak Island in Afognak quadrangle. Moore (1969) designated type section as rocks exposed along western shore of Uyak Bay in Kodiak quadrangle, about 70 km south of map area. Subsequent work by Nilsen and Moore (1979) indicated that unit is approximately 5,000 m thick, in contrast to estimated thickness of 30,000 m as originally suggested by Moore (1969). Nilsen and Moore (1979) found that unit is repeated structurally by folding and faulting, which makes internal stratigraphic correlation difficult; unit strikes northeast and dips steeply northwest and is generally deformed in tight, large-scale folds. Nilsen and Moore (1979) used a turbidite facies and facies-association scheme that generally follows the system of Mutti and Ricci Lucchi (1972, 1975, cited in Nilsen and Moore, 1979) and Nelson and Nilsen (1974, cited in Nilsen and Moore, 1979); under this system, Kodiak Formation consists largely of basin-plain- and slope-facies associations. Basin-plain facies is structurally lowest part of Kodiak Formation and is characteristic of most of formation on southeast side of Kodiak Island (Nilsen and Moore, 1979). Slope-facies rocks are found primarily on northwest side of Kodiak Island and are primarily thick mudstone sequences. Conglomerate and sandstone channels are found locally within slope-facies associations; Nilsen and Moore (1979) mentioned channels in Uyak Bay in particular, where channels are about 50 m thick. Fossils from Kodiak Formation include *Inoceramus kusiroensis* of Late Cretaceous (Maastrichtian) age. Correlated with Shumagin Formation to southwest and Valdez Group to northeast

Ksm **Saddle Mountain section of Magoon and others (1980) (Upper Cretaceous, Maastrichtian)**—Nonmarine sandstone, conglomerate, and minor siltstone and coal in a section 83 m thick (Magoon and others, 1980). Consists dominantly of fine- to medium-grained sandstone that becomes finer grained upward. Generally massive; some crossbedded sections. 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 most abundant in middle part of section. Sporomorphs *Cranwellia striata* (Couper) Srivastava, *Balmeisporites* spp., *Wodehouseia spinata* Stanley, *Proteacidites* spp., *Aquilapollenites bertillonites* Funkhouser, *A. reticulatus* Mtchedlishvili, and *A. delicatus* Stanley (Magoon and others, 1980) indicate Maastrichtian age. Unit was assigned to Kaguyak Formation by Bradley and others (1999), but is separated here because its lithology and depositional environment are distinctly different from Kaguyak Formation. Unit overlies Upper Jurassic Naknek Formation with angular unconformity; unit overlain by West Foreland Formation with angular unconformity. Unit found northeast of Chinitna Bay in Seldovia quadrangle

Kkg **Kaguyak Formation (Upper Cretaceous, Maastrichtian and Campanian)**—Dark-gray to pale-brown, typically thin-bedded, marine shale, siltstone, and fine-grained sandstone; measured thickness of more than 1,200 m (Detterman and others, 1996). Named by Keller and Reiser (1959) for rocks exposed near abandoned village of Kaguyak in Afognak C-6 1:63,360-scale quadrangle, south of map area. Unit mapped on south side of Kamishak Bay. Proportion of sandstone increases up-section. Load and flute casts common; in upper part of unit, graywacke is graded with numerous rip-up clasts. Overall depositional environment was near mid-fan 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, locally abundant in lower part of unit. Ammonites are most common and may range in size to as much as 1 m across. Fossils indicate latest Campanian and early Maastrichtian age. Unit unconformably overlies Naknek and Herendeen Formations; unit is unconformably overlain by Copper Lake Formation and younger units

Kcc **Cape Current terrane of Connelly (1978) (Upper Cretaceous)**—Informal unit described by Connelly (1978) as consisting principally of medium- to thick-bedded arkosic and lithic sandstone that contains occasional sections of vesicular pillow lava and pillow breccia. Slightly metamorphosed and moderately deformed. Crops out more extensively south of map area; crops out in a small area on northern end of Shuyak Island in Afognak quadrangle. Two bodies of red pelagic limestone containing many siliceous layers are present within unit along southern shore of Shuyak Island. Limestone is thin-bedded and tightly folded; contains sparse coccoliths of indeterminate age and Late Cretaceous foraminifera (approximately Turonian to early Santonian age, according to W.V. Sliter, written commun., *in* Connelly, 1978)

Km **Matanuska Formation (Upper Cretaceous, Maastrichtian, to upper Lower Cretaceous, Albian)**—Well-indurated, thinly bedded, dark-gray fossiliferous shallow marine shale containing conspicuous calcareous concretions, volcanic-lithic siltstone, sandstone, graywacke, and subordinate conglomerate (Winkler, 1992). According to Martin (1926), unit is at least

1,250 m thick. Diverse shallow to deep marine (in part, turbiditic) deposits derived from a northern source, either an unidentified mid-Cretaceous magmatic arc or the Jurassic arc represented in part by the Talkeetna Formation (Winkler, 1992). Upper part of unit is coeval with the flysch of the Valdez Group to the south. Rests with pronounced angular unconformity on Early Cretaceous and older strata (Csejtey and others, 1978)

KJs **Turbiditic sedimentary rocks of the Kahiltna flysch sequence (Cretaceous, Aptian and Valanginian or younger, to Upper Jurassic?)**—Monotonous sequence of intensely deformed and locally highly metamorphosed turbidites described by Csejtey and others (1992) and Reed and Nelson (1980). Includes dark-gray to black argillite, fine- to coarse-grained, generally dark-gray graywacke, siltstone, and shale turbidites, thinly bedded and dense cherty argillite, dark-gray polymictic pebble conglomerate, subordinate black chert pebble conglomerate, a few thin layers of dark-gray to black radiolarian chert and thin, dark-gray impure limestone interbeds. Sandstone includes graywacke in beds up to 2 m thick and feldspathic sandstone. Includes rocks mapped by Reed and Elliot (1970) as their units Km, Mzu, and Mzs. Locally contact metamorphosed on the margin of intrusions. Three fossils were found in this unit in the Tyonek quadrangle. Coquina beds south of McDoel Peak (southern edge of Talkeetna quadrangle) yielded *Buchia sublaevis* Keyserling of Valanginian age (Solie and others, 1991, their unit Ks). A middle Turonian *Inoceramus hobetsensis* Nagao and Matsumoto was also found within this unit north of the terminus of Hayes Glacier (William P. Elder, USGS, written commun., 1989 to Dwight Bradley). A float sample of chert also from this vicinity contained poorly preserved *Spumellariina*, which yielded a not-tightly constrained age between middle Toarcian (Lower Jurassic) to upper Valanginian (Lower Cretaceous) (E.A. Pessagno, Univ. of Texas, written commun., 2006, to Marti Miller, USGS); it is uncertain how this sample might constrain the age of this map unit. $^{40}Ar/^{39}Ar$ age determinations (table 1) on hornblende from igneous clasts in the conglomerate yielded Cenomanian ages. Fossils indicate the rocks are both Early and Late Cretaceous in age, and the radiometric ages on the conglomerate clasts indicate latest Early Cretaceous age igneous rocks formed a source for some of the unit. Thus, considering the Barremian to Aptian and Turonian to Santonian detrital zircon ages within unit Kes to the southwest, it appears there are at least two sequences of Cretaceous sedimentary rocks within unit KJs, which we are unable to distinguish based upon appearance. In the Talkeetna quadrangle to the north, similar rocks were assigned a Jurassic and Cretaceous age (map unit KJs, Reed and Nelson, 1980); however, the Jurassic fossils were derived from spatially and lithologically distinct rocks which we do not consider part of this map unit. The rocks of unit KJs are traditionally assigned to the informally named Kahiltna assemblage (Nokleberg and others, 1994). Studies by Ridgway and others (2002), Kalbas and others (2007), and Hampton and others (2007) have reported detrital zircon analyses that suggest the Kahiltna assemblage is, at least in part, Aptian or Albian or younger in age, similar to some of detrital zircon analyses reported for unit Kes below. However, these analyses are somewhat in conflict with the Valanginian fossils reported by Solie and others (1991). Reed and Nelson (1980) reported indeterminate broadleaf plant fossils occur in rocks of this unit that are lithologically similar to the largely Late Cretaceous Matanuska Formation (Km). The Kahiltna assemblage, widespread in southern Alaska, is often the repository for miscellaneous dark-colored sedimentary rock units and as such may not represent a coherent package of rocks. In the southwest part of the Tyonek quadrangle, the nature of the transition from this unit to the Kuskokwim Group is undefined. Both units have similar lithology and character and available mapping is insufficient to either distinguish the units or to indicate that they should be mapped as the same unit. Unit as mapped in the Tyonek quadrangle includes rocks mapped by Reed and Elliott (1970) as units Km, Mzu, and Mzs. Locally subdivided into the following:

Ksf **Feldspathic sedimentary rocks (Cretaceous)**—Reddish-brown-weathering, turbiditic, feldspathic wacke containing interbeds of locally calcareous siltstone, shown as unit Kw by Reed and Elliot (1970) in the northwestern Tyonek quadrangle

Kes **Turbiditic sedimentary and volcanic rocks (Cretaceous, Aptian or younger)**—Largely silty to sandy graywacke in beds up to 2 m thick. Sandy beds are medium to coarse grained, with quartz, feldspar, and chert clasts. Reed and Elliot (1970) reported that these rocks contain subordinate metavolcanic rocks; near the South Twin Glacier (western Tyonek quadrangle) outcrop is dominantly volcanic rocks. Unit contains detrital zircons with youngest grain ages of 138–122 Ma based on analyses from three samples (D.C. Bradley, USGS, written commun., 2008). A sample from the southwesternmost outcrop between Emerald Creek and the Skwentna River has youngest detrital zircon grain ages of 93–84 Ma (D.C. Bradley, USGS, written commun., 2008). Thus, considering the Barremian to Aptian detrital zircon ages and these younger detrital ages, it appears there are also two sequences of Cretaceous sedimentary rocks within unit Kes. Unit Kes is mapped only where detrital zircon analyses indicate the age of the sedimentary rocks. Detrital zircon ages are consistent with others from the informally named Kahiltna assemblage reported by Kalbas and others (2007) and Hampton and others (2007) and indicate the unit is Santonian or younger and suggest a long depositional history; the younger part of the sequence may be age correlative with the Kuskokwim Group exposed southwest of the map area

Khe **Herendeen Formation (Lower Cretaceous, Barremian and Hauterivian)**—Originally named Herendeen Limestone by Atwood (1911, p. 39) for exposures along east shore of Herendeen Bay on the southern Alaska Peninsula outside of the map area; renamed Herendeen Formation by Detterman and others (1996), who designate a 270-m-thick reference section south of the map area in hills southwest of Hot Spring in the Port Moller quadrangle (southern Alaska Peninsula). In the map area, unit crops out south of Kamishak Bay. Originally described as limestone, rocks are actually unusually uniform calc-arenaceous sandstone. Thin-bedded, medium-grained, dusky yellow to pale yellowish brown on freshly broken surfaces, and weather to conspicuous light-gray. Distinct platy fracture upon weathering and strong petroliferous odor when freshly broken. *Inoceramus* fragments form major component of formation, although complete specimens have only been found in the Mount Katmai area. A belemnite similar to *Acroteuthis* sp. *A* (Jones and Detterman, 1966) was found in rocks of formation just east of Staniukovich Mountain between Port Moller and Herendeen Bay. Ammonite fossils and other collections from Herendeen Formation in Mount Katmai area indicate Hauterivian and Barremian age (J.W. Miller, USGS, written commun., 1983–85; Detterman and others, 1996)

Jn **Naknek Formation, undivided (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. Largely consists of sandstone, conglomerate, and siltstone having a primarily plutonic provenance. 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). Aggregate thickness of the unit members exceeds 3,000 m, though the average thickness the formation is more typically 1,700 to 2,000 m (Detterman and others, 1996). Megafossils, particularly the pelecypod *Buchia* (Detterman and others, 1996), are common and with ammonites indicate age range of Oxfordian to late Tithonian (Late Jurassic). Detterman and others (1996; see also, Detterman and Hartsock, 1966; Martin and Katz, 1912) subdivided unit into the following members:

Jnk **Katolinat Conglomerate Member (Tithonian)**—Type section, designated by Detterman and others (1996), is on unnamed mountain on northeast shore of Lake Grosvenor (secs. 33 and 34, T. 17 S., R. 35 W., Mount Katmai C-4 1:63,360-scale quadrangle). About 450-m-thick pebble-boulder conglomerate and minor amounts of greenish-gray to yellowish-green sandstone containing abundant quartz, chert, and granitic and metamorphic rock clasts. Restricted to northern part of Alaska Peninsula, it is, in part, lateral facies equivalent of upper part of Indecision Creek Sandstone Member. Lower contact is gradational with Indecision Creek Sandstone Member. Upper contact is unconformity with overlying Lower Cretaceous Herendeen Formation. Unit mapped north of the Savonoski River in southwest part of map, in Mount Katmai quadrangle

Jni **Indecision Creek Sandstone Member (Tithonian and Kimmeridgian)**—First recognized by Keller and Reiser (1959); designated as informal member of Naknek Formation by Detterman and Reed (1980); formally named and described by Detterman and others (1996). Detterman and others (1996) designated an approximately 870-m-thick type section on east-facing slope of unnamed mountain near Mount Chiginagak in the Ugashik A-4 1:63,360-scale quadrangle, south of the map area. Consists of thin-bedded to massive, locally crossbedded, medium-gray, fine- to medium-grained arkosic sandstone and siltstone. Fresh biotite and hornblende are minor, but important, components of sandstone because they are interpreted to indicate first-cycle erosion from Alaska-Aleutian Range batholith. Indecision Creek Sandstone Member is abundantly fossiliferous, but almost exclusively restricted to pelecypods of genus *Buchia*. Depositional environment is shallow-water shelf to inner neritic (Detterman and others, 1996). Lower contact is conformable and slightly gradational with Snug Harbor Siltstone Member. Upper contact is unconformity with overlying Upper Cretaceous or Tertiary strata except where conformably and gradationally overlain by Staniukovich Formation or, in Mount Katmai region, Katolinat Conglomerate Member. Indecision Creek Sandstone Member is most widely exposed member of Naknek Formation

Jnp **Pomeroy Arkose Member (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). Sandstone is rich in quartz (40–45 percent) and sodic feldspar (30–35 percent) and as well as 15–20 percent hornblende and tourmaline. Volcanic lithic fragments make up 2–3 percent of the rock. Grains are sub-angular to sub-rounded. Matrix is generally clay but locally is tuffaceous. 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 siltstone contains a higher proportion of volcanic- and sedimentary-sourced components. Detterman and Hartsock (1966) indicated that most sections of 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; *Lytoceras*, *Phylloceras*, and *Buchia concentrica* suggest 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 (hornblende, tourmaline, and feldspar) indicate short transport and rapid burial

Jnst **Snug Harbor Siltstone Member (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); unit is about 250 m thick. 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; main fossils are *Buchia*, including *Buchia concentrica*, and ammonites *Amoeboceras*, *Phylloceras*, and *Perisphinctes*

Jnn **Northeast Creek Sandstone Member (Oxfordian)**—Light-gray, thin-bedded to massive arkosic sandstone, graywacke, and siltstone. Originally called the "lower sandstone member" and indicated to be as much as 250 m thick by Detterman and Hartsock (1966) who considered unit of only local significance. Later work on the Alaska Peninsula (Detterman and others, 1996) showed that the lateral equivalent of this unit, which they named the Northeast Creek Sandstone Member, is present along the entire length of the Alaska Peninsula. According to Detterman and Hartsock (1966), some beds have a tuffaceous matrix, zones of small pebbles, and thin beds of arenaceous siltstone. Fossils are most common in the lower part of unit and include ammonites, particularly *Cardioceras*, but also *Phylloceras* and *Lytoceras*. Detterman and Hartsock (1966) assigned a latest Callovian and early Oxfordian age based on *Cardioceras martini* in lower part of member and its association with *Cardioceras distans*, which then without *Cardioceras martini* continues to the top of the member. Detterman and others (1996) assigned only an Oxfordian age to the unit based on reinterpretation of the available information. Pelecypods including *Pleuromya*, *Quenstedtia*, *Oxytoma*, *Thracia*, and *Astarte* are present but uncommon as are gastropods, echinoids, and belemnites (Detterman and Hartsock, 1966). Lower contact intertongues with the Chisik Conglomerate Member. Upper contact gradational with overlying Snug Harbor Siltstone Member

Jnc **Chisik Conglomerate Member**—Massive to thick-bedded conglomerate and interbedded, crossbedded, quartzose sandstone, about 125 m thick on Chisik Island, but as much as 614 m thick south of map area. Clasts, as large as 2 m, are mainly granitic rocks, but up to 20 percent are metamorphic and volcanic rocks (Detterman and others, 1996). A K-Ar age determination (table 1, sample 62Ale 6e) on a quartz diorite cobble yielded an age of 156.6 Ma on biotite and 159.7 on hornblende, indicating provenance was likely the Alaska-Aleutian Range batholith (Detterman and others, 1965). Gradational and conformable contact with overlying Northeast Creek Sandstone Member

Jc **Chinitna Formation, undivided (Middle Jurassic, Callovian)**—Massive, marine, gray arenaceous shale and siltstone containing numerous large limestone concretions. Contains mixture of plutonic and volcanic detritus presumed to have been derived from erosion of the Talkeetna Formation and related plutonic rocks of the Early to Middle Jurassic magmatic arc. Unit is best exposed along the west coast of Cook Inlet and is subdivided into two members; upper Paveloff Siltstone Member and 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). Unit also mapped in the Anchorage quadrangle, north of the Castle Mountain Fault system. Unit age revised to Callovian by Imlay and Detterman (1973). Subdivided into the following:

Jcp **Paveloff Siltstone Member**—Massive, dark-gray arenaceous siltstone in the upper part and a thick sandstone unit at its base; between 275 m to more than 400 m thick in Kenai and Iliamna quadrangles (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. Siltstone is well indurated and uppermost part is thin-bedded and fractures into angular fragments. 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 common; fresh surfaces are very dark-gray, but weather buff to cream colored. Locally the limestone is bioclastic (Detterman and Hartsock, 1966). Many non-diagnostic pelecypods and gastropods have been collected from the lower sandstone (Detterman and Hartsock, 1966), whereas a wide variety of ammonites have been collected from the siltstone and limestone concretions higher in the section. Ammonites, include *Cadoceras*, *Stenocadoceras*, *Pseudocadoceras*, *Kepplerites*, *Kheraiceras*, and *Lilloettia* (Detterman and Hartsock, 1966) and indicate Callovian age, although the uppermost zone of the Callovian has not been identified. Paveloff Siltstone Member is the age equivalent of Shelikof Formation of the Alaska Peninsula; Shelikof Formation contains a higher proportion of coarse volcanic debris (Detterman and others, 1996)

Jct **Tonnie Siltstone Member**—Massive, dark-gray to brownish-gray arenaceous siltstone; weathers brownish-gray to red-brown (Detterman and Hartsock, 1966), typically about 250 m thick but thickens to as much as 400 m in exposures to the south. 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. Limestone concretions are generally ovoid and as much as 12–13 cm in diameter, extremely hard, and commonly fossiliferous (Detterman and Hartsock, 1966). Sandstone interbeds are compositionally similar but coarser grained than the siltstone. A thick (6–30 m) sandstone bed present at the base of the unit is medium-bedded to massive, fine- to medium-grained and grayish-brown. On Chisik Island (Kenai quadrangle), a thick (65 m) channel conglomerate, consisting 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). Unit is abundantly fossiliferous, yielding many mollusks, particularly ammonites *Paracadocreas*, *Pseudocadoceras*, *Phylloceras*, *Lilloettia*, *Kheraiceras*, *Kepplerites*, and *Xenocephilites*, numerous pelecypods, and rare belemnites, gastropods, and brachiopods indicate early Callovian age (Detterman and Hartsock, 1966)

Jt **Tuxedni Group, undivided (Middle Jurassic, lower Bathonian to Aalenian)**—Fossiliferous, light- to dark-gray and green marine graywacke, conglomerate, siltstone, and shale (Detterman and Hartsock, 1966). Graywacke ranges from feldspathic to lithic to laumontitic, conglomerate composed mainly of volcanic clasts in a graywacke matrix. Unconformably overlies Talkeetna Formation and is disconformably overlain by Chinitna Formation. Locally subdivided into the Red Glacier Formation, Gaikema Sandstone, Fitz Creek Siltstone, Cynthia Falls Sandstone, Twist Creek Siltstone, and Bowser Formation. Descriptions shown below are derived from Detterman and Hartsock (1966); age revised to Bathonian to Bajocian by Imlay and Detterman (1973) and to lower Bathonian to Aalenian by Detterman and Westermann (1992). Undivided unit shown only in Anchorage quadrangle

Jtb **Bowser Formation (Middle Jurassic, lower Bathonian and upper Bajocian)**—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 on the Iniskin Peninsula (Iliamna quadrangle). Coarse-grained sandstone and conglomerate matrix composed of angular fragments of feldspar and quartz; common accessory minerals biotite, augite, and magnetite. Light-gray sandstone is interbedded with dark-gray sandstone and is commonly calcareous and contains numerous coquina beds composed almost entirely of pelecypods *Inoceramus* and *Trigonia*. Conglomerate clasts are dominantly felsic volcanic rocks and basalt but include about 10 percent granitic rocks. Siltstone as much as 100 m thick is interbedded with conglomerate and sandstone and north of Chinitna Bay siltstone occurs in units 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, dark-brownish gray, weathering to light-brown. Lenticular limestone concretions containing ammonites are common north of Chinitna Bay. Overall thickness ranges from 380 to 560 m. Abundantly fossiliferous, containing ammonites and pelecypods. Most recently dated as late Bajocian to early Bathonian by Detterman and Westermann (1992), unit can be divided into two faunal zones which occur on either side of the break between Callovian and Bathonian. Lower faunal zone immediately overlies unconformity with Twist Creek Siltstone and contains ammonites *Cranocephalites*, *Arctocephalites*, *Siemiradzkia*, *Cobbanites*, and *Parareineckia* and is middle Bathonian in age. Upper faunal zone contains ammonites *Xenocephalites*, *Kheraiceras*, and *Kepplerites*

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

Jtc **Cynthia Falls Sandstone (Bajocian)**—Massive to thick-bedded graywacke sandstone and pebble conglomerate about 200 m thick (Detterman and Hartsock, 1966) in Kenai, Seldovia, and Iliamna quadrangles. Medium- to coarse-grained, greenish-gray to dark-green sandstone, graded bedding, weathers mottled light-gray due to the presence of zeolites. 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 makes up 10 to 20 percent of the formation, and is interbedded with the sandstone and may contain a few limestone concretions. Like underlying Fitz Creek Siltstone and Gaikema Sandstone, unit is coarsest grained in the vicinity of Gaikema Creek and finer grained away from this area. Fossils are relatively uncommon, thought in part due to rapid deposition in a nearshore environment. Sparse fauna includes ammonites *Chondroceras* and *Stephanoceras* and pelecypods *Inoceramus* sp. and *Mytilus* sp.

Jtf **Fitz Creek Siltstone (middle Bajocian)**—Thick sequence (up to 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) in Kenai, Seldovia, and Iliamna quadrangles. Fine-grained sandstone and, locally, conglomerate is interbedded. Siltstone in upper part of unit, could possibly be called silty shale. Unit is coarsest in vicinity of Gaikema Creek and rapidly becomes finer grained in all directions away from Gaikema Creek section. Unit is abundantly fossiliferous and is the lowest 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 in forms distinctly different than those found in the lower parts of the Tuxedni Group

Jtg **Gaikema Sandstone (lower middle Bajocian)**—Resistant, cliff-forming, massive to thin-bedded graywacke sandstone and cobble conglomerate 150 to 260 m thick (Detterman and Hartsock, 1966) in Kenai, Seldovia, and Iliamna quadrangles. Sandstone commonly occurs in graded beds up to 3 m thick, whereas conglomerate is well sorted within individual beds and rarely shows grading (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 in the Gaikema Sandstone are the first appearance of rocks presumably derived from the Alaska-Aleutian Range batholith. Siltstone, occurring mainly as thin interbeds in sandstone, is thin-bedded to massive, generally coarse silt to sandy, gray to olive-gray, and brownish to rusty brown weathering. In general, siltstone constitutes less than 10 percent of unit, though locally it can constitute as much as 40 percent. Siltstone apparently does not occur in close proximity to conglomeratic parts of unit (Detterman and Hartsock, 1966). Unit is fossiliferous throughout, containing pelecypods *Meleagrinella*, *Trigonia*, and *Inoceramus* and ammonites *Witchellia*(?), *Stephanoceras*, and locally, *Sonninia (Papilliceras)*, *Lissoceras*, and *Emileia*. Carbonized plant remains are locally present

Jtrg **Red Glacier Formation (lower Bajocian to Aalenian)**—Thin-bedded to massive, red-brown-weathering, dark-gray to moderate olive-gray, highly arenaceous siltstone, locally containing lenticular interbeds and concretions of reddish-gray, dense limestone and very minor coal seams (Detterman and Hartsock, 1966) in Kenai, Seldovia, and Iliamna quadrangles. Underlying this is light-tan to buff arkosic sandstone and thick black, silty to arenaceous, very fissile shale. Siltstone constitutes about 40 percent of unit, concentrated in upper part, sandstone about 25 percent, and shale the remainder. Overall thickness ranges from 600 m to as much as 2,000 m. Fossils most abundant in upper part of unit; no fossils known from lowermost part (as much as 600 m). Pelecypods include *Meleagrinella*, *Trigonia*, *Inoceramus*, *Camptonectes*, and *Pleuromya*. Ammonites occur in two distinct faunal assemblages: lower assemblage includes *Erycites*, *Tmetoceras*, and *Pseudolioceras* and faunal zone ranges from 450 to 1,400 m below the top of formation. Upper assemblage in upper 400 m of formation includes *Soninia*, *Emileia*, *Parabigottes* and in the uppermost 150 meters, *Papilliceras*, *Strigoceras*, *Lissoceras*, *Stephanoceras*, *Stemmatoceras*, and *Skirroceras*. Detterman and Hartsock (1966) suggested that formation "probably was deposited by progressive onlap onto an irregular south-dipping {*present geometry*} erosional surface on the Talkeetna Formation; some of the increase in section {*thickness*} probably due to subsidence of the basin during deposition (*italics added*)"

Jtk **Talkeetna Formation, undivided (Lower Jurassic)**—Bedded volcanic rocks widely distributed in the Talkeetna Mountains and west of Cook Inlet. Unit consists of flows, breccia, tuff, and agglomerate and locally interbedded minor sandstone and shale, all typically somewhat altered or metamorphosed (Detterman and Hartsock, 1966; Detterman and Reed, 1980). First described by Paige and Knopf (1907); the name Talkeetna Formation was introduced by Martin (1926), recognized as a widespread and important marker horizon in southern Alaska. Detterman and Hartsock (1966) formally divided unit into three members. Within the map area, Talkeetna Formation is locally subdivided, from top to bottom, into the following:

Jtkh **Horn Mountain Tuff Member**—Bedded tuff and tuffaceous feldspathic sandstone, locally containing porphyritic andesite flows. Bedded tuff is tan, red, green, purple, or mottled-color, thin-bedded to massive and fine- to coarse-grained (Detterman and Hartsock, 1966). Locally, tree stumps are preserved within tuff beds, suggesting subaerial deposition. However, thin-bedded laminated units that have graded bedding and contain rare belemnite fragments indicate some parts of the unit are marine. Measured thickness is as much as 870 m (Detterman and Hartsock, 1966). Above mentioned belemnites and plant fragments occur near the top of unit; fossils are not age diagnostic. In Talkeetna Mountains north of map area, fossils (*Weyla*) in upper part of Talkeetna Formation, which is considered correlative to the rocks of Horn Mountain Tuff Member, indicate a late Pliensbachian and Toarcian (Early Jurassic) age (Arthur Grantz, USGS, 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 grading to fine-grained tuff, clastic sedimentary rocks and flows northward in the map area (Detterman and Hartsock, 1966). 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). Estimated thickness of unit is between 685 and 870 m. No known fossil control

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 and in general, fining upward. Interbedded flows of andesite and basalt, thought to be partly submarine, are common, and increase in abundance and thickness southward (Detterman and Hartsock, 1966; Detterman and Reed, 1980). Bedded tuff is locally important, thickest in the southern exposures of the unit, and coarser in the more northern exposures. Member has an estimated minimum overall thickness of 1,000 m although a complete section has never been measured and those that have been measured are sections cut by extensive faulting, or have obscure contact relations with plutons of the Alaska-Aleutian Range batholith, or have been assimilated into the magma chamber under Iliamna Volcano (Detterman and Hartsock, 1966). Fossils are unknown in the map area and age is only inferred based on correlations with rocks in the Talkeetna Mountains type area

J₹lm **Limestone and marble (Lower Jurassic or Upper Triassic?)**—Light- to dark-gray, fine to medium-grained, massive to poorly bedded, non-fossiliferous limestone in discontinuous lenticular bodies within shear zones in the Talkeetna Formation. Individual lenses as much as 30 m thick in broad shear zones in the Talkeetna Formation along the Castle Mountain Fault and in the Talkeetna Mountains quadrangle (Winkler, 1992; Csejtey and others, 1978). Near intrusions, recrystallized to marble. Winkler (1992) assigned a Triassic age to the unit; however, there is little evidence to support such an assignment and there is no evidence to suggest a Triassic age for the enclosing Talkeetna Formation. The Upper Triassic Kamishak Formation is associated with the Talkeetna Formation on the Alaska Peninsula and possibly some of these limestone and marble bodies may represent an equivalent unit

Jp **Pogibshi formation of Kelley (1980), undivided (Lower Jurassic, Sinemurian to Hettangian and older?)**—Informally named Pogibshi formation of Kelley (1980) exposed on east side of Cook Inlet consists of volcaniclastic rocks interbedded with small amounts of limestone, coal, and tuffaceous argillite. Kelley (1980) divided the unit into three members on the basis of rock type, modal composition, and depositional texture. Stratigraphically lowest member, the Dangerous member, consists of volcaniclastic breccia, conglomerate, and sandstone and is in depositional contact with informal Port Graham formation of Kelley (1980) (₹pg here). Locally tuffaceous dark-gray sedimentary rocks in the Dangerous member make it hard to distinguish from the Port Graham formation of Kelley (1980). July member consists of dacitic pyroclastic rocks, tuffaceous sandstone, granule conglomerate, and mudstone. Kelley (1980) indicated that the high quartz content and abundance of glassy debris help to distinguish this unit from other parts of his Pogibshi formation. The uppermost member, the Naskowhak member, consists of greenish-gray tuffaceous mudstone and siltstone, and tuff. Locally, the basal part of the Naskowhak member includes laterally extensive coal-bearing units that help to distinguish the Pogibshi formation of Kelley (1980) from the otherwise lithologically similar Talkeetna Formation on the west side of Cook Inlet. Unit is reportedly intruded by the tonalite of Dogfish (Koyuktolik) Bay (₹qd) and possibly by the diorite of Point Bede (₹qd) [both in the southern Seldovia quadrangle]; if so, the recently determined Triassic age on the diorite (D.C. Bradley, USGS, oral commun., 2007) may indicate that the Pogibshi is, in part, significantly older than the Talkeetna Formation. Martin (1915, 1926) reported a diverse Lower Jurassic fauna along the coast southwest of Seldovia. Bradley and others (1999) erroneously attributed these Jurassic collections by Martin (1915) to the Port Graham formation of Kelley (1980); however, those collections were from localities within the outcrop area Bradley and others (1999) assigned to the Talkeetna Formation, which we reassign back to the Pogibshi formation of Kelley (1980). Fossils noted in the two Martin reports (1915, 1926) included several species of scleractinian corals, numerous bivalves (mostly pectinaceans), gastropods, and ammonites. A brief visit by R.B. Blodgett (USGS contractor, written commun., 2007) to a section of early Sinemurian age exposed about 3 km west of Seldovia showed it to contain numerous pectinacean bivalves, gastropods, and several species of scleractinian corals. Bivalves, both articulated and disarticulated specimens, appear to belong to the genus *Weyla*, an Early Jurassic index fossil found primarily along western coast of North and South America. Lower Jurassic ammonites from these same rocks were discussed and, in part, illustrated in Imlay (1981), who recognized both Sinemurian and Hettangian fossil assemblages. A fossil determination by A.K. Armstrong (USGS) of a collection made by J.S. Kelley yielded poorly preserved Permian corals (sample 75JK-151B, www.alaskafossil.org).

Due to the poor state of preservation of the coral material, we tentatively discount this collection until further material can be collected and identified from this locality. Connelly (1978) and Connelly and Moore (1979) suggested correlation of these rocks with the Upper Triassic Shuyak Formation of Shuyak Island and farther south Afognak Island, which is intruded by the Afognak pluton of Triassic age (see also Wilson and others, 2005). Rioux and others (2007) reported an age on a metamorphosed volcaniclastic rock within the Border Ranges Fault system in the Anchorage quadrangle that may be equivalent to the informally defined Pogibshi Formation of Kelley (1980). The sample yielded two distinct populations of ages, reported as 202.1±1.2 and 205.8±0.4 Ma by Rioux and others (2007)

Ŧpg **Port Graham formation of Kelley (1980) (Upper Triassic, Norian)**—Dominantly dark-gray, carbonaceous limestone and silty limestone containing varying amounts of silica cement (Kelley, 1980). Fine-grained, dark-gray, siliceous to limy mudstone, silty sandstone, and dark-gray to dark-olive-gray, thin- to medium-bedded chert having mudstone partings are also common lithologies according to Kelley (1980). Limy beds tend to be most common in the lower (middle Norian) part of the unit (R.B. Blodgett, USGS contractor, written commun., 2007 and unpub. data of Humble Oil Company [now Exxon-Mobil] reported by R.B. Blodgett); whereas the upper part (of late Norian age) is composed of considerably more volcaniclastic fragment-rich and shaly beds. Volcaniclastic fragment-rich beds contain a diverse, but uncommon molluscan fauna consisting of both bivalves and gastropods; shaly beds tend to have a monotaxic fauna of monotid bivalves. Fossils locally abundant, as reported by Kelley (1980); mostly thin-shelled mollusks, but also corals, echinoids, ammonites, and trace fossils. Martin and others (1915) and Martin (1926) reported bivalves *Halobia* cf. *H. superba* Mojsisovics, *Pseudomonotis* (now placed in genus *Monotis*) *subcircularis* Gabb, *Nucula*?, and coral *Astrocoenia*? sp. *Halobia* cf. *H. superba* was suggested by Martin (1926) to possibly indicate Carnian age (this species was later re-identified as middle Norian age *Halobia* by Silberling and others, 1997), while *Monotis subcircularis* was noted to indicate late Norian age. Silberling and others (1997) provided a detailed analysis of known Late Triassic bivalve fauna known from the Port Graham area (Seldovia quadrangle) and reported that middle Norian age *Halobia lineata* and *H. dilitata* in collections reported by Martin (1915; USGS Mesozoic localities 6380 and 6382, respectively). Two different species of late Triassic *Monotis* were reported by Silberling and others (1997): *Monotis* (*Pacimonotis*) *subcircularis* and *Monotis* (*Monotis*) *alaskana*, and late middle Norian ammonite *Steinmannites*. Kelley (1984) and Bradley and others (1999) assigned an upper age limit of Early Jurassic to unit, although no fossils of this age are found. Early Jurassic fossils do occur in upper part of overlying Pogibshi formation of Kelley (1980)

**Kamishak Formation (Upper Triassic, Norian)**—Limestone, chert, porcellanite, and minor tuff. Detterman and Reed (1980) divided unit 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 Kamishak Formation by Kellum (1945, as cited in Detterman and Reed, 1980). Unit primarily found along west side of Cook Inlet, east of Alaska Range-Aleutian Range crest. Fossils in unnamed middle Member and Bruin Limestone Member yield a Norian age (Detterman and Reed, 1980; C.D. Blome, USGS, oral commun., 1981). Cut by abundant dikes and sills related either to Cottonwood Bay Greenstone or Talkeetna Formation. Subdivided into the following:

Ŧku **Ursus Member**—Thin-bedded, light-gray limestone, locally dolomitic, and minor interbedded gray chert and porcellanite and minor tuff, about 150 m thick. Limestone is fine-grained biomicrite. Depositional environment was moderate to high-energy, shallow water. Contact with overlying Talkeetna Formation is considered a disconformity; however, in most locations it is a fault, nonetheless units appear structurally conformable (Detterman and Reed, 1980). Contact with underlying middle Member is gradational where thin-bedded, light-gray limestone changes to dark-gray, medium-bedded to massive limestone of middle Member (Detterman and Reed, 1980)

Ŧkm **Middle Member**—Thin- to medium-bedded, dark-gray to black limestone and calcilutite, locally dolomitic, and minor black chert and gray tuff, about 530 m thick. Limestone is fine-grained microsparite. Calcite is locally altered to chert, suggesting a deep-basin environment. Unit is nearly always complexly folded and commonly cut by dikes and sills of mafic igneous rocks (Detterman and Reed, 1980). Contact with underlying Bruin Limestone Member may be gradational; however, Bruin Limestone Member is more highly contorted (Detterman and Reed, 1980)

Ŧkb **Bruin Limestone Member**—Massive to thin-bedded, light- to dark-gray limestone; coral and echinoid bioherms, banded green and white chert at least 610 m thick. Environment was apparently high energy, marine, shallow water. Sections of unit are incomplete and dikes and sills of mafic igneous rocks similar to underlying Cottonwood Bay Greenstone (Ŧc) are ubiquitous; unit is considered at least 610 m thick. Contact with Cottonwood Bay Greenstone is not exposed, but where units are in close proximity, they appear concordant (Detterman and Reed, 1980)

**Shuyak Formation (Upper Triassic)**—Consists of two members: a sedimentary member in fault contact with a volcanic member. Sedimentary member is inferred to overlie volcanic member (Connelly and Moore, 1979). Unit structurally overlies schist of Kodiak Island (Jsch) and Uyak Complex (KMm) but usually is separated from them by the Afognak pluton (Ŧqd). Estimated thickness is more than 7,000 m (Connelly, 1978). Divided into the following:

Ŧss **Shuyak Formation, sedimentary member**—Volcaniclastic sequence consisting of thin- to medium-bedded lithic sandstone that contains lesser amounts of conglomerate, argillite, and siliceous tuff and is intruded by mafic dikes and sills (Connelly and Moore, 1979) in the Barren Islands and on Shuyak Island. As described by Connelly and Moore (1979), unit is rich in primary andesitic material and displays flute casts and complete Bouma sequences that indicate deposition by turbidity currents. Rocks either are broadly folded or dip homoclinally to southeast and have undergone prehnite-pumpellyite-facies metamorphism (Connelly and Moore, 1979). Pelecypod *Halobia halorica* of Late Triassic (Norian) age as identified by N. Silberling was reported by Connelly and Moore (1979)

Ŧsv **Shuyak Formation, volcanic member**—Vesicular pillow greenstone; locally contains beds of pillow-breccia agglomerate, tuff, and argillite (Connelly and Moore, 1979) on Shuyak Island. Greenstone is tholeiitic in composition

## IGNEOUS ROCKS

### VOLCANIC AND HYPABYSSAL 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. Also includes tephra-rich colluvium in the vicinity of and west of Redoubt Volcano where these deposits both mantle and are incorporated into deposits of Holocene glaciation (Till and others, 1993; F.H. Wilson, unpub. data). Lava flows and clasts are porphyritic, typically glassy, gray to black, and commonly vesicular. Andesite is dominant composition and may constitute 60 percent or more of rocks. Unit typically forms volcanic edifices and includes deposits related to the volcanic centers at Katmai, Kaguyak Crater, Four-Peaked Mountain, Mount Douglas, Augustine Island, Iliamna Volcano, Mount Spurr, and Redoubt Volcano. May include Tertiary volcanic rocks as mapped by Magoon and others (1976). South of Capps Glacier, rocks of this unit have been variously assigned by previous workers to glacial deposits or volcanic deposits. As described by Emily Finzel (written commun., 2009), these outcrops consist of clast- and matrix-supported conglomerate containing ashy stringers, and appearing volcaniclastic. Clasts are extrusive, mostly vesicular and porphyritic, dark-gray to black basalt(?) with white phenocrysts. Minor clasts have maroon and yellow-green groundmass. Unit is locally subdivided into the following:

Qvd **Dacitic to rhyolitic domes (Holocene)**—"Dacitic or rhyolitic vitrophyres having plagioclase, pyroxene, and (or) hornblende phenocrysts in a brown to grayish brown glassy groundmass that is locally devitrified. Local red to yellow orange fumarolic alteration" (Riehle and others, 1993). Dacitic domes at Kaguyak Crater

Qhv **Volcanic rocks (Holocene)**—Andesite and basalt lava flows, and sills. Primarily extrusive rocks, typically form present day edifices of historically active volcanoes. Unit caps ridges and includes massive lava flows, agglomerate, and lahar deposits, primarily associated with volcanic centers at Augustine, Redoubt, Spurr, Hayes, and Iliamna including North Twin and South Twin

Qad **Andesite and dacite domes (Pleistocene)**—Dome complexes of Double Glacier volcano (Reed and others, 1992) and Johnson Glacier dome complex of Iliamna Volcano (Waythomas and Miller, 1999). Composite dome complex of Double Glacier volcano consists of medium- to coarsely porphyritic hornblende andesite and dacite. Three K-Ar andesite whole-rock ages were determined on these domes, two are considered minimum ages at 627±24 and 763±17 ka (sample 78AR 290) and one (sample 90AR 99), yielded 887±15 ka (Reed and others, 1992, table 1 here)

QTv **Old volcanic rocks, undivided (Pleistocene or 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 site was examined briefly by Detterman and Reed (1980). Scoriaceous olivine basalt at Seven Sisters (about 40 km west of Augustine Island) is thought to represent a volcanic neck and feeder-dike system. Second site, about 17 km northwest of Chinitna Bay, was thought to consist largely of andesitic tuff and breccia having a smooth to gently rounded topographic expression. No age control exists for either center; however, Detterman and Reed (1980) suggested olivine basalt of the Seven Sisters is most closely related to Intricate Basalt (unit Tb) of possible Pliocene age, whereas the andesite(?) at West Glacier Creek seemed more similar to Augustine Volcano and Iliamna Volcano products. Also included in this map unit, but too small to show, are basaltic andesite porphyry dikes and sills intruding Jurassic sedimentary rocks between Chinitna and Iniskin Bays and andesite (Detterman and Hartsock, 1966) and basalt lava flows, sills, and plugs in Mount Katmai area (Riehle and others, 1987). Extrusive rocks typically cap ridges and include massive lava flows, agglomerate, and lahar deposits (Riehle and others, 1987)

Tvu **Tertiary volcanic rocks, undivided (Tertiary)**—Andesite, basalt, and dacite lava flows, tuff, lahar deposits, volcanic breccia, and hypabyssal intrusions throughout the map area. In Anchorage and Talkeetna Mountains quadrangles, unit includes small lenses of fluviatile conglomerate. Csejtey and others (1978) and Winkler (1992) described a crude stratification, where felsic rocks and pyroclastic rocks occur stratigraphically lower and basaltic and andesitic flows occur in the upper part of the section. Age control is sparse and unit is generally considered to range throughout the Tertiary; however, most age determinations yield Eocene and older ages (54–60 Ma, Winkler, 1992). Outside the map area, Eocene plant fossils have been found in volcaniclastic rocks in unit. Flows possibly correlative with unit occur within the Arkose Ridge Formation and yield ages ranging 46 to 54 Ma. Detterman and Hartsock (1966) suggested middle to late Tertiary age for undivided volcanic rocks in Iliamna quadrangle. Locally subdivided into the following:

Tb **Basaltic volcanic rocks (Pliocene)**—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 (west of map area, however a small outcrop of this unit appears at edge of map west of Kakhonak Lake), but also south of Gibraltar Lake outside of map area, and in mafic dikes too small to show on map. Detterman and Reed (1980) reported K-Ar dates of 4.4±0.5 and 5.1±1.0 Ma on an olivine basalt dike that cuts Naknek Formation

Tpg **Gibraltar Lake Tuff (Pliocene? to Oligocene?)**—Defined by Detterman and Reed (1980), unit is divided into upper nonwelded member and lower welded member. Upper member, west of map area, 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 Intricate Basalt. Lower member is at least 300 m thick, consists of light- to medium-gray and tan rhyolitic crystal and lithic welded tuff; locally, interbedded porphyritic rhyolite flows. Unconformably overlies older Tertiary basalt and andesite. Detterman and Reed (1980) had little age control; however based on geomorphic character and comparison with other Tertiary age units, they suggested that the age was more likely Pliocene than Oligocene

Tmv **Paleogene volcanic rocks, undivided (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, 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, either as volcanic necks of eroded volcanoes or as caldera complexes. Limited age determinations unit and subdivisions range from approximately 29.3 to 44.4 Ma (Thrupp, 1987; Nelson and others, 1983). Inferred to represent northern extension of Meshik Arc of the Alaska Peninsula (Wilson, 1985). Locally subdivided into the following:

Tmb **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). Many of the rocks are associated with identifiable eruptive centers. Ages range from 29.5±1.5 to 44.4±1.7 Ma

Tmf **Tuffaceous felsic volcanic rocks (Eocene?)**—Rhyolitic breccia, ash-flow tuff, and flows in Tyonek, Ilimna, and Lake Clark quadrangles. 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)

Tfv **Felsic volcanic and sub-volcanic rocks (Eocene)**—Rhyolite, rhyodacite, and dacite. Predominantly subaerial lavas and tuffs, and lesser domes and other hypabyssal intrusions; includes minor quartz-feldspar-sericite tuffaceous sandstone of Anderson (1969a). Rhyolite flows are aphanitic to sparsely porphyritic with plagioclase and (or) hornblende phenocrysts and are locally flow-banded; dacitic tuff and subvolcanic intrusions contain oscillatory-zoned plagioclase, quartz, and amphibole (L.E. Burns, Division of Geological and Geophysical Surveys, written commun., 2010; Oswald, 2006). Individual flows and tuffs are meters to tens of meters thick; overall unit may be as much as several hundred meters thick. Includes plagioclase-quartz-hornblende dacite porphyry (Tdp) of Csejtey (1974), porphyritic rhyolite (rh) of Anderson (1969a), rhyolite, dacite, and ash flow tuff (Trt, Tdt, Tft), rhyolite, rhyodacite, and dacite (Tr, Trd, Td), and vitric and dacite flows (Tv, Tdf) of L.E. Burns (DGGS, written commun., 2010), dacite porphyry (Tdp), rhyolite tuff (Trt), felsic tuff and extrusive rhyolite of Oswald (2006). Not part of Meshik Arc (Wilson, 1985), typically found in Anchorage and Talkeetna Mountains quadrangles. Ages range from 35.6±0.2 to 45.2±0.5 Ma (table 1)

Tem **Mafic volcanic rocks (Eocene)**—Predominantly reddish-brown-weathering basaltic andesite and basalt lavas, often columnar-jointed, and including lesser tuff, and local cinder deposits. Basaltic lavas are aphanitic to porphyritic, having plagioclase and (or) pyroxene phenocrysts; andesite lavas locally are trachytic textured and plagioclase- and Fe- Ti-oxide rich (Oswald, 2006). Also includes aphanitic and sparsely phenocrystic pyroxene andesite (Tpa) of Csejtey (1974); andesite and basalt of Anderson (1969b); andesitic and basaltic tuff (Tat, Tbt), andesite and basalt flows (Taf; Tmb, Tma) , basalt (Tb), and andesite (Ta) of L.E. Burns (DGGS, written commun., 2010); and andesite tuff (Tat), andesite, intermediate, and mafic flows (Taf, Tif, Tmf), basalt (Tb), and “mafic to intermediate composition lavas” of Oswald (2006). Individual flows and tuff beds are tens of meters thick; as a whole, unit may be several hundred meters thick. Not part of Meshik Arc (Wilson, 1985), typically found in Anchorage and Talkeetna Mountains quadrangles. Ages range from 44.4±0.2 to 60.1±4.6 Ma (table 1)

TKd **Dikes and sills (Tertiary to Cretaceous)**—Dikes, sills and small intrusive bodies of mafic to felsic composition. Dikes yield a wide range of ages (table 1), representing multiple intrusive events throughout region. Felsic and intermediate hypabyssal rocks from the Anchorage quadrangle include six whole-rock K-Ar ages of 40.0±1.6 to 54.8±2.7 Ma and three zircon fission track ages of 36.8±4.8 to 41.3±6.0 Ma (Winkler, 1992; table 1 here). Also in the Anchorage quadrangle, a basalt sill yielded a whole-rock K-Ar age of 40.9±1.6 Ma (Silberman and Grantz, 1984). A $^{40}Ar/^{39}Ar$ plateau age on amphibole from an andesite dike yielded an age of 58.64±0.52 Ma. Unit also includes unit TJds of Winkler (1992) that yielded widely different whole-rock K-Ar ages of 38±2 and 130±6 Ma. A basaltic-andesite dike intruding McHugh Complex yielded an $^{40}Ar/^{39}Ar$ hornblende plateau age of 115±2 Ma, whereas an intermediate composition dike yielded an $^{40}Ar/^{39}Ar$ isochron(?) age of 57.0±0.22 Ma (sample 88ADw 230; W. Clendenin, South Carolina Department of Natural Resources, Geological Survey, written commun., cited in Bradley and others, 1999). Lytwyn and others (2000) described a suite of dikes ranging in composition from basalt to rhyolite that they associated with near-trench intrusions commonly related to the subduction of Kula-Farallon spreading center

Tpv **Intermediate to mafic volcanic rocks (Paleocene)**—Massive welded tuff beds greater than several meters thick; generally andesitic and dacitic composition. Unit includes informally named Porcupine Butte andesite of Solie and Layer (1993), a columnar jointed andesite plug forming the neck of a Paleocene volcanic center. Solie and Layer (1993) obtained a $^{40}Ar/^{39}Ar$ isochron age on biotite from the andesite at Porcupine Butte of 60.82±0.43 Ma (sample 90DNS 31, table 1). A U/Pb zircon age of 61.9±0.3 Ma was determined on crystal-lithic andesite tuff east of the toe of the Trimble Glacier (Friedman, Univ. of British Columbia, written commun., 2005). Only basalt in this unit lies between Trimble and Hayes Glaciers (in Tyonek quadrangle) and includes rocks mapped by Solie and others (1991) as their unit

TMzb. Several $^{40}Ar/^{39}Ar$ whole-rock ages were obtained on the basalt, yielding 66.0±0.9, 57.9±1.9, and 62.1±0.4 Ma (Layer and Solie, 2008, table 1 here). The basalt was mapped by Solie and others (1991) in contact with the shale, siltstone, and limestone unit (KJsl) of Solie and others (1991); in the vicinity of the basalt they reported their KJsl unit may underlie the basalt and their KJcs unit. Some welded tuff of probable Cretaceous age appears similar in texture and composition; however, we distinguish these by their more greenish color

TKft **Felsic tuff (early Tertiary or Cretaceous)**—Crystalline tuff and lapilli tuff in north-central Tyonek quadrangle (Solie and others, 1991)

TKv **Older volcanic rocks, undivided (Paleocene to Upper Cretaceous)**—Plagioclase porphyritic andesite, dacite, and less common basalt. Rocks deposited as tuff have variable degrees of welding and variable thickness. In southwest part of Talkeetna quadrangle, Reed and Nelson (1980) mapped interbedded tuff, mafic volcanic flows, sandstone, shale, and minor calcareous mudstone as their unit Tvs. Volcanic rocks are chiefly medium- to coarse-grained greenish-gray crystal lithic lapilli tuff and volcanic rubble flows in units as much as 150 m thick. They considered these rocks Tertiary age and related to early or middle Tertiary plutonism in the Alaska Range; however, mapping by Haeussler suggests that these rocks may be Cretaceous age on the basis of correlation with the volcanic rocks north of Dickason Mountain in north-cental Tyonek quadrangle, described below in unit Kv. Where possible, on the basis of field evidence, largely color, or geochronologic analysis, volcanic rocks were assigned to map units Tpv, Kv, or Kvs. Locally subdivided into the following:

Kv **Intermediate and felsic volcanic rocks (Cretaceous)**—Andesite, dacite, and rhyolite flows and tuff. Includes massive and crystal-rich tuff, containing either hornblende or plagioclase as phenocryst phases as well as flow-banded rhyolite. Hornblende andesite, north of Dickason Mountain in Tyonek quadrangle, yielded a whole-rock $^{40}Ar/^{39}Ar$ age of 58.3±1.1 Ma and a hornblende age of 89.7±3.0 Ma (table 1). The 58.3 Ma date is similar in age to that of a pluton exposed in the region surrounding this outcrop (Bear Cub pluton, Solie and Layer, 1993); however, hornblende age suggests that eruption of the andesite may have been earlier. Rocks north of Dickason Mountain in north-central Tyonek quadrangle yielded a 98.2±0.4 Ma age (table 1). Flow-banded rhyolite between north and south branches of Trimble Glacier yielded a $^{40}Ar/^{39}Ar$ age of 122.4±1.5 Ma (table 1), much older than age of the surrounding Paleocene granite of unit TKg (dated at the same locality at 60.4±0.8 Ma (table 1) and thus the volcanic rock age may quite likely be reset by this intrusion and as such is probably a minimum age. In Talkeetna Mountains quadrangle, Drake and Layer (2001) reported $^{40}Ar/^{39}Ar$ ages of 100.5±0.7 and 132.8±0.7 Ma on a metarhyolite, however, phases dated yielded poor plateaus and were strongly discordant (table 1)

ŦRvm **Mafic dikes, sills, and plugs (Triassic?)**—Diabasic bodies intruding Shuyak Formation (unit ŦRss and ŦRvs) on west side of Shuyak Island at Neketa Bay in Afognak quadrangle; unit does not have visible thermal aureoles (Connelly and Moore, 1979)

ŦRn **Nikolai Greenstone and related rocks (Upper and (or) Middle Triassic)**—Massive, dark-gray-green, dark-gray-brown, and maroon-gray, subaerial and submarine basalt flows and minor interbedded volcaniclastic sedimentary rocks, aquagene and epiclastic tuff, breccia, argillite, and radiolarian chert (Nokleberg and others, 1992). Widely distributed and several thousands of meters thick. Includes unnamed Triassic greenstone units in Talkeetna Mountains quadrangle (Csejtey and others, 1978). Commonly associated with Late Triassic carbonate and cherty carbonate rocks. Together with Chitistone Limestone and Nizina Limestone units, unit is one of the diagnostic units of the Wrangellia terrane (Jones and others, 1977). Commonly metamorphosed to lower greenschist facies. A similar and correlative unit, Cottonwood Bay Greenstone of the Alaska Peninsula, is described below

ŦRc **Cottonwood Bay Greenstone (Upper Triassic, Carnian or older)**—Largely dark-gray to dark-green, porphyritic to amygdaloidal basaltic flows altered to greenstone (Detterman and Reed, 1980). Locally includes andesite, chert, limestone, and tuffaceous sedimentary rock, all weakly metamorphosed. About 60 percent of unit is metabasalt. Unit occurs either as roof pendants of or east of Alaska-Aleutian Range batholith in Iliamna and Mount Katmai quadrangles. Basal beds of Bruin Limestone Member of Kamishak Formation contain volcanic rocks similar to Cottonwood Bay Greenstone and with this evidence Detterman and Reed (1980) assigned a Late Triassic age to unit. Because Kamishak Formation is Norian age, Detterman and Reed (1980) stated that Cottonwood Bay Greenstone is probably older than Norian

Ti **Intrusive rocks, undivided (Tertiary)**—Generally consists of fine- to medium-grained granodiorite and quartz diorite, but also includes granite (Nelson and others, 1983) in Mount Katmai and Iliamna quadrangles. Typically surrounded by well-developed hornfels zones and sporadic hydrothermal alteration in country rocks, includes volcanic necks, sills, and dikes. Also includes dikes, sills, and stock-like masses of felsic to mafic composition. Parts were included in Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972). Locally divided into the following:

Tpi **Intermediate intrusive rocks (Pliocene and latest Miocene)**—Fine- to medium-grained granodiorite and quartz diorite, in intrusive bodies located along Pacific coast at Cape Douglas in Afognak quadrangle. K-Ar ages range from 4.2±0.2 to 8.22±0.25 Ma (Shew and Lanphere, 1992)

Toegr **Granitic rocks (Oligocene and late Eocene)**—Compositionally variable suite of medium- to coarse-grained, grayish-white, granitic rocks in Lake Clark, Iliamna, and northern Mount Katmai quadrangles (Reed and Elliott, 1970; Detterman and Reed, 1980; Nelson and others, 1983; Riehle and others, 1987). Rock types range from biotite granite and biotite-hornblende granite to granodiorite, tonalite, and quartz diorite. Plutons are considered part of the Tertiary phase of the Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972) and tend to be exposed along its western margin. Potassium-argon ages range from 25.6±0.8 to 43.9 Ma (Reed and Lanphere, 1972, 1973; Nelson and others, 1985; Winkler, 1992; table 1, here). Many of the younger ages are discordant

Tgn **Gabbronorite (Oligocene? or Eocene?)**—Coarse-grained hornblende- and biotite-bearing olivine gabbronorite stock located along the western map area boundary in the Lake Clark quadrangle (Nelson and others, 1983). “Relations to surrounding igneous rocks are unknown, but the stock is most likely related to the Tertiary volcanic rocks in this part of the Lake Clark quadrangle” (Nelson and others, 1983)

Thg **Hypabyssal granitic rocks (Paleocene?)**—Granitic rocks commonly containing miarolitic cavities, beta quartz, or granophyric texture (Solie and others, 1991; P.J. Haeussler, unpub. data, 2008) in Tyonek quadrangle. Medium- to fine-grained and usually porphyritic granitic rocks containing few mafic minerals. Miarolitic cavities commonly contain native sulfur. Commonly orange to reddish weathering. Age likely Paleocene, although few of these granitic rocks have been dated. Granite porphyry of Dickason Mountain (Solie and others, 1991) is included here as one of these hypabyssal intrusive bodies. Layer and Solie (2008) obtained a $^{40}Ar/^{39}Ar$ plateau age on hornblende from this pluton of 54.7±0.6 Ma (table 1). Thus, these granitic rocks may be slightly younger than the most common Paleocene granitic rocks (Tpgr) of this region

Tpgr **Granitic rocks of Paleocene age (Paleocene)**—Predominantly medium-grained composite plutons of granite, syenite, tonalite, quartz monzonite, quartz monzodiorite, quartz diorite, granodiorite, and minor diorite. Biotite is chief mafic mineral. Locally weakly foliated or containing flow structures. Unit is widespread in map area and includes rocks of map unit Ti7, Ti10, and Ti11 of Nelson and others (1983), granodiorite of Harding Icefield (Wilson and others, 2008), the Ruth pluton of the McKinley series of Reed and Nelson (1980) and unit Tbgd of Csejtey and others (1978), as well as other plutons throughout the map area. Unit includes “near-trench” plutons (Bradley and others, 1998) intruding flysch of the Kodiak Formation (Kkd) and the Valdez Group (see below). Numerous radiometric ages (table 1) predominantly fall within the Paleocene epoch (53.2 to 64 Ma) and decrease eastward in an abrupt step at the approximate longitude of Cook Inlet. Plutons to the north of Castle Mountain Fault system intrude the so-called Kahiltna flysch (KJs and subdivisions) but yield ages consistent with other plutons of this unit west of Cook Inlet

Tgd **Biotite-hornblende-granodiorite**—Medium-grained, hypidiomorphic-granular biotite-hornblende granodiorite including the Chilligan River pluton of Reed and Elliott (1970; see also Reed and Nelson, 1980; Nelson and others, 1983; and Wilson and others, 2006). Tourmaline is a characteristic accessory mineral. Also includes unit Thgd, hornblende granodiorite of Csejtey and others (1978). K-Ar ages on hornblende and biotite range from 54.7±2.1 to 62.8 Ma (table 1)

Tpd **Biotite diorite**—Diorite, quartz diorite, quartz monzodiorite and quartz monzonite in a large compositionally variable pluton cropping out over an area of about 11 km$^2$ near Dickason Mountain (Solie and others, 1991) in Tyonek quadrangle. Generally coarse- to medium-grained; a fine-grained variant is also found. More mafic phases contain olivine, both clino- and orthopyroxene, and biotite, whereas more quartz- and potassium-feldspar-rich phases contain amphibole and (or) biotite (Solie and others, 1991). Referred to as the Bear Cub pluton, Solie and Layer (1993) obtained a $^{40}Ar/^{39}Ar$ isochron age on biotite of 60.78±0.42 Ma (sample 90DNS 7, table 1). Isochron analysis indicated slight excess argon in the sample, which might explain the slightly older plateau age of 61.2±0.4 Ma reported by Layer and Solie (2008) for this sample. Layer and Solie (2008) also reported a whole-rock $^{40}Ar/^{39}Ar$ average age of 55.9±0.5 Ma on a nearby sample (sample 90WG 119, table 1)

TKg **Granitic rocks, undivided (Paleocene to Late Cretaceous)**—Fine- to coarse-grained, epizonal, biotite and biotite-hornblende granite; granodiorite; quartz monzonite; and alkali granite. Unit crops out in Anchorage and Talkeetna Mountains quadrangles (Winkler, 1992; J.M. Schmidt, unpub. data, 2008) and in western part of Tyonek quadrangle (Layer and Solie, 2008) and includes the Styx River batholith of Reed and Elliott (1970). Plutons of this age and composition are widespread throughout south and southwest Alaska. Within map area, K-Ar and $^{40}Ar/^{39}Ar$ ages typically range between 63.6±0.4 and 67.4±0.7 Ma in Anchorage and Talkeetna Mountains quadrangles with an outlier at 57.7±0.5 reported (Csejtey and others, 1978, Winkler, 1992, Drake and Layer, 2001) and 59.1 to 66.8 Ma on biotite in Tyonek quadrangle (Reed and Lanphere, 1972, 1973; P.J. Haeussler, USGS, written commun., 2008; Layer and Solie, 2008; see table 1 here). Plutons of unit and its subdivision, TKgd, west of Susitna River were generally included in Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972). Locally subdivided into the following:

TKgd **Granodioritic rocks**—Widespread, predominately epizonal medium-grained plutons of granodiorite, quartz diorite, diorite, and tonalite as mapped by Reed and Lanphere (1969, 1972, 1973), Magoon and others (1976), Csejtey and others (1978), Winkler (1992), Wilson and others (1998). Locally weakly foliated, subhedral and (or) seriate texture. K-Ar ages on biotite and hornblende range between 60.0 and 73.5 Ma in map area (Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976; P.J. Haeussler, USGS, written commun., 2008). A hydrothermally altered sample in Anchorage quadrangle yielded slightly younger ages of 54.7±1.6 to 56.6±1.7 Ma (table 1)

TKgb **Gabbroic rocks (Tertiary and (or) Cretaceous)**—Poorly exposed small bodies of mafic rocks in Talkeetna Mountains and Tyonek quadrangles. In Talkeetna Mountains, Csejtey and others (1978) described a medium- to light-gray, coarse- to medium-grained, plagioclase and pale-green hornblende-bearing leucogabbro; unpublished data of J.M. Schmidt also described the presence of diorite associated with the gabbroic rocks. Reed and Elliot (1970) and Wilson and others (1998) described diorite and olivine and (or) hornblende gabbro which occurs as intrusive bodies and inclusions in other Tertiary intrusive rocks in Tyonek quadrangle. Age is poorly constrained; however, samples of hornblendite and gabbro from Tyonek quadrangle yielded $^{40}Ar/^{39}Ar$ plateau ages of about 84 and 70 Ma (see replicates in table 1), respectively

Kgr **Granite (Cretaceous)**—Coarse-grained, light-pink granite; contains subrounded quartz phenocrysts as much as 1 cm in size; medium-grained matrix of sodic plagioclase and granophyre and about 10 percent biotite and hornblende (Nelson and others, 1983; Detterman and Reed, 1980). Exposed in small plutons on southern margin of Lake Clark quadrangle and northern Iliamna quadrangle. Unit is in fault contact with surrounding plutons. Radiometric age control is lacking

Kgd **Granodiorite (Late Cretaceous)**—Granodiorite, tonalite, and quartz monzodiorite bodies mapped by Nelson and others (1983) in eastern Lake Clark quadrangle and considered part of Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972). Medium- to coarse-grained, light-to medium-gray, contain hornblende, biotite, and, rarely muscovite and locally have cataclastic textures. Although mapped as separate plutons by Nelson and others (1983), a number of these are thought to be fault offset extensions of each other. In Anchorage quadrangle includes Willow Creek pluton of Winkler (1992) described as “pervasively altered, zoned pluton occupying much of headwaters of Willow Creek***. Pluton has a 30- to 200-m-wide outer margin of hornblende quartz diorite and lesser hornblende tonalite. Pluton core is hornblende-biotite granodiorite, and lesser hornblende-biotite quartz monzodiorite and biotite quartz monzonite. Foliation is common, particularly near margins. Mineralized veins of Willow Creek mining district are predominantly hosted in this pluton. Partial alteration of mafic minerals to chlorite+magnetite±pyrite-chalcopyrite is common throughout pluton; sericite-ankerite-rutile alteration is common within 30 m of major gold-bearing quartz veins

(R.J. Newberry, Univ. of Alaska, Fairbanks, written commun., 1989)." Samples from Willow Creek Pluton yield discordant and subconcordant K-Ar ages ranging from 70.1 to 78.8±2.4 Ma and K-Ar ages from propylitized plutonic samples and gold-bearing veins and dikes that cut pluton indicate episodes of alteration and quartz veining at 66 and 57 Ma (Winkler, 1992). K-Ar and $^{40}Ar/^{39}Ar$ ages from the west side of Cook Inlet range from 63.1±1.8 to 80.7 Ma (Reed and Lanphere, 1972; P.J. Haeussler, USGS, written commun., 2008); a number of ages are either discordant or have disturbed spectra. One of the plutons (Ki13 of Nelson and others, 1983) intrudes rocks of apparent Late Cretaceous age

Kqd **Quartz diorite (Late Cretaceous)**—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). Biotite-hornblende ratio is quite variable although color index remains constant. Deuteric epidote is common. Crops out in a northeast to southwest trend from Tyonek quadrangle to Lake Clark quadrangle. Mapped as Tertiary or Cretaceous granodiorite, quartz diorite, and diorite by Magoon and others (1976). Shown as Cretaceous here based on five samples with K-Ar ages ranging from 65.6 to 75.5 Ma (table 1 here; Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976)

Kqms **Quartz monzonite, monzonite, and syenite (Late Cretaceous)**—Massive, coarse-grained, light-gray porphyritic quartz monzonite (Detterman and Reed, 1980; Nelson and others, 1983) in Iliamna quadrangle. In northern Tyonek quadrangle, fine- to medium-grained pink monzonite or syenite intrudes sedimentary rocks of unit KJs. Pluton contains primary pyroxene and has yielded a concordant U/Pb zircon age of 80.3±0.1 Ma (table 1 here, P.J. Haeussler, USGS, written commun., 2008). Pluton is distinctive in being more K-spar rich and quartz poor than other granitic rocks in the region. K-Ar ages range from 75.6 to 85.5 Ma (Reed and Lanphere, 1972; table 1, here). Unit also includes undated plutons in Talkeetna Mountains quadrangle

Kum **Ultramafic rocks (Late Cretaceous)**—"Small, structurally bounded, pervasively sheared, discordant bodies of serpentinized ultramafic rocks wholly enclosed in pelitic schist (Jps) near Bald Mountain Ridge" (Winkler, 1992), in Anchorage quadrangle north of community of Wasilla. Age of ultramafic rocks unknown, but early Late Cretaceous K-Ar ages of 88.9±4.4 and 91.0±4.6 Ma (samples 73ACy 17 and 74Asj 100a, table 1) are presumed to date emplacement of serpentinite (Winkler, 1992). However, dates on enclosing schist (unit Kps) are significantly younger than these ultramafic ages

Kogr **Older granite (Cretaceous, Cenomanian)**—Coarse-grained biotite granite mapped on boundary between Tyonek and Talkeetna quadrangles. Yielded a $^{40}Ar/^{39}Ar$ plateau age on biotite of 96.9±1.4 Ma (sample 02PH 375A, table 1). In Tyonek quadrangle, unit also includes a syenite body exposed in the ice field north of Chakachamna Lake that yielded a 109±3.2 Ma K-Ar date on hornblende (Reed and Lanphere, 1972; Magoon and others, 1976; sample 70AR 208, table 1 here). This syenite yields a significantly older age than other intrusive bodies assigned to this unit; it is likely that the determined age was partially reset by intrusion of the surrounding Tertiary plutons, suggesting the emplacement age may be older yet

Klt **Leucotonalite and trondhjemite (Early Cretaceous, Albian to Barremian)**—"Medium-grained plugs and elongate, irregular-shaped, sill-like bodies of leucocratic plutonic rocks in northern Chugach Mountains in a zone about 5 km wide near Border Ranges Fault. According to Pavlis and others (1988), bodies intrude crystalline rocks of the Peninsular terrane (see Jones and others, 1981), the McHugh Complex of the Chugach terrane, and the Border Ranges fault which separates the terranes. Rocks generally are foliated and contain less than 10 percent mafic minerals including muscovite, biotite, or hornblende (and minor garnet). Radiometric ages *** include: K-Ar ages on hornblende (126 and 124 Ma), biotite (116 Ma), and muscovite (110 Ma), and a concordant U/Pb zircon age of 103 Ma ***. These ages are comparable to $^{40}Ar/^{39}Ar$ plateau ages on hornblende (129, 125, and 114 Ma), biotite (123 Ma), and muscovite (118 Ma), and two Rb/Sr mineral isochrons (133 and 130 Ma) reported by Pavlis and others (1988). This spectrum of ages and observed fabrics in the rocks are interpreted to result from progressive syntectonic emplacement of the plutons during ductile and then brittle thrusting along Border Ranges fault in the Early Cretaceous (Pavlis and others, 1988). How these plutons formed and were injected into an active regional subduction boundary is enigmatic" (Winkler, 1992). Many of the age determinations reported in this quote from Winkler (1992) are listed in table 1 along with additional age determinations. However, we were not able to locate sample data for a number of the reported age determinations

KJq **Quartz monzodiorite (Cretaceous? and (or) Jurassic?)**—Medium-gray, medium-grained, hypidiomorphic granular hornblende-biotite quartz monzodiorite containing variable amounts of clinopyroxene located in extreme northwest part of Kenai quadrangle and northeast part of Lake Clark quadrangle (Nelson and others, 1983; Wilson and others, 2006). 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 (Reed and Lanphere, 1973; Nelson and others, 1983; samples 70AR 184 and 68AR 261, also 69AR 399, table 1 here). Part of the Alaska-Aleutian Range batholith of Reed and Lanphere (1969, 1972)

**Alaska-Aleutian Range batholith (Jurassic phase)**—Subdivided into the following:

Jtr **Trondhjemite (Late Jurassic)**—Medium- to coarse-grained, seriate, leucocratic trondhjemite containing 10 percent muscovite and about 5 percent interstitial, perthitic potassium feldspar (Nelson and others, 1983). Occurs in two bodies in Kenai quadrangle immediately west of Redoubt Volcano and in headwaters of Big River north of Double Glacier (Reed and others, 1992). Comprises a large body in central part of batholith in Iliamna quadrangle west of Chinitna Bay. In Talkeetna Mountains and Anchorage quadrangles, consists of altered, sheared, and locally faintly foliated trondhjemite in large, structurally discordant, northeast-trending plutons intruding quartz diorite and amphibolite (Winkler, 1992). Generally accepted K-Ar age determinations range from 129 to 148.5 Ma throughout exposure area and can be considered cooling ages; U/Pb zircon ages range between 152.7 to 156.9 Ma in Talkeetna Mountains quadrangle (see table 1)

Jqd **Quartz diorite, tonalite, and diorite (Jurassic)**—Locally foliated medium-grained quartz diorite and tonalite; the dominant map unit of Alaska-Aleutian Range and Talkeetna Mountains part of the batholith. Hornblende is the primary mafic mineral, biotite increases in proportion to the presence of quartz and potassium feldspar. Detterman and Reed (1980) reported that rocks of unit in Iliamna region grade to diorite but they did not observe it grading into quartz monzonite or granodiorite of their unit Jqm. Potassium-argon ages generally range from 146 to 181 Ma, discounting discordant or suspect age determinations; most age determinations cluster around 160 Ma (table 1). U/Pb zircon ages range from 168.9 to 190.5 Ma for the batholith (table 1) in Talkeetna Mountains and Anchorage quadrangles. Two small exposures of gabbro and diorite are included in unit. Includes a group of lamprophyre and basalt dikes on west side of Cook Inlet that intrude the quartz diorite. Plutons are probably plutonic equivalent of volcanic rocks of Talkeetna Formation, usually found in close proximity to Talkeetna Formation. The Alaska-Aleutian Range batholith has been best described and dated by Reed and Lanphere (1969, 1972, 1973). Two samples (62Ale 2 and 65AR 906, table 1), collected northeast of Iliamna Lake yielded middle Cretaceous K-Ar age determinations and may indicate presence of an otherwise unrecognized middle Cretaceous magmatic event or may more likely indicate resetting by nearby middle Tertiary plutons

Jqm **Granodiorite and quartz monzonite (Middle and late Early 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. In Mount Katmai quadrangle, unit exposed on eastern margin of Jurassic batholith on Alaska Peninsula part of the map. K-Ar age determinations range from 155 to 174 Ma and U/Pb zircon ages in Talkeetna Mountains and Anchorage quadrangles range from 168.3 to 177.5 Ma (table 1)

Jmu **Mafic and ultramafic plutonic rocks (Middle and late Early Jurassic)**—Small areas of gabbro, hornblende gabbro, hornblendite, and pyroxenite in Iliamna and Mount Katmai quadrangles within Jurassic Alaska-Aleutian Range batholith of Detterman and Reed (1980); appear unrelated to mafic and ultramafic rocks in Anchorage quadrangle (unit Jum, described below). K-Ar ages of 160 and 183 Ma were reported by Reed and Lanphere (1972; table 1 here). Locally show evidence of contact metamorphism by younger intrusions

**Plutons proximal to the Border Ranges Fault Zone**

Jeqd **Quartz diorite and tonalite (Middle and Early Jurassic)**—"Series of discordant intermediate plutons between Nelchina Glacier and Lazy Mountain in the northern Chugach Mountains" (Winkler, 1992). They are relatively homogeneous, fine- to medium-grained quartz diorite, and tonalite, having extensive areas sheared and altered (Winkler, 1992). Locally foliated medium-grained quartz diorite and tonalite. As mapped by Rioux and others (2007), also includes trondhjemite, which yields significantly older ages (184.1 to 193.3 Ma) than trondhjemite of map units Jtr and Klt described above. Potassium-argon ages generally range from 167 to 194 Ma (table 1). U/Pb zircon ages range between 183 and 193.9 Ma (table 1) similar to, but marginally older than similar composition plutons of Alaska-Aleutian Range batholith

Jum **Mafic and ultramafic rocks, undivided (Middle Jurassic or older?)**—Complexly intermixed series of mafic to intermediate plutonic rocks (Winkler, 1992). "Plutons consist of gabbronorite, hornblende gabbro, diorite, and tonalite. *** Xenoliths of gabbro show ductile deformation as though they still were warm when intruded by silicic magmas and migmatitic textures are common at contacts between lithologies" (Winkler, 1992). Plutons are cut by steeply dipping faults that form northern part of Border Ranges Fault system. Fault-bounded cumulate ultramafic and mafic rocks of Wolverine and Eklutna complexes of Winkler (1992) are also included in unit and have an inferred age of Middle and Early Jurassic based on correlation with Tonsina complex of adjacent Valdez quadrangle and intrusion by Middle and Early Jurassic dikes (Winkler, 1992)

Ŧqd **Quartz diorite to diorite (Late Triassic)**—Quartz diorite, tonalite and diorite in Seldovia and Afognak quadrangles. In Seldovia quadrangle, unit includes diorite of Point Bede and tonalite of Dogfish Bay (Koyuktolik Bay) of Bradley and others (1999), both on east side of Cook Inlet. Unit also includes Afognak pluton in Afognak quadrangle, a quartz diorite pluton in the Barren Islands (Cowan and Boss, 1978), and diabasic hypabyssal intrusions in Shuyak Formation (Connelly and Moore, 1979). Diorite of Point Bede of Bradley and others (1999) is fine- to medium-grained, nonfoliated quartz diorite; the Afognak pluton is a large, multiphase hornblende diorite, quartz diorite, and tonalite pluton exposed along northwestern Afognak Island (Connelly and Moore, 1979; Roeske and others, 1989). Tonalite of Dogfish Bay of Bradley and others (1999) is medium-grained nonfoliated tonalite that shows chloritic alteration similar to that found in diorite of Point Bede and hence, was assigned a similar age. Bradley and others (1999) assumed plutons in Seldovia quadrangle were Jurassic based on correlation with the pluton in the Barren Islands that yielded a K-Ar hornblende age of 191±1.3 Ma (Cowan and Boss, 1978, table 1 here). However, a Triassic age was recently determined on zircon from the diorite (D.C. Bradley, oral commun., 2007). Bradley and others (1999) also mapped a light-gray, fine-grained to aphanitic felsite body south of the tonalite of Dogfish Bay. This felsite is undated and is tentatively assigned Triassic age due to its proximity and similar setting to this map unit. Bradley and others (1999) suggested the felsite could be Jurassic or Early Tertiary; however, no other rocks of Tertiary age are reported in this vicinity west of the Border Ranges Fault system in Seldovia quadrangle. Kelley (1980, 1984) mapped an intrusive contact between the diorite and his informal Pogibshi formation (Jp); however, the newly determined Triassic zircon date from the diorite and the Jurassic fossils from the Pogibshi indicate that there is some error in interpretation of the available data. Possible scenarios include an incorrectly mapped contact, a wider range of age for Pogibshi formation of Kelley (1980), or inheritance in the zircon. Afognak pluton has a well-developed contact-metamorphic aureole in Shuyak Formation; its boundary with Schist of Kodiak Island (Jsch) is apparently a fault (Roeske and others, 1989). A fission-track age determination on zircon by Clendenen (1991) yielded 153 Ma. K-Ar ages on hornblende from the Afognak pluton and associated migmatite range from 187.5±5.5 to 197±5.8 Ma (Roeske and others, 1989); however, a U/Pb age determination of 217±10 Ma is interpreted to indicate the emplacement age (Roeske and others, 1989)

## MÉLANGE AND METAMORPHIC ROCKS

[Unless otherwise indicated, the stratigraphic position or age given is of the protolith of the metamorphic rock units]

TKc **Cataclastite (Eocene? and Cretaceous, metamorphic age)**—Chlorite-rich, fine-grained granular rocks formed by cataclasis and retrograde alteration of mafic and ultramafic plutonic rocks and mafic volcanic rocks (Winkler, 1992). May be equivalent lithologically to sheared gabbronorite included here in unit Jum. Deformation in the Border Ranges Fault is at least as old as Early Cretaceous; however, much of the fabric may be an Eocene overprint from reactivation of the old thrust as a strike-slip boundary. "Lithologies and fabrics of these rocks may resemble parts of the Haley Creek metamorphic assemblage (Plafker and others, 1989), which to the east in the Valdez 1° x 3° quadrangle represents the southern margin of the Wrangellia terrane, and includes presumed basement for the terrane" (Winkler, 1992).

However, because these rocks would be considered part of the Hidden terrane (Wilson and others, 2008), they are not assigned to Wrangellia terrane

TKgg **Gneiss (Tertiary or Cretaceous, metamorphic age)**—Gneiss, possibly of Mesozoic protolith age in Tyonek quadrangle west of Shamrock Glacier; extrapolated from adjacent Lime Hills quadrangle (B.M. Gamble and B.L. Reed, USGS, written commun., 1996)

**Valdez Group (Upper Cretaceous)**—A widespread unit of coastal region of south-central Alaska. Consists primarily of complexly deformed metasedimentary graywacke, siltstone, and shale generally considered to be deposits of turbidity currents in an oceanic trench (Tysdal and Case, 1979; Nelson and others, 1985; Winkler and Plafker, 1981, 1993; Winkler, 1992). Includes a variety of interbedded, tholeiitic metavolcanic and meta-intrusive rocks and locally a mélange facies. Unit ranges in metamorphic grade from laumontite- to mid-greenschist facies and locally reaches amphibolite facies outside the map area east of Copper River (Nelson and others, 1985; Winkler and Plafker, 1981). Valdez Group is correlative with Kodiak Formation (Capps, 1937; Wilson and others, 2005), Shumagin Formation (Wilson and others, 1999), and partially with Sitka Graywacke (Gehrels and Berg, 1992), which together make up the Chugach terrane that extends for more than 1,700 km along southern coast of Alaska (Plafker and others, 1977; 1994). Valdez Group is subdivided here into the following:

Kvs **Metasedimentary rocks, undivided**—Dark-gray, thin- to thick-bedded, laumontite- to mid-greenschist facies, moderately sorted to poorly sorted sandstone, siltstone, and mudstone flysch; sandstone is fine- to coarse-grained, mainly composed of plagioclase, quartz, and igneous rock fragments (Tysdal and Case, 1979; Dumoulin, 1987). Unit is a thick sequence of rhythmically alternating, multiply deformed, metamorphosed sandstone-siltstone turbidites having beds generally ranging from a few centimeters to a few meters thick and locally, massive beds as much as tens of meters thick (Winkler and Plafker, 1981; Nelson and others, 1985; Winkler, 1992; Winkler and Plafker, 1993; Bradley and others, 1999). Point-count analysis by Dumoulin (1987) showed Valdez Group sandstone contains between 6 to 30 percent quartz, 23 to 45 percent feldspar, and 28 to 68 percent lithic fragments; lithic fragments are dominantly volcanic versus sedimentary rocks. Proportion of lithic fragments decreases west to east, as feldspar and quartz increases (Nelson and others, 1985). Conglomeratic sandstone containing clasts of quartzite, intermediate and felsic volcanic rocks, and rare sandstone, limestone, and granitic rocks is uncommon but widely distributed, occurring at base of some sandstone beds (Bradley and others, 1999; Bradley and Miller, 2006). In some places, primary sedimentary structures such as graded bedding, current-ripple cross-lamination, convolute bedding, and sole markings are preserved (Nelson and others, 1985; Winkler, 1992; Winkler and Plafker, 1993). Metamorphic grade ranges from prehnite-pumpellyite to lower greenschist facies. Assigned Late Cretaceous (Campanian? to Maastrichtian) age on the basis of scattered occurrences of *Inoceramus kusiroensis* Nagao and Matsumoto and *Inoceramus concentrica* Ulrich (Jones and Clark, 1973; Tysdal and Plafker, 1978; Tysdal and Case, 1979; Nelson and others, 1985; Bradley and others, 1999). D.C. Bradley (USGS, oral commun., 2007) reported 70 Ma detrital zircons from unit near Anchorage along Turnagain Arm

Kvv **Mafic metatuff**—Altered chlorite-epidote-actinolite semischist interbedded with metasedimentary rocks in a small area near head of Metal Creek. Tuff may be analogous to widespread thicker metavolcanic rocks in Cordova and Valdez quadrangles according to Winkler (1992). Age inferred from association with sedimentary rocks of the Valdez Group, within which it is interbedded

Kvgs **Schist**—In the Seward quadrangle, Tysdal and Case (1979) describe “interbedded siltstone, graywacke, and less abundant tuff, tuffaceous sandstone, and basalt (pillow basalt?); igneous rocks are typically dark green, metasiltstone is shiny steel-gray, and metasandstone is dark-gray; metamorphosed chiefly to biotite zone of greenschist facies, but locally to chlorite zone; typical metamorphic-mineral assemblages of biotite zone are biotite-muscovite-chlorite-quartz-epidote-calcite-albite; actinolite is present in some metavolcanic rocks; chlorite zone assemblages are similar but lack biotite”. Unit is an upper greenschist to lower amphibolite facies schistose equivalent of the Valdez Group; unit mapped along west side of Placer River Fault in Seward quadrangle. A K-Ar date on biotite semischist of 51.5±1.5 Ma (table 1) was reported by Nelson and others (1985) from a locality along Placer River Fault in Seward quadrangle

Kvm **Mélange of Iceworm Peak of Kusky and others (1997)**—Tectonic mélange consisting of blocks of graywacke in a phacoidally cleaved matrix of slate having a Valdez Group protolith for both matrix and blocks (Bradley and others, 1999; Bradley and Wilson, 2000). Mapped only in Seldovia and Kenai quadrangles but may be more extensive along McHugh Complex and Valdez Group contact (Kusky and others, 1997). Intruded by Paleocene dikes (Kusky and others, 1997) not shown here

Kivs **Metamorphosed intermediate volcanic and sedimentary rocks (Cretaceous)**—Dominantly andesitic composition on east side of the Tordrillo Mountains in Tyonek quadrangle (P.J. Haeussler, USGS, unpub. data, 2008). Most exposures consist of metamorphosed and altered volcanic tuff, breccia, or agglomerate. More mafic compositions are suggested by one outcrop of pillow lavas (small pillows, up to 30 cm in diameter). Metasedimentary rocks consist of volcaniclastic turbidites and rare non-volcaniclastic turbidites. Some rocks are light-green, but others are light-gray and not altered and not metamorphosed. Age best constrained at a locality near Hayes River Pass where the youngest detrital zircons in volcaniclastic sedimentary rocks were dated between 136–151 Ma, Hauterivian or younger (D.C. Bradley, USGS, written commun., 2008). As these rocks were typical of the sedimentary rocks of the unit, it seems likely they are the same age. Although age of remainder of unit is not constrained, all dated volcanic rocks in Tyonek quadrangle (see unit Kv) are Cretaceous or younger, which suggests that rocks of unit Kivs are no older than Cretaceous. Magoon and others (1976) included these rocks in their undivided metasedimentary rocks unit of Jurassic and (or) Cretaceous age. Other authors have included these rocks in the informally named Kahiltna assemblage (see for example, Jones and others, 1981)

Kps **Pelitic schist (Cretaceous?)**—Quartz-muscovite-albite-chlorite schist in southwestern Talkeetna Mountains, about 16 km north of Wasilla. Schist remarkably uniform in lithology; no correlative rocks known (Albanese and others, 1983; Winkler, 1992). Mineralogy indicates greenschist metamorphism, which Winkler (1992) interpreted probably was retrograded from amphibolite facies metamorphism. Jurassic age was inferred for the prograde metamorphism based on age of adjacent amphibolite of unit Jma (Winkler, 1992; shown as unit JPam here); analysis of detrital zircons collected from modern sediments by Van Wyck and Norman (2005) appears to support this interpretation. However, detrital zircon analysis from a bedrock sample reported by Bradley and others (2009) shows a peak at about 75 Ma, interpreted to indicate Late Cretaceous deposition of the sedimentary protolith of the schist. K-Ar muscovite ages of about 66 to 51 Ma (Csejtey and others, 1978; Silberman and others, 1978a,b; Winkler, 1992; M.L. Silberman, USGS, written commun., 1978; table 1 here) from the schist are thought to reflect intrusion of adjacent tonalite and quartz monzonite (see table 1). Corresponds to unit Jps of Winkler (1992) in Anchorage quadrangle, and unit MzPzs, schist at Willow Creek, of Magoon and others (1976)

MzPzm **Metamorphosed mafic volcanic and sedimentary rocks (Mesozoic and Paleozoic)**—Metamorphosed mafic volcanic rocks, phyllite, schist, quartzite, marble, calc-silicate rocks, serpentinite, gabbro, and chert. Mixed unit of varying affinity and protolith and metamorphic age. Dominant rock is metamorphosed mafic volcanic rocks which may be equivalent to the Chilikadrotna Greenstone and the Talkeetna Formation (Nelson and others, 1983)

KMm **McHugh and Uyak Complexes, undivided (Cretaceous to Mississippian)**—Tectonic mélange consisting largely of Mississippian through mid-Cretaceous protoliths of oceanic affinity (Clark, 1973; Connelly, 1978; Tysdal and Case, 1979; Winkler, 1992). Unit is found towards the Gulf of Alaska relative to the Border Ranges Fault system in the Anchorage, Kenai, Seldovia, and Afognak quadrangles. According to Clark (1973), unit consists of two lithologically distinct, but structurally juxtaposed packages. Dominant or most common is a metaclastic sequence "composed predominantly of gray, gray-green, and dark-green weakly metamorphosed *** siltstone, graywacke, arkose, and conglomeratic sandstone" (Clark, 1973). A metavolcanic sequence consists of "greenstones of mostly basaltic composition and texture, that are commonly associated with radiolarian metachert, cherty argillite, and argillite. Small amounts of ultramafic rocks and marble occur locally as isolated, discontinuous outcrops or lenticular masses" (Clark, 1973). Uyak Complex of Connelly (1978) is similar in character though the metaclastic-equivalent part consists dominantly of deformed gray chert and argillite (Connelly, 1978). Within the McHugh and Uyak Complexes, "broad zones as wide as 1 km of intense shearing lack any stratal continuity and, in many places, are marked by angular, elongate phacoids, either enclosed in pervasively sheared matrix or juxtaposed against other phacoids. Larger phacoids are lithologically diverse, consisting of schist, amphibolite, marble, sandstone, conglomerate, diorite, gabbro, serpentinized ultramafic rocks, and mafic volcanic rocks" (Winkler, 1992). Metamorphic minerals include muscovite, epidote, calcite, chlorite, albite, and veinlets of prehnite (Tysdal and Case, 1979). Blocks of mafic and ultramafic rocks are serpentinized near their margins (Connelly, 1978). Slickensides are common both as subparallel, anastomosing fractures in competent rocks and as closely spaced fractures in less competent rocks (Connelly (1978). Connelly (1978) reported detailed structural analysis in the Uyak Complex indicated that mean slip direction during deformation was N 38º W (±11º) and that transport was southeast under northwest (present day) on the basis of work by Moore and Wheeler (1975). Ultramafic, gabbroic, basaltic (greenstone) rocks are interpreted as fragments of dismembered oceanic crust conveyed by plate motion into a subduction zone and deformed into a tectonic mélange (Connelly, 1978). In the McHugh Complex, sedimentary rocks of the matrix have yielded Early Cretaceous (Valanginian) fossils, whereas protolith ages on blocks in the mélange have yielded radiolarians of Cretaceous (Albian-Aptian), Jurassic, and Triassic age (Bradley and others, 1999; Winkler and others, 1981), Permian conodonts and fusilinids of Tethyan affinities (Connelly, 1978; Stevens and others, 1997; Bradley and others, 1999), and Mississippian to Pennsylvanian conodonts (Nelson and others, 1986). D.C. Bradley (USGS, oral commun., 2007) reported 70 Ma detrital zircons from metasandstone within the McHugh Complex collected along Turnagain Arm in the Anchorage quadrangle. Bradley and others (1999) locally subdivided the McHugh Complex into distinct lithologic packages loosely similar to the two packages originally defined by Clark (1973)

Mzg **Gabbro (Mesozoic)**—Dark-green, medium- to coarse-grained gabbro and minor leucogabbro and plagiogranite (Bradley and others, 1999) in Seldovia quadrangle. Fault-bounded bodies in the McHugh Complex; following Bradley and others (1999), only the larger bodies are shown here. Associated with McHugh Complex basalt and chert unit (KTrmc), which Bradley and others (1999) suggested may indicate a genetic relation. Bradley and others (1999) thought the relation may indicate Triassic to middle Cretaceous age; however, they assigned an undifferentiated Mesozoic age to the unit. Bradley and Karl (2000) reported a concordant U/Pb zircon age of 227.7±0.6 Ma (sample 91DW 87, table 1)

Mzu **Ultramafic plutonic rocks (Mesozoic)**—Predominantly layered, variably serpentinized dunite containing rare to locally abundant layers of chromite and pyroxenite and fault slices of garnet pyroxenite and serpentinite (Bradley and others, 1999) in Seldovia quadrangle. Bradley and others (1999) reported at least 7 fault-bounded bodies, all associated with the McHugh Complex. Most bodies are bounded by low angle thrust faults. This was originally suggested for the Red Mountain body, but as discussed in Bradley and others (1999), it is not a klippe as interpreted by Magoon and others (1976), but rather is bounded by late stage, subvertical faults. However, Bradley and others (1999) did suggest a thrust may bound the Red Mountain body at depth. They also inferred that the gabbro (Mzg) and ultramafic rocks, while not spatially associated, are comagmatic and therefore by extension may be of Triassic to middle Cretaceous age; nonetheless, they assigned an undifferentiated Mesozoic age to these rocks

KJms **McHugh Complex, graywacke and conglomerate (Early Cretaceous to Late Jurassic, Pliensbachian)**—Fault-bounded blocks of massive conglomerate and graywacke that range up to several kilometers in structural thickness (Bradley and others, 1999) in Seldovia quadrangle. Bradley and others (1999) reported that deformation has generally obliterated primary sedimentary features; they interpreted the conglomerate and massive graywacke to be of turbiditic origin and locally noted presence of thin- and medium-bedded turbiditic graywacke. Graywacke is matrix-supported, poorly sorted, and has clasts consisting primarily of chert and volcanic rock fragments (Bradley and others, 1999). Bradley and others (1999) reported Pliensbachian radiolarians in conformably underlying ribbon chert at one locality and considered unit ranges in age regionally from Early Jurassic, Pliensbachian to as young as Early Cretaceous

KTrmc **McHugh Complex, basalt and chert (Early Cretaceous, Albian to Middle Triassic, Ladinian)**—"Pillow and massive basalt, depositionally overlain by complexly folded and faulted radiolarian chert" (Bradley and others, 1999) in the Seldovia quadrangle. Bradley and others (1999, citing a C.D. Blome, USGS written commun. of 1994) reported radiolaria in bedded chert ranging in age from Middle Triassic, Ladinian to Early Cretaceous, Albian

**Jsch** **Greenschist and blueschist (Jurassic, metamorphic age)**—Diverse, well-foliated, multiply-deformed, variably foliated, metasedimentary and metavolcanic rocks. Metamorphism varies from greenschist to amphibolite facies (Winkler, 1992) and rocks are locally glaucophane-bearing and crossite-bearing suggesting unit was metamorphosed under conditions transitional to and including blueschist facies (Forbes and Lanphere, 1973; Carden and Decker, 1977; Carden and others, 1977; Connelly and Moore, 1979; Winkler and others, 1981; Bradley and others, 1999). Sedimentary protoliths were shale, chert, tuffaceous arenite, and limestone; volcanic protoliths were probably mostly basalt (Winkler, 1992). Outcrops along northern flank of Chugach Mountains in Anchorage, Seldovia, and Valdez quadrangles, closely associated with Border Ranges Fault system. In Anchorage quadrangle, includes the Knik River schist (JPzm of Winkler, 1992, or Knik River terrane of Pavlis, 1983; Pavlis and others, 1988) and the Seldovia Schist of Roeske (1986; see also Cowan and Boss, 1978; Bradley and others, 1999). Unit is correlative with the Raspberry Schist of Roeske and others (1989) in the Kodiak Island archipelago, exposed along Border Ranges Fault system to the southwest. Carden and others (1977) reported 10 K-Ar ages on mica (including chlorite) and amphibole from unit ranging from 157.8.3±4.8 to 196.6±5.8 Ma, and Bradley and Karl (2000) reported $^{40}Ar/^{39}Ar$ plateau ages on mica of 190.98±0.3 and 191.7±0.3 Ma and on hornblende of 191.92±0.6 Ma. Roeske and others (1989) reported Rb/Sr isochron ages ranging from 189 to 212 Ma (table 1, here). Dating of the blueschist facies metamorphism of this metamorphic complex supports a pattern of decreasing age from west to east as originally suggested by Sisson and Onstott (1986). Clark (1972, cited in Winkler, 1992) reported a single Permian fossil collection from limestone. The Raspberry Schist of Roeske and others (1989) is intruded by the Triassic Afognak pluton. Locally, schist probably of this unit is included in the McHugh Complex melange. Winkler (1992) suggested that the diverse protolith lithologies may indicate tectonic mixing prior to metamorphism

**JPk** **Kakhonak Complex (Jurassic, Triassic, and Permian? or older?)**—Lithologically diverse and complex assemblage of metamorphosed mafic plutonic, volcanic, and sedimentary rocks found on west side of Cook Inlet in Iliamna quadrangle, defined by Detterman and Reed (1980). Detterman and Hartsock (1966) mapped "metalimestone", argillite, quartzite, metatuff, greenstone, and phyllite. Detterman and Reed (1980) described unit as largely consisting of roof pendants within the Alaska-Aleutian Range batholith and thought that the Kakhonak Complex represented, in part, the metamorphic equivalent of Upper Triassic and Lower Jurassic rocks, that is, the Kamishak and Talkeetna Formations, of the vicinity. However, quartzite and quartz-mica schist within the Kakhonak Complex have no direct equivalent within the sedimentary rocks of the vicinity, indicating other protoliths may have contributed to the complex. Because Permian rocks were known from Puale Bay, south of the map area, a possible Paleozoic age was not ruled out by Detterman and Reed (1980). Internal contacts are typically faults, resulting in a tectonic mix of lithologies. Although most of the rocks of this complex are at greenschist facies, the rocks range in metamorphic grade from not metamorphosed to granulite facies. No known age control

**Jpmu** **Plutonic and metamorphic rocks, undifferentiated (Middle to Early Jurassic, metamorphic age)**—Poorly exposed, intricately intermixed schist, amphibole, and small dikes and veinlets of granodiorite (Csejtey and others, 1978) in Talkeetna Mountains. Two rock types, amphibolite and sheared quartz diorite, dominate unit (Csejtey and others, 1978). Locally subdivided into unit Jqd described above and JPam and JPmb, described below:

**JPam** **Amphibolite (Lower Jurassic or older)**—Dark-gray to dark-green, fine- to coarse-grained hornblende-plagioclase amphibolite, quartz-rich amphibolite, and mafic schist. Protolith is unknown. Amphibolite is intruded by foliated hornblende-biotite tonalite of unit Jgd; proportion of tonalite increases southeastward within map unit. Unit was mapped as unit Jmi by Csejtey and others (1978) and was correlated with their unit Jam, which was mapped north of map area. Csejtey and others (1978) map unit Jmi also includes minor greenschist and foliated diorite. Amphibolite from Csejtey's map area yielded a K-Ar hornblende age of 176.6±5.1 Ma (Csejtey and others, 1978) and a $^{40}Ar/^{39}Ar$ plateau age on hornblende from a biotite-hornblende gneiss of 161.9±0.3 Ma (J.M. Schmidt, unpub. data, 2008, table 1, here). A metaigneous rock sample yielded an apparent Permian or Pennsylvanian U/Pb zircon age (C.P. Hults and D.C. Bradley, USGS, unpub. data), which is consistent with the apparent protlith age of the marble, unit JPmb. Unit age is constrained as older than Jqd by cross-cutting tonalite intrusions tentatively assigned to Jqd. Unit is overlain by Tertiary volcanic rocks (Csejtey and others, 1978; Oswald, 2006) of unit Tvu. Unit description modified after Csejtey and others (1978) and Oswald (2006). North of the map area, but still within in the Talkeetna Mountains quadrangle, similar rocks were mapped by Kline and others (1990) and correlated with metamorphic complex of the Gulkana River of Nokelberg and others (1989) and Strelna Metamorphics of Plafker and others (1989)

JPmb **Marble (Jurassic, metamorphic age; Permian?, protolith age)**—White, coarse- to medium-grained marble with porphyroblastic crystals of garnet and diopside (Csejtey and others, 1978). In Talkeetna Mountains quadrangle, forms lenticular interbeds, as much as a few tens of meters thick, within amphibole of unit Jam of Csejtey and others (1978) (unit JPam, here) and basaltic to andesitic metamorphosed volcanogenic sequence (Pzv) of presumably late Paleozoic age of Csejtey and others (1978). As shown here, includes units Jmrb, Jmb, Pls of Csejtey and others (1978). Poorly preserved and generally unidentified crinoid columnals, brachiopods, bryozoans, and rarely, corals were reported from the rocks that Csejtey and others (1978) mapped as their unit Pls. Kline and others (1990) mapped similar unit in Talkeetna Mountains quadrangle north of the map area and reported late Wolfcampian to Leonardian (Cisuralian) and Leonardian (late Cisuralian) to Guadalupian conodonts

ŦPvs **Basaltic to andesitic metavolcanic and sedimentary rocks (Triassic?, Permian, Cisuralian, and Pennsylvanian?)**—Interlayered heterogeneous, dominantly marine sequence over 5000 m thick (Csejtey and others, 1978). Consists primarily of metamorphosed flows and tuffs of basaltic and andesitic compositions; subordinate mudstone, bioclastic marble, and dark-gray to black phyllite. Includes olive green, medium-grained volcaniclastic crystal lithic tuff, pyroxene-hornblende meta-andesite flows, and meta-sandstone. Locally may also include Triassic age rocks that more commonly would be assigned to the Nikolai Greenstone (unit Ŧn) if mapping allowed; hence inferred Triassic age. Low-grade regional metamorphism. Includes part of units Pzv and Pzt of Csejtey and others (1978)

**BEDROCK**

bu **Bedrock, unknown**—Areas of known or apparent bedrock exposure. Bedrock type unknown

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**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska.

[Samples listed by map units and ordered from south to north and east to west. Quadrangle is the 1:250,000-scale sheet. Methods: A, Lead-alpha, a largely discredited technique; K/Ar, conventional potassium-argon; 40/39, $^{40}Ar/^{39}Ar$; Rb/Sr, rubidium-strontium; Nd/Sm, neodymium-samarium, U/Pb, uranium-lead]

| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KL-027, KL081 | Qod | Anchorage | 61.3922 | 149.8550 | Tephra | 40/39 | Glass | 0.378 | 0.067 | Goose Bay tephra, composite of 3 analyses | Reger and others, 1995 |
| 84AYb 71 | Qv | Mount Katmai | 58.0217 | 155.565 | Andesite | K/Ar | Plagioclase | 0.582 | 0.085 | Lava flow | Shew and Lanphere, 1992 |
| 84ARj 134B | Qv | Mount Katmai | 58.0783 | 155.4183 | Andesite | K/Ar | Plagioclase | 0.389 | 0.071 | Lava flow | Shew and Lanphere, 1992 |
| 84AYb 65 | Qv | Mount Katmai | 58.1033 | 155.42 | Dacite | K/Ar | Plagioclase | 0.394 | 0.046 | Lava flow | Shew and Lanphere, 1992 |
| 85AYb 223 | Qv | Mount Katmai | 58.14 | 155.5533 | Andesite | K/Ar | Plagioclase | 0.954 | 0.109 | Andesite porphyry flow | Shew and Lanphere, 1992 |
| 83ARj 143 | Qv | Mount Katmai | 58.4867 | 154.2867 | Andesite | K/Ar | Plagioclase | 0.446 | 0.388 | Lava flow | Shew and Lanphere, 1992 |
| 84AYb 24 | Qv | Afognak | 58.63 | 153.895 | Andesite | K/Ar | Whole-rock | 0.506 | 0.182 | Basaltic andesite plug or dome | Shew and Lanphere, 1992 |
| 84ARj 142B | Qv | Afognak | 58.6567 | 153.63 | Andesite | K/Ar | Plagioclase | 0.884 | 0.246 | Lava flow | Shew and Lanphere, 1992 |
| G-24-2 n.1 | Qv | Afognak | 58.95 | 153.4633 | Andesite | K/Ar | Whole-rock | 0.70<br>1.00 | 2.1<br>3.0 | | Magoon and others, 1976 |
| 85CNS 26 | Qv | Tyonek | 61.075 | 152.1267 | Andesite | K/Ar | Whole-rock | 2.08 | 0.2 | Mount Spurr, isolated remnant, minimum age due to minor alteration, 2.08 ± .20 my | Turner and Nye, 1986; Nye and Turner, 1990 |
| AMS-A02 | Qv | Tyonek | 61.2433 | 152.1167 | Andesite | K/Ar | Whole-rock | 0.112 | 0.008 | Mount Spurr, also called 85CNS24 | Nye and Turner, 1990; Turner and Nye, 1986 |
| AMS-B01 | Qv | Tyonek | 61.245 | 152.3083 | Andesite | K/Ar | Whole-rock | 0.255 | 0.052 | Mount Spurr, also called 85CNS59 | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-B02 | Qv | Tyonek | 61.2467 | 152.3083 | Andesite | K/Ar | Whole-rock | 0.155 | 0.014 | Mount Spurr | Nye and Turner, 1990 |
| AMS-B05 | Qv | Tyonek | 61.2483 | 152.3083 | Andesite | K/Ar | Whole-rock | 0.065 | 0.015 | Possible sill, also called 85CNS55B | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-A04 | Qv | Tyonek | 61.255 | 152.145 | Andesite | K/Ar | Whole-rock | 0.134 | 0.021 | Minimum age based on observation of groundmass glass, also called 85CNS22 | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-B08 | Qv | Tyonek | 61.2567 | 152.2967 | Andesite | K/Ar | Whole-rock | 0.139 | 0.009 | Mount Spurr, also called 85CNS42 | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-A05 | Qv | Tyonek | 61.2583 | 152.1467 | Andesite | K/Ar | Whole-rock | 0.110 | 0.006 | Mount Spurr, also called 85CNS21 | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-A06 | Qv | Tyonek | 61.26 | 152.1467 | Andesite | K/Ar | Whole-rock | 0.100 | 0.011 | Mount Spurr, mean of 2 replicates, also called 85CNS37 | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-B10 | Qv | Tyonek | 61.26 | 152.2967 | Andesite | K/Ar | Whole-rock | 0.119 | 0.016 | Mean of 3 replicates, Mount Spurr, also called 85CNS40 | Nye and Turner, 1990, Turner and Nye, 1986 |
| AMS-A08 | Qv | Tyonek | 61.2667 | 152.1567 | Andesite | K/Ar | Whole-rock | 0.059 | 0.014 | Mount Spurr; mean of 3 replicates, also called 85CNS35 | Nye and Turner, 1990, Turner and Nye, 1986 |
| 01PH 411A | Qv | Tyonek | 61.3389 | 152.0917 | Volcanic rock | 40/39 plateau | Whole-rock | 1.8 | 0.5 | Holocene? Mount Spurr volcanic rocks, 9 fractions, 76% 39Ar release | Haeussler and others (written commun., 2008) |
| 78AR 290DK | Qad | Kenai | 60.7167 | 152.6667 | Andesite | K/Ar | Whole-rock | 0.763 | 0.017 | Dark band in banded andesite | Reed, Lanphere and Miller, 1992 |
| 78AR 290LT | Qad | Kenai | 60.7167 | 152.6667 | Andesite | K/Ar | Whole-rock | 0.627 | 0.024 | Light band in banded andesite | Reed, Lanphere and Miller, 1992 |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 90AR 99 | Qad | Kenai | 60.77 | 152.7 | Andesite | K/Ar | Whole-rock | 0.887 | 0.015 | Estimated latitude and longitude | Reed and others, 1992 |
| 84AYb 69 | QTv | Mount Katmai | 58.07 | 155.7317 | Andesite | K/Ar | Whole-rock | 2.45 | 0.21 | Lava flow | Shew and Lanphere, 1992 |
| 85AYb 214 | QTv | Mount Katmai | 58.0783 | 155.8067 | Andesite | K/Ar | Plagioclase | 2.00 | 0.11 | Basaltic andesite porphyry | Shew and Lanphere, 1992 |
| 86ARj 62 | QTv | Mount Katmai | 58.3867 | 155.2267 | Andesite | K/Ar | Plagioclase | 2.64 | 0.04 | Basaltic andesite porphyry flow | Shew and Lanphere, 1992 |
| DT75-213 | Tkn | Tyonek | 61.2483 | 151.1017 | Ash | K/Ar | Plagioclase | 15.8<br>15.9 | 1.8<br>1.5 | Chuitna River section; Beluga Coal field. Ash bracketed by Seldovian flora | Turner and others, 1980 |
| DT75-212 | Tks | Seldovia | 59.77 | 151.1333 | Ash | K/Ar | Plagioclase | 32.2<br>30.1 | 1.9<br>1.8 | 33m stratigraphically above DT75-211. Sterling Formation; age may be too old due to detrital contamination | Turner and others, 1980 |
| DT75-211 | Tks | Seldovia | 59.77 | 151.1333 | Ash | Fission-track | Zircon | 5.4 | 0.6 | 20-40m stratigraphically above DT75-210. Sterling Formation | Turner and others, 1980 |
| DT75-211 | Tks | Seldovia | 59.77 | 151.1333 | Ash | K/Ar | Plagioclase | 11.7<br>14.1 | 0.9<br>1.1 | 20-40m stratigraphically above DT75-210. Sterling Formation; age may be too old due to detrital contamination | Turner and others, 1980 |
| DT75-210 | Tks | Seldovia | 59.77 | 151.1333 | Ash | K/Ar | Plagioclase | 7.2 | 0.6 | Sterling Formation, Clamgulchian Stage | Turner and others, 1980 |
| DT75-209b | Tks | Seldovia | 59.7967 | 151.1083 | Tuff | K/Ar | Plagioclase | 9.1<br>8.2 | 0.7<br>0.8 | Sterling? Formation, age may be too old due to detrital contamination | Turner and others, 1980 |
| DT75-208 | Tks | Seldovia | 59.7967 | 151.1117 | Tuff | K/Ar | Hornblende<br>Plagioclase | 4.7<br>4.2 | 0.6<br>1.4 | 35m stratigraphically higher than DT75-206. Sterling Formation | Turner and others, 1980 |
| DT75-207 | Tks | Seldovia | 59.7967 | 151.1117 | Tuff | Fission-track | Zircon | 4.9 | 0.8 | 24m stratigraphically higher than DT75-206. Sterling Formation | Turner and others, 1980 |
| DT75-207 | Tks | Seldovia | 59.7967 | 151.11167 | Tuff | K/Ar | Plagioclase | 7.6<br>7.5 | 0.6<br>0.6 | 24m stratigraphically higher than DT75-206. Believed to be too old due to detrital contamination | Turner and others, 1980 |
| DT75-206 | Tks | Seldovia | 59.7967 | 151.1117 | Ash | Fission-track | Zircon | 5.6 | 0.9 | Composite of four thin beds, Sterling Formation | Turner and others, 1980 |
| DT75-206 | Tks | Seldovia | 59.7967 | 151.1117 | Ash | K/Ar | Plagioclase | 4.6<br>8.4 | 0.7<br>0.7 | Composite of four thin beds. Age may be too old due to detrital contamination | Turner and others, 1980 |
| 6-25-77-1 | Tks | Seldovia | 59.8233 | 151.0417 | Ash | K/Ar | Plagioclase | 6.9 | 0.5 | Sterling Formation, Clamgulchian Stage | Turner and others, 1980 |
| 7-14-73-3 | Tks | Kenai | 60.0683 | 151.6467 | Ash | Fission-track | Zircon | 8.5 | 1.0 | Kenai Peninsula, Sterling Formation. Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| 7-14-73-3 | Tks | Kenai | 60.0683 | 151.6467 | Ash | K/Ar | Plagioclase | 8.9 | 1.0 | Kenai Peninsula, Sterling Formation. Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| 7-13-73-9 | Tks | Kenai | 60.1858 | 151.4617 | Ash | K/Ar | Plagioclase | 7.0 | 0.7 | Kenai Peninsula, location revised, Sterling Formation. Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-13-73-6 | Tks | Kenai | 60.205 | 151.4333 | Ash | K/Ar | Hornblende<br>Plagioclase | 7.4<br>8.8 | 0.7<br>0.5 | Kenai Peninsula, location revised, Sterling Formation. Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| DT75-201 | Tks | Kenai | 60.205 | 151.435 | Tuff | K/Ar | Hornblende<br>Plagioclase | 5.0<br>5.9 | 0.8<br>0.5 | Crystal tuff, Sterling Formation. Each is mean of 2 splits | Turner and others, 1980 |
| DT75-200 | Tks | Kenai | 60.2358 | 151.4008 | Ash | Fission-track | Zircon | 6.60 | 0.7 | Sterling Formation, Clamgulchian Stage | Turner and others, 1980 |
| DT75-203 | Tb | Seldovia | 59.7033 | 151.2783 | Tuff | Fission-track | Apatite | 12.9 | 5.1 | Crystal vitric tuff mostly altered to clay | Turner and others, 1980 |
| DT75-203 | Tb | Seldovia | 59.7033 | 151.2783 | Tuff | K/Ar | Plagioclase | 8.8 | 0.9 | Crystal vitric tuff mostly altered to clay. Mean of 2 analyses | Turner and others, 1980 |
| 7-21-73-5 | Tb? | Seldovia | 59.7058 | 151.28 | Ash | Fission-track | Zircon | 8.1 | 1.0 | Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| DT75-202 | Tb | Seldovia | 59.71 | 151.2383 | Tuff | K/Ar | Plagioclase | 7.2 | 1.3 | Crystal vitric tuff | Turner and others, 1980 |
| DT75-204 | Tb | Seldovia | 59.7117 | 151.2683 | Ash | Fission-track | Zircon | 7.6 | 0.7 | Crystal vitric tuff | Turner and others, 1980 |
| DT75-204 | Tb | Seldovia | 59.7117 | 151.2683 | Ash | K/Ar | Plagioclase | 8.1 | 0.7 | Mean of 2 analyses | Turner and others, 1980 |
| 7-22-73-4 | Tb? | Seldovia | 59.7617 | 151.1692 | Ash | Fission-track | Zircon | 8.1 | 1.0 | Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| 7-22-73-4 | Tb? | Seldovia | 59.7617 | 151.1692 | Ash | K/Ar | Plagioclase | 8.1 | 0.8 | Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| 7-21-73-1 | Tb? | Seldovia | 59.7683 | 151.1575 | Ash | Fission-track | Zircon | 8.8 | 1.0 | Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| 7-21-73-1 | Tb? | Seldovia | 59.7683 | 151.1575 | Ash | K/Ar | Plagioclase | 11.3 | 0.7 | Age revised in Turner and others (1980) | Triplehorn and others, 1977; Turner and others, 1980 |
| 01PH 409A | Twf | Tyonek | 61.2894 | 151.9364 | Tuff | U/Pb | Zircon | 43.4 | 0.2 | Andesite tuff in West Foreland Formation, 3 concordant, overlapping fractions, 4 fractions run | Haeussler and others (written commun., 2008) |
| BIL99-14-C2 | Tw | Talkeetna Mountains | 62.0403 | 147.6103 | Dacite | 40/39 | Biotite | 55.6 | 0.3 | Pseudo-plateau age on dacite clast in Wishbone Formation | Cole and others, 2006 |
| BC98-7-C5 | Tw | Anchorage | 61.9792 | 147.7375 | Granite | 40/39 plateau | Biotite | 169.3 | 0.9 | Granite clast in Wishbone Formation | Cole and others, 2006 |
| 77AGz-Ar3 | Tar | Anchorage | 61.695 | 149.7183 | Basalt | K/Ar | Whole-rock | 50.0 | 2.5 | Approximate location, basalt flow | Silberman and Grantz, 1984; Winkler, 1992 |
| 77AGz-Ar10 | Tar | Anchorage | 61.75 | 149.24 | Basalt | K/Ar | Whole-rock | 46.1 | 2.8 | Approximate location, basalt dike | Silberman and Grantz, 1984, Winkler, 1992 |
| 76ACy 19 | Tar | Anchorage | 61.7722 | 149.1722 | Meta-graywacke | K/Ar | Biotite | 67.5 | 2.4 | Metamorphosed graywacke | Csejtey and others, 1978; Winkler, 1992 |
| 78ASi-M19 | Tar | Anchorage | 61.8083 | 149.9067 | Basalt | K/Ar | Whole-rock | 56.2 | 1.7 | Approximate location | Silberman and Grantz, 1984; Winkler, 1992 |
| 78ASi-M21 | Tar? | Anchorage | 61.8483 | 149.77 | Basalt | K/Ar | Whole-rock | 51.8 | 1.6 | Approximate location, incorrect sample ID. in Winkler, 1992 | Silberman and Grantz, 1984; Winkler, 1992 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79AGz-38A | Tar | Anchorage | 61.925 | 148.4783 | Rhyolite | K/Ar | Whole-rock | 45.5 | 1.8 | Approximate location | Silberman and Grantz, 1984; Winkler, 1992 |
| 79AGz-38B | Tar | Anchorage | 61.925 | 148.4783 | Rhyolite | K/Ar | Potassium feldspar | 51.4 | 1 | Ash flow tuff, alkali feldspar. Approximate location | Silberman and Grantz, 1984; Winkler, 1992 |
| 78ASi-M23 | Tar | Anchorage | 61.93 | 148.5 | Rhyolite | K/Ar | Whole-rock | 50.5 | 1.5 | Arkose Ridge Formation, approximate location, tuff | Silberman and Grantz, 1984, Winkler, 1992 |
| 6-27-77-6 | Tch | Anchorage | 61.7717 | 148.935 | Tuff | Fission-track | Zircon | 53.1 | 1.3 | Ash parting in coal bed no. 5, Evan Jones mine, crystal vitric tuff | Triplehorn and others, 1984, Winkler, 1992 |
| 6-27-77-6 | Tch | Anchorage | 61.7717 | 148.935 | Tuff | K/Ar | Plagioclase | 55.1 | 1.7 | Ash parting in coal bed no. 5, Evan Jones mine, crystal vitric tuff, concordant | Triplehorn and others, 1984, Winkler, 1992 |
| 8-7-78-8 | Tch | Anchorage | 61.7717 | 148.935 | Tuff | K/Ar | Plagioclase | 52.2 | 1.6 | Premier Group coal bed no. 5, Evan Jones coal mine, crystal vitric tuff | Triplehorn and others, 1984, Winkler, 1992 |
| 8-7-78-8 | Tch | Anchorage | 61.7717 | 148.935 | Tuff | Fission-track | Zircon | 52.8 | 1.5 | Premier Group coal bed no. 8, Evan Jones coal mine, crystal vitric tuff | Triplehorn and others, 1984, Winkler, 1992 |
| 8-7-78-4 | Tch | Anchorage | 61.7717 | 148.935 | Tuff | K/Ar | Plagioclase | 55.8 | 1.7 | Premier Group coal bed no. 8, Evan Jones coal mine, crystal vitric tuff | Triplehorn and others, 1984, Winkler, 1992 |
| 8-7-78-4 | Tch | Anchorage | 61.7717 | 148.935 | Tuff | Fission-track | Zircon | 43.5 | 1.4 | Premier Group coal bed no. 8, Evan Jones coal mine, age inconsistent with others, crystal vitric tuff | Triplehorn and others, 1984, Winkler, 1992 |
| M-25-88 | TKd | Afognak | 58.2333 | 153.0417 | Intrusive rock | Fission-track | Zircon | 55 | | Mean age of individual crystals is 56 Ma; dike cutting Shuyak Formation., elevation 0m | Clendenen, 1991 |
| n.a. | TKd | Seldovia | 59.3195 | 151.2917 | Felsic dike | 40/39 | White mica | 57.3 | 0.1 | Port Dick prospect, hydrothermal alteration preferred date from single step (1000° C) and 67.8 % of gas | Haeussler and others, 1995 |
| 88ADw 230 | TKd | Seldovia | 59.3933 | 150.665 | Intermediate dike | 40/39 isochron | Hornblende | 57.0 | 0.22 | Leucocratic porphyry dike that cuts the McHugh Complex near the head of Seldovia Bay | Bradley and others, 1992; 1999; 2000 |
| 93ASB 66 | TKd | Seldovia | 59.3938 | 151.2186 | Basaltic andesite | 40/39 plateau | Hornblende | 115.0 | 1.7 | Hornblende-phyric basaltic andesite dike cutting graywacke of McHugh Complex 4km SE of the head of Tutka Bay | Bradley and others, 1999; 2000 |
| K/Ar5 | TKd | Lake Clark | 60.2772 | 154.8378 | Andesite | K/Ar | Biotite | 62.7 | 1.9 | Augite andesite porphyry | Eakins and others, 1978 |
| 77E 216 | TKd | Lake Clark | 60.37 | 155.2033 | Dacite | K/Ar | Biotite | 59.50 | 1.8 | Biotite dacite | Eakins and others, 1978 |
| 82BB289 | TKd | Lake Clark | 60.3833 | 153.8833 | Mafic dike | K/Ar | Hornblende | 79.6 | 2.4 | Dike cutting Tlikakila Complex, Lake Clark B-3 quadrangle, approximate location, T.3N., R.27W., Section 1 | Wallace and others, 1989 |
| 2203N | TKd | Seward | 60.6667 | 149.7500 | Felsic dike | K/Ar | Whole-rock | 52.7 | 1.6 | Hydrothermally altered felsic dike, approximate location, Kenai Star Mine | Silberman and others, 1981; Mitchell and others, 1981; Haeussler and others, 1995 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2237B | TKd | Seward | 60.8000 | 149.6667 | Granite | K/Ar | Muscovite | 53.2 | 1.6 | Hydrothermally altered albite-granite dike, approximate location, Kenai Star Mine | Silberman and others, 1981; Mitchell and others, 1981; Haeussler and others, 1995 |
| 91AKU 137 | TKd | Anchorage | 61.0481 | 149.1078 | Felsic intrusion | 40/39 plateau | Mica | 54.1 | .1 | Crow Pass felsic intrusion, minor argon loss, cooling age | Haeussler and others (1995) in: Bradley and others, 2000 |
| 80AMS 34 | TKd | Anchorage | 61.0533 | 149.1217 | Dacite | K/Ar | Muscovite | 54.5 | 1.6 | Dacite dike | Nelson and others, 1985, Winkler, 1992 |
| 80KMS 32I | TKd | Anchorage | 61.0533 | 149.1217 | Dacite | K/Ar | Whole-rock | 54.8 | 2.7 | Dacite dike | Nelson and others, 1985, Winkler, 1992 |
| CKA-1 | TKd | Anchorage | 61.2717 | 149.3033 | Felsic rock | K/Ar | Whole-rock | 50.2 | 2.5 | Felsic sill | Updike and Ulery, 1983, Winkler, 1992 |
| CKA-2 | TKd | Anchorage | 61.32 | 149.3167 | Felsic rock | K/Ar | Whole-rock | 50.0 | 2.6 | Felsic dike | Updike and Ulery, 1983, Winkler, 1992 |
| 01PH 413B | TKd | Tyonek | 61.5451 | 152.1696 | Mafic dike | 40/39 plateau | Whole-rock | 55.8 | 0.5 | 7 fractions, 95% 39Ar released | Haeussler and others (written commun., 2008) |
| 81BS 116C | TKd | Seward | 60.6155 | 149.5680 | Felsic dike | K/Ar | Whole-rock | 52.5 | 1.6 | Dike, Oracle Mine, cutting Valdez Group (Kvs) | Nelson and others, 1985; Bradley and others, 1992 |
| 02PH 459B | TKd | Tyonek | 61.6422 | 152.0575 | Diabase | 40/39 plateau | Whole-rock | 55.2 | 2.3 | Diabase dike from dike swarm, replicate analysis, 4 fractions, 69% 39Ar release | Haeussler and others (written commun., 2008) |
| | | | | | | | | 56.5 | 0.9 | Replicate analysis, 5 fractions, 83% 39Ar release | |
| L & N 8 | TKd | Anchorage | 61.6467 | 147.98 | Dacite | Fission-track | Zircon | 49.6 | 6.8 | Dacite dike | Little and Naeser, 1989, Winkler, 1992 |
| L & N 9 | TKd | Anchorage | 61.66 | 147.91 | Dacite | Fission-track | Zircon | 47.3 | 5.3 | Dacite dike | Little and Naeser, 1989, Winkler, 1992 |
| 02PH 332B | TKd | Tyonek | 61.6699 | 152.0827 | Basalt | 40/39 plateau | Whole-rock | 51.6 | 2.1 | Plagioclase basalt dike, replicate analysis, 5 fractions, 86% 39Ar release | Haeussler and others (written commun., 2008) |
| | | | | | | | | 52.0 | 0.8 | Replicate analysis, 4 fractions, 63% 39Ar release; stair step up-no plateau | |
| L & N 6 | TKd | Anchorage | 61.6833 | 147.8167 | Dacite | Fission-track | Zircon | 47.8 | 7.0 | Oxidized dacite dike | Little and Naeser, 1989, Winkler, 1992 |
| L & N 7 | TKd | Anchorage | 61.6833 | 147.8333 | Dacite | Fission-track | Zircon | 42.9 | 5.5 | Oxidized dacite dike | Little and Naeser, 1989, Winkler, 1992 |
| 02PH 461B | TKd | Tyonek | 61.6868 | 152.0753 | Mafic dike | 40/39 plateau | Whole-rock | 57.0 | 0.8 | Replicate analysis, 4 fractions, 79% 39Ar release | Haeussler and others (written commun., 2008) |
| | | | | | | | | 57.9 | 0.9 | Replicate analysis, 5 fractions, 79% 39Ar release | |
| L & N 3 | TKd | Anchorage | 61.6967 | 147.715 | Dacite | Fission-track | Zircon | 41.3 | 6.0 | Dacite dike | Little and Naeser, 1989, Winkler, 1992 |
| 02PH 334C | TKd | Tyonek | 61.7112 | 152.3290 | Mafic dike | 40/39 plateau | Whole-rock | 51.0 | 1.0 | Mafic dike swarm dike, 4 fractions, 91% 39Ar release | Haeussler and others (written commun., 2008) |
| 02PH 342C | TKd | Tyonek | 61.7301 | 152.3342 | Diabase | 40/39 plateau | Whole-rock | 55.0 | 1.2 | Diabase dike from dike swarm, 6 fractions, 86% 39Ar release | Haeussler and others (written commun., 2008) |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 78ASi-M22A | TKd | Anchorage | 61.75 | 148.5333 | Rhyolite | K/Ar | Whole-rock | 37.5 | 1.2 | Rhyolite stock, approximate location | Silberman and Grantz, 1984, Winkler, 1992 |
| 81AWk 51B | TKd | Anchorage | 61.755 | 148.275 | Basalt | K/Ar | Whole-rock | 38 | 2 | Basalt dike, very low K2O, reset | Winkler, 1992 |
| 81AWk 49A | TKd | Anchorage | 61.755 | 148.33 | Basalt | K/Ar | Whole-rock | 130 | 6 | Basalt dike | Winkler, 1992 |
| 78ASi-M6 | TKd | Anchorage | 61.7667 | 148.52833 | Rhyolite | K/Ar | Whole-rock | 40.0 | 1.6 | Rhyolite dike | Silberman and Grantz, 1984, Winkler, 1992 |
| 02PH 336B | TKd | Tyonek | 61.7699 | 152.4027 | Mafic dike | 40/39 plateau | Whole-rock | 57.1 | 3.3 | Replicate analysis, 4 fractions, 79% 39Ar release | Haeussler and others (written commun., 2008) |
| | | | | | | | | 58.0 | 0.9 | Replicate analysis, 4 fractions, 70% 39Ar release | |
| 78ASi-M8 | TKd | Anchorage | 61.7733 | 148.505 | Dacite | K/Ar | Whole-rock | 43.5 | 1.7 | Dacite dike | Silberman and Grantz, 1984, Winkler, 1992 |
| MLS 5 | TKd | Anchorage | 61.7767 | 149.42 | Lamprophyre | K/Ar | Hornblende | 66.2 | 2.0 | Lamprophyre dike in tonalite | Silberman and others, 1978b, Winkler, 1992 |
| L & N 1 | TKd | Anchorage | 61.7783 | 147.4967 | Dacite | Fission-track | Zircon | 36.8 | 4.8 | Dacite dike | Little and Naeser, 1989, Winkler, 1992 |
| 79AG-112 | TKd | Anchorage | 61.7917 | 147.5717 | Dacite | K/Ar | Whole-rock | 45.5 | 2.3 | Dacite stock, approximate location | Silberman and Grantz, 1984, Winkler, 1992 |
| 78ASi-M45 | TKd | Anchorage | 61.8367 | 148.0933 | Basalt | K/Ar | Whole-rock | 40.9 | 1.6 | Basalt sill, approximate location | Silberman and Grantz, 1984, Winkler, 1992 |
| 8-TMA3-1 | TKd | Talkeetna Mountains | 62.0375 | 147.8842 | Andesite | 40/39 | Whole-rock | 45.5 | 0.3 | Pseudo-plateau age; isochron age of 38 Ma | Cole and others, 2006 |
| 79AGz 102 | TKd | Talkeetna Mountains | 62.0583 | 148.0 | Intrusive rock | K/Ar | Whole-rock | 46.7 | 2.3 | Plug, approximate location | Silberman and Grantz,1984 |
| 01PJ35A | TKd | Talkeetna Mountains | 62.3047 | 148.6214 | Rhyolite | 40/39 plateau | Whole-rock | 31.1 | 0.5 | Vitric rhyolite intrusion. No isochron determined. Humped plateau, suggesting disturbance | Oswald, 2006 |
| 99Pe 21 | TKd | Talkeetna Mountains | 62.3901 | 149.0628 | Felsite | 40/39 plateau | Biotite | 52.1 | 0.4 | Felsite or rhyodacite flow | Drake and Layer, 2001 |
| 01PJ05A | TKd | Talkeetna Mountains | 62.565 | 148.8899 | Dacite | 40/39 plateau | Hornblende | 44.6 | 1.1 | Porphyritic dacite intrusion. Isochron age 45.0±1.0 Ma | Oswald, 2006 |
| 6-27-1 | Tb | Iliamna | 59.0733 | 154.0417 | Basalt | K/Ar | Whole-rock | 4.40<br>5.10 | 0.5<br>1.0 | — | Magoon and others, 1976; Determan and Reed, 1980 |
| 79AGz 116 | Tmf | Talkeetna Mountains | 62.1 | 148.16667 | Tuff | K/Ar | Whole-rock | 43.6 | 2.2 | Pyroclast in tuff breccia, approximate location | Silberman and Grantz, 1984 |
| 77AMb 122 | Tmv | Afognak | 58.88 | 153.2967 | Andesite | K/Ar | Hornblende | 29.3 | 8.4 | Sill | Shew and Lanphere, 1992 |
| GT8 | Tmv | Iliamna | 59.11 | 154.94 | Andesite | K/Ar | Whole-rock | 31.30 | 0.9 | — | Thrupp and Coe, 1986 |
| GT4 | Tmv | Iliamna | 59.64 | 154.45 | Andesite | K/Ar | Plagioclase | 33.80 | 6.8 | — | Thrupp and Coe, 1986 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GT9 | Tmb | Iliamna | 59.31 | 154.62 | Andesite | K/Ar | Whole-rock | 29.50 | 1.4 | — | Thrupp and Coe, 1986 |
| GT10 | Tmb | Lake Clark | 60.57 | 154.34 | Basalt | K/Ar | Whole-rock | 44.4 | 1.7 | — | Thrupp and Coe, 1986 |
| 79AGz 112 | Tem | Talkeetna Mountains | 62.0 | 148.2217 | Basalt | K/Ar | Whole-rock | 60.1 | 4.6 | Basalt flow, approximate location, suspect age due to low K2O | Silberman and Grantz, 1984 |
| 79AGz 107 | Tem | Talkeetna Mountains | 62.0733 | 147.7983 | Andesite | K/Ar | Whole-rock | 48.4 | 2.4 | Andesite flow, approximate location | Silberman and Grantz, 1984 |
| 79AGz 106 | Tem | Talkeetna Mountains | 62.125 | 147.7633 | Basalt | K/Ar | Whole-rock | 55.5 | 3.5 | Basalt flow, approximate location | Silberman and Grantz, 1984 |
| 75ASj 526 | Tem | Talkeetna Mountains | 62.2808 | 148.7238 | Andesite | K/Ar | Whole-rock | 56.3 | 2.5 | — | Csejtey and others, 1978, Hillhouse and others, 1985; Amos and Cole, 2003 |
| 01PJ40A | Tem | Talkeetna Mountains | 62.2953 | 148.667 | Basalt | 40/39 plateau | Whole-rock | 46.1 | 0.4 | Isochron age 46.0±0.5 Ma. Very low calculated percent radiogenic argon | Oswald, 2006 |
| 75ASj 520 | Tem | Talkeetna Mountains | 62.4772 | 149.4917 | Andesite | K/Ar | Hornblende | 50.4 | 2.0 | — | Csejtey and others, 1978, Hillhouse and others, 1984, 1985; Amos and Cole, 2003 |
| 00BP02 | Tem | Talkeetna Mountains | 62.4780 | 148.7839 | Basalt | 40/39 | Whole-rock | 44.4 | 0.2 | Basalt flow | J.M. Schmidt, written commun., 2008 |
| 01PJ10D | Tem | Talkeetna Mountains | 62.5889 | 148.8662 | Basalt | 40/39 plateau | Whole-rock | 44.9 | 1.0 | Isochron age 44.8±1.0 Ma | Oswald, 2006 |
| 01PJ20B | Tem | Talkeetna Mountains | 62.5889 | 148.8662 | Basalt | 40/39 plateau | Whole-rock | 21.6 | 2.1 | Isochron age 25.5±5.8 Ma. Discordance between plateau and isochron suggests sample was highly disturbed and therefore age is questionable. | Oswald, 2006 |
| 75ASj 521B | Tem | Talkeetna Mountains | 62.59 | 148.8945 | Andesite | K/Ar | Whole-rock | 51.3 | 2.5 | — | Csejtey and others, 1978, Hillhouse and others, 1984, 1985; Amos and Cole, 2003 |
| 8-TMA3-1 | Tem | Talkeetna Mountains | 62.0375 | 147.8842 | Andesite | 40/39 | Whole-rock | 45.5 | 0.3 | Pseudo-plateau age; isochron age of 38 Ma | Cole and others, 2006 |
| GLAC99-17 | Tem | Talkeetna Mountains | 62.0219 | 147.9850 | Basalt | 40/39 plateau | Whole-rock | 45.6 | 5.1 | — | Cole and others, 2006 |
| STM1-85 | Tem | Talkeetna Mountains | 62.0456 | 147.7239 | Basaltic andesite | 40/39 plateau | Whole-rock | 48.3 | 1.6 | — | Cole and others, 2006 |
| 00BP01 | Tfv | Talkeetna Mountains | 62.4780 | 148.7839 | Rhyodacite | 40/39 | White mica | 45.2 | 0.5 | Rhyodacite dome. Total gas isochron 46.4±0.1 Ma | J.M. Schmidt, written commun., 2008 |
| 81AMH 65A | Tfv | Anchorage | 61.3867 | 147.5367 | Dacite | K/Ar | Whole-rock | 43.6 | 1.6 | Dacite dike | Nelson and others, 1985, Winkler, 1992 |
| 70ACs 423 | Tfv | Anchorage | 61.065 | 149.7967 | Dacite | K/Ar | Hornblende | 34.8 | 2.0 | Dike or sill, age recalculated using constants of Steiger and Jager (1977) | Berry and others, 1976; MacKevett, 1976; 1978, Clark and others, 1976; Winkler, 1992 |
| 2-TMA3-3 | Tfv | Talkeetna Mountains | 62.0389 | 147.9139 | Rhyolite | 40/39 | Whole-rock | 44.1 | 0.2 | Pseudo-plateau age, disturbed age spectrum | Cole and others, 2006 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-TMA3-6 | Tfv | Talkeetna Mountains | 62.0417 | 147.9017 | Rhyolite | 40/39 plateau;<br>40/39 | Whole-rock;<br>K-feldspar | 35.6<br>33.7 | 0.2<br>0.4 | Well defined plateau and isochron age;<br>K-feldspar yielded pseudo-plateau age | Cole and others, 2006 |
| GLA99-18c | Tfv | Talkeetna Mountains | 62.0219 | 147.9942 | Rhyolite | 40/39 | Whole-rock | 37.9 | 0.2 | Pseudo-plateau age | Cole and others, 2006 |
| 99ANS-9A | Tfv | Talkeetna Mountains | 62.0472 | 148.0200 | Dacite | 40/39 plateau | Whole-rock | 39.9 | 0.7 | Well defined plateau and isochron age | Cole and others, 2006 |
| | | | | | | | | | | | Cole and others, 2006 |
| 90WG 143F | Tpv | Tyonek | 61.8792 | 152.3361 | Basalt | 40/39 average | Whole-rock | 57.9 | 1.9 | Maximum age thought to be about 65 Ma | Layer and Solie, 2008 |
| 01PH 414A | Tpv | Tyonek | 61.6275 | 152.2295 | Tuff | 40/39 plateau | Whole-rock | 56.9 | 0.7 | Crystal tuff, 8 fractions, 94% 39Ar release | Haeussler and others (written commun., 2008) |
| 02PH 462A | Tpv | Tyonek | 61.7174 | 151.9910 | Tuff | U/Pb | Zircon | 61.9 | 0.3 | Crystal lithic tuff, 2 concordant, overlapping fractions; 4 run in all | Haeussler and others (written commun., 2008) |
| 90WG 154 | Tpv | Tyonek | 61.8694 | 152.2386 | Volcanic rock | 40/39 plateau | Whole-rock | 62.1 | 0.4 | — | Layer and Solie, 2008 |
| 90MR 117C | Tpv | Tyonek | 61.8829 | 152.3017 | Basalt | 40/39 average | Whole-rock | 66.0 | 0.9 | — | Layer and Solie, 2008 |
| 90DNS 31 | Tpv | Tyonek | 61.9256 | 151.9880 | Andesite | 40/39 isochron | Whole-rock | 60.82 | 0.43 | Location given as Porcupine Butte | Solie and Layer, 1993 |
| 90DNS 31 | Tpv | Tyonek | 61.9256 | 151.9880 | Andesite | 40/39 plateau | Whole-rock | 60.5 | 0.6 | Location given as Porcupine Butte | Layer and Solie, 2008 |
| 99ANS-18A | Tpv | Talkeetna Mountains | 62.0242 | 147.8611 | Andesite | 40/39 | Whole-rock | 45.7 | 1.4 | — | Cole and others, 2006 |
| 99ANS-17a | Tpv | Talkeetna Mountains | 62.0825 | 147.8256 | Tuff | 40/39 plateau | Alkali feldspar | 59.0 | 0.3 | Andesitic tuff, plateau age; quality not mentioned; a biotite analysis from this sample had no plateau but showed evidence of the 59 Ma age | Cole and others, 2006; S.W. Nelson, USGS ret., oral comm., 4/18/01 |
| 02PH 348A | TKft | Tyonek | 61.9026 | 151.8227 | Tuff | 40/39 plateau | Whole-rock;<br>Hornblende | 58.3<br>89.7 | 1.0<br>3.0 | Massive crystal-lithic tuff, 7 fractions, 82% 39Ar release<br>3 fractions, 61% 39Ar release | Haeussler and others (written commun., 2008) |
| 01PH 415A | Kv | Tyonek | 61.6519 | 152.2207 | Rhyolite | 40/39 plateau | Hornblende | 122.4 | 1.5 | Flow-banded rhyolite, 7 fractions, 85% 39Ar released | Haeussler and others (written commun., 2008) |
| 02PH 348A | Kv | Tyonek | 61.9026 | 151.8227 | Tuff | 40/39 plateau | Whole-rock; | 58.3 | 1.0 | Massive crystal-lithic tuff, 7 fractions, 82% 39Ar release<br>3 fractions, 61% 39Ar release | Haeussler and others (written commun., 2008) |
| | | | | | | | Hornblende | 89.7 | 3.0 | | |
| 02PH 317A | Kv | Tyonek | 61.9860 | 151.5237 | Tuff | 40/39 plateau | Whole-rock | 98.2 | 0.4 | Crystal-lithic tuff, 4 fractions, 61% 39Ar release | Haeussler and others (written commun., 2008) |
| 99JS 48B | Kv | Talkeetna Mountains | 62.2691 | 149.0267 | Metarhyodacite | 40/39 plateau | Biotite;<br>White mica | 100.5<br>132.8 | 0.7<br>0.7 | Plateau was not flat. Biotite “severely altered”, strongly discordant with coexisting white mica. Porphyritic quartz-eye metarhyodacite | Drake and Layer, 2001 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 83APb 30 | Tpi | Mount Katmai | 58.11 | 154.6833 | Granodiorite | K/Ar | Biotite | 5.00 | 0.18 | Chloritized biotite, minimum age, pluton | Shew and Lanphere, 1992 |
| 84ARj 79A | Tpi | Mount Katmai | 58.2783 | 154.5 | Granodiorite | K/Ar | Biotite | 2.45 | 0.07 | Serpent Tongue pluton | Shew and Lanphere, 1992 |
| 79H9 | Tpi | Afognak | 58.7 | 153.6217 | Quartz diorite | K/Ar | Biotite | 4.2 | 0.2 | Dike or sill | Shew and Lanphere, 1992 |
| 77AEg 74 | Tpi | Afognak | 58.865 | 153.4133 | Granodiorite | K/Ar | Biotite | 4.8 | 0.5 | Dike or sill | Shew and Lanphere, 1992 |
| 84AEm 18A | Tpi | Afognak | 58.6117 | 153.8433 | Andesite | K/Ar | Whole-rock | 8.22 | 0.25 | Basaltic andesite porphyry sill | Shew and Lanphere, 1992 |
| 84ADt 95 | Tpi | Afognak | 58.635 | 153.5917 | Andesite | K/Ar | Plagioclase | 7.72 | 0.54 | Andesite(?) sill | Shew and Lanphere, 1992 |
| 83AR 28 | Toegr | Mount Katmai | 58.78 | 154.965 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 35.8<br>35.3 | 1.1<br>1.1 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| A123 | Toegr | Mount Katmai | 58.8083 | 154.63 | Granodiorite | K/Ar | Biotite | 29.1 | 0.9 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 67AR 570 | Toegr | Mount Katmai | 58.8283 | 154.73 | Granodiorite | K/Ar | Hornblende | 26.7 | 0.8 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 83AR 29 | Toegr | Mount Katmai | 58.8333 | 154.9117 | Granodiorite | K/Ar | Biotite | 37.6 | 1.1 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| A113 | Toegr | Mount Katmai | 58.8717 | 154.5817 | Granodiorite | K/Ar | Biotite | 27.4 | 0.8 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 83AR 22 | Toegr | Mount Katmai | 58.8767 | 154.99 | Granodiorite | K/Ar | Biotite | 29.2 | 0.9 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| 66ALe 5 | Toegr | Mount Katmai | 58.895 | 154.8183 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 28.2<br>26.0 | 0.8<br>0.8 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977). Reverse discordant | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 83AR 19 | Toegr | Mount Katmai | 58.95 | 154.8133 | Granodiorite | K/Ar | Biotite | 26.6 | 0.8 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| 83AR 18 | Toegr | Mount Katmai | 58.96 | 154.7383 | Quartz diorite | K/Ar | Hornblende | 34.3 | 1.2 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| 67AR 571 | Toegr | Mount Katmai | 58.855 | 154.765 | Quartz diorite | K/Ar | Biotite<br>Hornblende | 27.8<br>26.1 | 0.6<br>0.8 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977). Reverse discordant | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 67AR 563 | Toegr | Mount Katmai | 58.9183 | 154.5817 | Quartz diorite | K/Ar | Biotite | 26.8<br>25.6 | 0.8<br>0.8 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 83AR 18 | Toegr | Mount Katmai | 58.96 | 154.7383 | Quartz diorite | K/Ar | Biotite | 27.5 | 0.8 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| 66AR 1289 | Toegr | Iliamna | 59.0533 | 154.6517 | Quartz diorite | K/Ar | Biotite<br>Hornblende | 35.6<br>37.0 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66ALe 23 | Toegr | Lake Clark | 60.04 | 154.17 | Quartz monzonite | K/Ar | Biotite | 43.9 | — | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972 |
| 66ALe 25 | Toegr | Lake Clark | 60.415 | 153.61 | Quartz monzonite | K/Ar | Biotite | 39.6 | — | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976 |
| 70AR 159 | Toegr | Lake Clark | 60.705 | 153.28 | Granodiorite | K/Ar | Biotite; Hornblende | 38.6 39.3 | 1.1 1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| 68AR 251 | Toegr | Lake Clark | 60.7233 | 153.5383 | Granodiorite | K/Ar | Biotite Hornblende | 39.4 41.9 | 1.1 1.3 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| CHK00-1 | Toegr | Talkeetna Mountains | 62.0544 | 148.1911 | Granite | 40/39 plateau | K-feldspar | 39.0 | 0.4 | Fine-grained granite | Cole and others, 2006 |
| L & N 2 | Toegr | Anchorage | 61.7517 | 148.5083 | Granodiorite | K/Ar | Hornblende | 37.7 | 2.2 | — | Little, 1988, Little and Naeser, 1989, Winkler, 1992 |
| L & N 2 | Toegr | Anchorage | 61.7517 | 148.5083 | Granodiorite | Fission-track | Zircon | 37.3 | 4.7 | — | Little, 1988, Little and Naeser, 1989, Winkler, 1992 |
| 70AR 181 | Toegr | Lake Clark | 60.7683 | 153.3367 | Granodiorite | K/Ar | Biotite | 34.8 | 1 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| W4A | Toegr | Anchorage | 61.7917 | 149.325 | Granite | K/Ar | Muscovite | 56.6 | n.a. | Altered granite, Bullion Mountain | Silberman and others, 1978a, b |
| 68AR 248 | Toegr | Lake Clark | 60.8383 | 153.5817 | Quartz monzonite | K/Ar | Biotite | 38.6 | 1.1 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| 70AR 165 | Toegr | Lake Clark | 60.8683 | 153.415 | Granodiorite | K/Ar | Biotite | 37.5 | 1.0 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 68AR 245 | Toegr | Lake Clark | 60.93 | 153.345 | Quartz monzonite | K/Ar | Biotite | 34.6 | 1.3 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| 68AR 244 | Toegr | Lake Clark | 60.9467 | 153.545 | Granodiorite | K/Ar | Biotite; Hornblende | 31.9 36.3 | 0.9 1.8 | Age recalculated using constants of Steiger and Jager (1977). Discordant | Reed and Lanphere, 1969, 1973; Magoon and others, 1976; Nelson and others, 1983 |
| 70AR 104 | Toegr | Talkeetna | 62.7972 | 152.1528 | Granodiorite | K/Ar | Biotite; Hornblende | 37.1 39.8 | 1.1 1.6 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973, 1974, Reed and Nelson, 1977, 1980 |
| 70AR 109 | Toegr | Talkeetna | 62.8187 | 151.6555 | Granodiorite | K/Ar | Biotite; Hornblende | 35.2 36.6 | 0.9 1.4 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973, 1974, Reed and Nelson, 1977, 1980 |
| 70AR 1-12 | Toegr | Talkeetna | 62.8738 | 151.5738 | Granodiorite | K/Ar | Biotite; Hornblende | 33.2 36.3 | 0.9 1.6 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973, 1974, Reed and Nelson, 1977, 1980 |
| 70AR 127 | Toegr | Talkeetna | 62.8867 | 151.787 | Quartz diorite | K/Ar | Biotite; Hornblende | 35.3 39.5 | 1.0 1.4 | Age recalculated using constants of Steiger and Jager (1977). Discordant | Reed and Lanphere, 1972, 1973, 1974, Reed and Nelson, 1977, 1980 |
| M2-1Z | Tpgr | Afognak | 58.2017 | 153.2067 | Intrusive rock | Fission-track | Apatite | 64 | — | Afognak pluton, elevation 0m | Clendenen, 1991 |
| M-25-88 | Tpgr | Afognak | 58.2333 | 153.0417 | Intrusive rock | Fission-track | Apatite | 55 | — | Dike cutting Shuyak Formation., elevation 0m | Clendenen, 1991 |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

[Samples listed by map units and ordered from south to north and east to west. Quadrangle is the 1:250,000-scale sheet. Methods: A, Lead-alpha, a largely discredited technique; K/Ar, conventional potassium-argon; 40/39, $^{40}Ar/^{39}Ar$; Rb/Sr, rubidium-strontium; Nd/Sm, neodymium-samarium, U/Pb, uranium-lead]

| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 90ADW 809 | Tpgr | Seldovia | 59.343 | 151.8212 | Andesite | 40/39 plateau | Amphibole | 58.64 | 0.52 | Andesite dike, might have intruded Port Graham Formation near Port Graham | Lytwyn and others, 2000 |
| 88ACy 9 | Tpgr | Seldovia | 59.4733 | 150.3367 | Granodiorite | 40/39 isochron | Biotite | 54.2 | 0.08 | Nuka pluton | Bradley and others, 1999; 2000; Lytwyn and others, 2000 |
| 88ACy 9 | Tpgr | Seldovia | 59.4733 | 150.3367 | Granodiorite | U/Pb | Monazite | 56 | 0.5 | Nuka pluton | Bradley and others, 2000 |
| 92PH 454B | Tpgr | Seldovia | 59.5428 | 150.1806 | Granite | 40/39 plateau | Biotite | 53.7 | 0.1 | Thunder Bay granitic sill, slightly disturbed spectrum | Haeussler and others 1995; Bradley and others, 2000 |
| Paguna | Tpgr | Seldovia | 59.7083 | 150.135 | Granodiorite | 40/39 plateau | n.a. | 53.4 | 1.5 | Paguna stock, approximate location | Bradley and others, 1999 |
| 91ADw 55g | Tpgr | Seldovia | 59.8828 | 150.4638 | Granodiorite | 40/39 plateau | Biotite | 54.2 | 1.1 | Chernof Stock | Bradley and others, 2000 |
| 92AKu 71b | Tpgr | Seldovia | 59.9774 | 150.1611 | Granodiorite | 40/39 plateau | Biotite | 53.2 | 1.1 | Tustemena pluton | Bradley and others, 1999; 2000 |
| 92PH 215C | Tpgr | Anchorage | 61.0803 | 148.275 | Granite | 40/39 plateau | Mica | 52.8 | 0.1 | Granite at Homestake mine, minor argon loss, cooling age | Haeussler and others (1995) in: Bradley and others, 2000 |
| 92PH 215D | Tpgr | Anchorage | 61.0803 | 148.275 | Granite | 40/39 plateau | White mica | 53.7 | 0.1 | Homestake Mine, hydrothermally altered granite, minor argon loss | Haeussler and others, 1995 |
| 02PH 410A | Tpgr | Tyonek | 61.2915 | 152.0274 | Quartz monzonite | U/Pb | Zircon | 58.8 | 0.5 | Three concordant, overlapping fractions, 4 fractions run | Haeussler and others (written commun., 2008) |
| 70AR 195 | Tpgr | Tyonek | 61.2917 | 152.0183 | Quartz monzonite | K/Ar | Biotite | 58.4 | 1.7 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 01PH 419A | Tpgr | Tyonek | 61.3298 | 152.0520 | Quartz monzonite | 40/39 plateau | Hornblende | 55.5 | 1.9 | 10 fractions, 91% 39Ar release | Haeussler and others (written commun., 2008) |
| 70AR 191 | Tpgr | Tyonek | 61.3317 | 152.5767 | Quartz monzonite | K/Ar | Biotite | 57.0 | 1.6 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 70AR 200 | Tpgr | Tyonek | 61.425 | 151.955 | Quartz monzonite | K/Ar | Biotite | 58.0 | 1.6 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 70AR 194 | Tpgr | Tyonek | 61.4583 | 152.6333 | Granite | K/Ar | Biotite | 57.4 | 1.6 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 70AR 199 | Tpgr | Tyonek | 61.4945 | 152.0125 | Quartz monzonite | K/Ar | Biotite | 59.8 | 1.7 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 02PH 413A | Tpgr | Tyonek | 61.5451 | 152.1696 | Granite | U/Pb | Zircon | 57.3 | 0.3 | Three concordant, overlapping fractions; 5 run in all | Haeussler and others (written commun., 2008) |
| 02PH 385A | Tpgr | Tyonek | 61.5585 | 150.9107 | Granodiorite | 40/39 plateau | Hornblende | 57.7 | 1.5 | Hornblende-biotite granodiorite, replicate analysis, 4 fractions, 76% 39Ar release | Haeussler and others (written commun., 2008) |
| | | | | | | | | 58.3 | 1.1 | Replicate analysis, 2 fractions, 67% 39Ar release | |
| 90DNS 62 | Tpgr | Tyonek | 61.6927 | 152.0561 | Granite | 40/39 average | Biotite | 61.9 | 0.7 | | Layer and Solie, 2008 |
| 90WG 121 | Tpgr | Tyonek | 61.7906 | 151.9093 | Quartz monzonite | 40/39 plateau | Hornblende | 53.7 | 0.4 | — | Layer and Solie, 2008 |
| 90DNS 17 | Tpgr | Tyonek | 61.8591 | 151.8734 | Granite | 40/39 plateau | Hornblende | 54.7 | 0.6 | Porphyritic granite porphyry | Layer and Solie, 2008 |
| 67AR 404 | Tpgr | Talkeetna | 62.4425 | 152.8133 | Quartz monzonite | K/Ar | Biotite | 57.6 | 1.6 | Cathedral pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70AR 114 | Tpgr | Talkeetna | 62.6022 | 151.5453 | Quartz monzonite | K/Ar | Biotite | 56.6 | 1.6 | Kahiltna pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985 |
| 75ACy 7 | Tpgr | Talkeetna Mountains | 62.625 | 149.41 | Quartz monzonite | K/Ar | Biotite | 58.6 | 1.8 | — | Csejtey and others, 1978; Hillhouse and others, 1984 |
| 70AR 121 | Tpgr | Talkeetna | 62.7005 | 152.6072 | Quartz monzonite | K/Ar | Biotite | 57.9 | 1.6 | Ruth pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985; Hillhouse and others, 1985 |
| 70AR 112 | Tpgr | Talkeetna | 62.7103 | 151.1745 | Quartz monzonite | K/Ar | Muscovite<br>Biotite | 55.9<br>57.1 | 1.6<br>1.6 | Kahiltna pluton. New muscovite measurement published in Lanphere and Reed, (1985); old analysis was 53.6 Ma. Biotite age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985 |
| 75ACy 2 | Tpgr | Talkeetna Mountains | 62.7628 | 149.9388 | Quartz monzonite | K/Ar | Biotite | 56.3 | 1.7 | — | Csejtey and others, 1978, Hillhouse and others, 1984 |
| 67AR 427 | Tpgr | Talkeetna | 62.837 | 152.202 | Quartz monzonite | K/Ar | Biotite | 57.4 | 1.6 | Tonzona pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed,1985 |
| 70AR 116 | Tpgr | Talkeetna | 62.898 | 150.5722 | Quartz monzonite | K/Ar | Biotite | 57.6 | 1.5 | Ruth pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985; Hillhouse and others, 1985 |
| 70AR 115 | Tpgr | Talkeetna | 62.9375 | 150.9033 | Quartz monzonite | K/Ar | Biotite | 56.7 | 1.6 | McKinley pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985 |
| 70AR 117 | Tpgr | Talkeetna | 62.998 | 150.3972 | Quartz monzonite | K/Ar | Biotite | 57.1 | 1.5 | Ruth pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980; Lanphere and Reed, 1985; Hillhouse and others, 1985 |
| 75ACy 92 | Tpgr | Talkeetna Mountains | 62.9972 | 149.3967 | Quartz monzonite | K/Ar | Biotite | 57.8 | 1.7 | — | Csejtey and others, 1978; Hillhouse and others, 1984 |
| 66AR 1393 | Tgd | Lake Clark | 60.1383 | 154.07 | Granodiorite | K/Ar | Biotite<br>Hornblende | 62.8<br>61.0 | —<br>— | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Nelson and others, 1983 |
| K/Ar2 | Tgd | Lake Clark | 60.3075 | 154.6433 | Granodiorite | K/Ar | Biotite | 56.2 | 1.7 | Hornblende biotite granodiorite | Eakins and others, 1978 |
| 69AR 330 | Tgd | Tyonek | 61.26 | 152.7633 | Granodiorite | K/Ar | Biotite<br>Hornblende | 54.7<br>60.7 | 2.1<br>2.3 | Age recalculated using constants of Steiger and Jager (1977). Discordant | Reed and Lanphere, 1972, 1973 |
| 73ACy 101 | Tgd | Talkeetna Mountains | 62.3117 | 149.7755 | Tonalite | K/Ar | Biotite | 54.8 | 1.6 | — | Csejtey and others, 1978 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 75ACy 146 | Tgd | Talkeetna Mountains | 62.957 | 148.805 | Granodiorite | K/Ar | Biotite | 58.6 | 1.8 | — | Csejtey and others, 1978, Hillhouse and others, 1984 |
| TT-1-72 | Tgd | Talkeetna Mountains | 62.9745 | 148.4305 | Granodiorite | K/Ar | Biotite | 58.7 | 1.7 | Age recalculated using constants of Steiger and Jager (1977) | Csejtey and others, 1978, Turner and Smith, 1974 |
| 90WG 119 | Tpd | Tyonek | 61.7606 | 151.8975 | Diorite | 40/39 average | Whole-rock | 55.9 | 0.5 | — | Layer and Solie, 2008 |
| 90DNS 7 | Tpd | Tyonek | 61.8376 | 152.0187 | Diorite | 40/39 isochron;<br>40/39 plateau | Biotite | 60.78<br>61.2 | 0.42<br>0.4 | Location given as west of Dickason Mountain. Isochron shows slight excess argon | Solie and Layer, 1993; Layer and Solie, 2008 |
| 66ALe 29 | TKg | Tyonek | 61.21 | 152.3817 | Quartz monzonite | K/Ar | Biotite | 59.7 | — | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969; Magoon and others, 1976 |
| 69AR 328 | TKg | Tyonek | 61.2117 | 152.9183 | Quartz monzonite | K/Ar | Biotite | 53.9 | 1.5 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 69AR 393 | TKg | Tyonek | 61.2433 | 152.5133 | Quartz monzonite | K/Ar | Biotite;<br>Hornblende | 54.4<br>65.2 | 1.6<br>1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 70AEr 255 | TKg | Tyonek | 61.3067 | 152.7033 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 59.6<br>59.1 | 1.7<br>1.7 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 01PH 420A | TKg | Tyonek | 61.3614 | 152.1672 | Granite | 40/39 plateau | Biotite | 62.5 | 0.8 | Hornblende granite, 11 fractions, 93% 39Ar release | Haeussler and others (written commun., 2008) |
| 69AR 383 | TKg | Tyonek | 61.365 | 152.945 | Quartz monzonite | K/Ar | Biotite | 62.0 | 1.6 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 70AR 200 | TKg | Tyonek | 61.425 | 151.955 | Quartz monzonite | K/Ar | Hornblende | 60.2 | 1.8 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 69AR 239 | TKg | Tyonek | 61.44 | 152.94 | Quartz monzonite | K/Ar | Biotite;<br>Hornblende | 61.7<br>56.9 | 1.8<br>1.7 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 02PH 329A | TKg | Tyonek | 61.4615 | 151.3570 | Granite | 40/39 plateau | Biotite | 59.3 | 0.2 | Fine-grained biotite granite, 8 fractions, 82% 39Ar release | Haeussler and others (written commun., 2008) |
| 01PH 415A | TKg | Tyonek | 61.6519 | 152.2207 | Granite | 40/39 plateau | Biotite | 60.4 | 0.8 | 8 fractions, 80% 39Ar released | Haeussler and others (written commun., 2008) |
| 70AR-8-11 | TKg | Tyonek | 61.6667 | 152.0833 | Quartz monzonite | K/Ar | Biotite | 60.5 | 2.4 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 02ADW 313A | TKg | Tyonek | 61.6674 | 152.3029 | Granite | U/Pb | Zircon | 60.5 | 0.5 | Four concordant fractions | Haeussler and others (written commun., 2008) |
| 69AR 207 | TKg | Tyonek | 61.705 | 152.9233 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 62.1<br>64.2 | 1.8<br>2.5 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 02PH 426A | TKg | Tyonek | 61.7336 | 152.0739 | Granite | U/Pb | Zircon | 60.2 | 0.3 | Fine-grained granite, 4 concordant, 3 overlapping fractions, 4 run in all. | Haeussler and others (written commun., 2008) |
| MLS 6 | TKg | Anchorage | 61.81 | 149.3483 | Pegmatite | K/Ar | Muscovite;<br>Feldspar | 66.8<br>64.7 | 2.0<br>1.9 | Concordant, mineralized pegmatite dike, alkali feldspar | Madden-McGuire and others, 1990; Winkler, 1992 |
| W41A | TKg | Anchorage | 61.8183 | 149.2917 | Pegmatite | K/Ar | Muscovite | 66.0 | — | Holland Prospect, copper sulphide bearing pegmatite | Silberman and others, USGS, written commun., 1978 |
| 90SAL 44A | TKg | Tyonek | 61.8809 | 152.2577 | Granite | 40/39 average | Biotite;<br>Hornblende | 66.3<br>63.6 | 1.5<br>0.4 | Reverse discordant | Layer and Solie, 2008 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 02ADW 305B | TKg | Tyonek | 61.8872 | 152.3143 | Granite | 40/39 plateau | Hornblende | 65.1<br>67.0 | 1.6<br>1.1 | Hornblende granite, replicate analysis, 6 fractions, 69% 39Ar released | Haeussler and others (written commun., 2008) |
| 69AR 310 | TKg | Tyonek | 61.9017 | 152.8967 | Quartz monzonite | K/Ar | Biotite | 66.8 | 1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977, 1980 |
| 90DNS 36 | TKg | Tyonek | 61.896 | 152.1395 | Granodiorite | 40/39 plateau | Hornblende | 68.0 | 0.7 | Dacite sill, good plateau | Layer and Solie, 2008 |
| 75ACy 135 | TKg | Anchorage | 61.9883 | 149.4167 | Granodiorite | K/Ar | Biotite;<br>Muscovite | 65.0<br>67.2 | 2.0<br>2.0 | Concordant | Csejtey and others, 1978, Silberman and others, 1978a,b, Winkler, 1992 |
| 69AR 305 | TKg | Talkeetna | 62.0633 | 152.9167 | Granodiorite | K/Ar | Biotite | 67.5 | 1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977, 1980 |
| 01WE01 | TKg | Talkeetna Mountains | 62.1363 | 149.2603 | Granodiorite | 40/39 plateau | Biotite;<br>Hornblende | 66.0<br>67.4 | 0.5<br>0.7 | Approximate location, near Gunsite prospect. Slightly discordant ages. Hornblende isochron 67.5±0.7, biotite isochron 66.6±0.6 | J.M. Schmidt, written commun., 2008 |
| 01WE02 | TKg | Talkeetna Mountains | 62.1363 | 149.2603 | Granodiorite | 40/39 plateau | White mica | 64.7 | 0.5 | Approximate location, near Gunsite prospect. Altered medium-grained biotite granodiorite. Mafic minerals altered to chlorite, abundant sericite alteration of plagioclase. Hydrothermal age? | J.M. Schmidt, written commun., 2008 |
| 70AR 132 | TKg | Talkeetna | 62.2367 | 152.7858 | Quartz monzonite | K/Ar | Biotite | 66.2 | 1.9 | Kohlsaat pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977; 1980 |
| 99MBW 403 | TKg | Talkeetna Mountains | 62.3948 | 149.2916 | Granodiorite | 40/39 plateau | Hornblende | 57.7 | 0.5 | Biotite-hornblende granodiorite | Drake and Layer, 2001 |
| 99MBW 458 | TKg | Talkeetna Mountains | 62.4244 | 149.0722 | Granite | 40/39 plateau | Potassium feldspar | 68.5 | 0.6 | Biotite granite. Flat plateau, no evidence of argon loss. However, as a K-feldspar, it must be considered suspect | Drake and Layer, 2001 |
| 70AR 2-14 | TKg | Talkeetna | 62.5478 | 152.1883 | Granodiorite | K/Ar | Biotite | 66.2 | 1.8 | Cascade pluton. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977, 1980 |
| 77BT 224 | TKgd | Lake Clark | 60.6317 | 154.5783 | Diorite | K/Ar | Hornblende | 69.4 | 2.1 | Hornblende diorite | Eakins and others, 1978, Nelson and others, 1983 |
| 70AR 146 | TKgd | Kenai | 60.7433 | 152.9583 | Granodiorite | K/Ar | Biotite | 68.2 | 1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 70AR 147 | TKgd | Kenai | 60.865 | 152.68 | Granodiorite | K/Ar | Biotite; Hornblende | 65.4<br>67.6 | 1.8<br>2.0 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 70AR 140 | TKgd | Kenai | 60.9433 | 152.8617 | Granodiorite | K/Ar | Biotite; Hornblende | 65.1<br>70.5 | 1.9<br>2.0 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70AR 188 | TKgd | Tyonek | 61.0083 | 152.3967 | Quartz diorite | K/Ar | Biotite; Hornblende | 64.2<br>66.4 | 1.8<br>1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Detterman and others, 1976; Magoon and others, 1976 |
| 68AR 258 | TKgd | Tyonek | 61.1017 | 152.4817 | Quartz diorite | K/Ar | Biotite; Hornblende | 62.3<br>63.5 | 1.8<br>1.9 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, Detterman and others, 1976; Magoon and others, 1976 |
| 70AR 134 | TKgd | Tyonek | 61.1617 | 152.095 | Granodiorite | K/Ar | Biotite; Hornblende | 64.4<br>70.4 | 1.8<br>2.1 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Detterman and others, 1976; Magoon and others, 1976 |
| 66ALe 28 | TKgd | Tyonek | 61.2167 | 152.6183 | Quartz diorite | K/Ar | Biotite;<br><br>Hornblende | 50.5;<br>51.1<br>63.0 | —<br>—<br>— | Age recalculated using constants of Steiger and Jager (1977). Probably discordant. | Reed and Lanphere, 1969 |
| MLS 9 | TKgd | Anchorage | 61.7783 | 149.3033 | Tonalite | K/Ar | Plagioclase; Chlorite | 54.7<br>56.6 | 1.6<br>1.7 | Propylitized tonalite, concordant | Madden-McGuire and others, 1990, Winkler, 1992 |
| 73ACy 95 | TKgd | Talkeetna Mountains | 62.1075 | 148.9955 | Granodiorite | K/Ar | Biotite; Hornblende | 61.7<br>71.3 | 1.9<br>2.1 | Discordant | Csejtey and others, 1978 |
| 73ACy 94 | TKgd | Talkeetna Mountains | 62.0772 | 149.1872 | Tonalite | K/Ar | Biotite; Hornblende | 61.7<br>61.0 | 1.9<br>1.8 | — | Csejtey and others, 1978 |
| 72ACy 127 | TKgd | Talkeetna Mountains | 62.1462 | 149.3083 | Tonalite | K/Ar | Biotite; Hornblende | 66.4<br>64.3 | 2<br>2 | Age recalculated using constants of Steiger and Jager (1977), biotite-hornblende tonalite, reverse concordant | Csejtey, 1974, Csejtey and others, 1978 |
| 72ACy 117 | TKgd | Talkeetna Mountains | 62.15 | 149.225 | Quartz diorite | K/Ar | Biotite; Hornblende | 67.3<br>64.6 | 2<br>2 | Age recalculated using constants of Steiger and Jager (1977), reverse concordant | Csejtey, 1974, Csejtey and others, 1978 |
| 02PH 388A | TKgb | Tyonek | 61.5700 | 150.7670 | Hornblendite | 40/39 plateau | Hornblende | 83.5<br><br>84.2 | 5.2<br><br>1.3 | Replicate analysis, 3 fractions, 84% 39Ar release<br>Replicate analysis, 3 fractions, 75% 39Ar release | Haeussler and others (written commun., 2008) |
| 02ADW 317A | TKgb | Tyonek | 61.7732 | 152.2407 | Gabbro | 40/39 plateau | Hornblende | 69.0<br>72.3 | 1.1<br>2.6 | Replicate analysis, 5 fractions, 58% 39Ar released; poor plateau | Haeussler and others (written commun., 2008) |
| K-2-88 | Kkd | Afognak | 58.1717 | 152.895 | Metagraywacke | Fission-track | Zircon | 72 | | Kodiak Formation graywacke, elevation 0m | Clendenen, 1991 |
| 78ASi-M7 | Km | Anchorage | 61.75 | 148.55 | Hornfels | K/Ar | Whole-rock | 40.0 | 1.2 | Hornfelsed shale, approximate location | Silberman and Grantz, 1984, Winkler, 1992 |
| M-19-88 | KMm | Afognak | 58.21 | 153.21 | Intrusive rock | Fission-track | Apatite | 53 | | Dike cuts Uyak Complex, elevation 0m | Clendenen, 1991 |
| M-19-88 | KMm | Afognak | 58.21 | 153.0017 | Intrusive rock | 40/39 isochron | Hornblende | 59.3 | 2.2 | Dike cuts Uyak Complex, 58.3 Ma total fusion age | Clendenen, 1991, Bradley and others, 2000 |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Clark73 | KMm | Anchorage | 61.0027 | 149.66 | Granitic clast | K/Ar | Hornblende | 146. | 7.0 | Granitic clast in metaconglomeratic sandstone within the McHugh Complex | Clark, 1973; Magoon and others, 1976; Clark, 1972, Clark and others, 1976; Karl and others, 1979 |
| 70AR 169 | Kgd | Lake Clark | 60.5983 | 153.405 | Granodiorite | K/Ar | Biotite; Hornblende | 63.1<br>69.0 | 1.8<br>2.0 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| 60AGz 45 | Kgd | Tyonek | 61.4633 | 150.7433 | Granodiorite | K/Ar | Hornblende | 73.5 | — | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969 |
| 01PH 417A | Kgd | Tyonek | 61.5013 | 150.7534 | Quartz diorite | 40/39 plateau | Hornblende | 73.8 | 1.1 | Hornblende quartz diorite, 8 fractions, 96% 39Ar released | Haeussler and others (written commun., 2008) |
| 02PH 322A | Kgd | Tyonek | 61.5790 | 150.5509 | Granodiorite | 40/39 plateau | Biotite | 74.9 | 0.4 | Biotite granodiorite, 4 fractions, 20% 39 Ar released; Ar loss | Haeussler and others (written commun., 2008) |
| 02PH 345A | Kgd | Tyonek | 61.7472 | 152.2916 | Granodiorite | 40/39 plateau | Hornblende | 78.4 | 1.1 | Hornblende granodiorite, 5 fractions, 94% 39Ar release | Haeussler and others (written commun., 2008) |
| W077A | Kgd | Anchorage | 61.77 | 149.3183 | Granite | K/Ar | Biotite;<br>Hornblende | 58.1<br>70.1 | —<br>— | Chloritized biotite, Hatcher Pass | Silberman, M. L., USGS, written commun., 1978 |
| MLS 10 | Kgd | Anchorage | 61.7833 | 149.313 | Tonalite | K/Ar | Muscovite | 56.6 | 1.7 | Altered tonalite, quartz-sericite selvage on gold-bearing vein at Bullion mine | Silberman and others, 1978b, Madden-McGuire and others, 1990, Winkler, 1992 |
| WKW | Kgd | Anchorage | 61.785 | 149.3083 | Granite | K/Ar | Biotite | 78.4 | — | Kelley Willow Prospect | Silberman and others, 1978a,b |
| 66AGz W4 | Kgd | Anchorage | 61.7867 | 149.2183 | Tonalite | K/Ar | Biotite;<br>Hornblende | 72.0<br>74.4 | 2.2<br>2.2 | Concordant | Csejtey and others, 1977, 1978, Silberman and others, 1978a,b, Winkler, 1992 |
| MLS 4 | Kgd | Anchorage | 61.7917 | 149.325 | Tonalite | K/Ar | Biotite;<br>Hornblende | 78.8<br>72.2 | 2.4<br>2.2 | Reverse discordant | Silberman and others, 1978b, Winkler, 1992 |
| 66AGz W2 | Kgd | Anchorage | 61.8133 | 149.2133 | Tonalite | K/Ar | Biotite;<br>Hornblende | 69.0<br>73.3 | 2.1<br>2.2 | Subconcordant | Csejtey and others, 1977, 1978, Silberman and others, 1978a,b; Winkler, 1992 |
| 60AGz 40 | Kgd | Anchorage | 61.8267 | 149.2417 | Tonalite | K/ar | Hornblende | 73.1 | 2.2 | — | Csejtey and others, 1978; Winkler, 1992 |
| 84AWk29 | Kgd | Anchorage | 61.88 | 149.0267 | Tonalite | K/Ar | Biotite;<br>Hornblende | 68.0<br>73.0 | 1.4<br>1.7 | Discordant | Winkler, 1992 |
| 73ACy 97 | Kgd | Anchorage | 61.942 | 148.9938 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 67.4<br>71.8 | 2.0<br>2.2 | Discordant | Csejtey and others, 1978, Winkler, 1992 |
| 66ALe 30 | Kqd | Tyonek | 61.0333 | 152.1433 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 72.6<br>73.9 | —<br>— | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and others, 1976 |
| 70AR 168 | Kqd | Lake Clark | 60.6417 | 153.1583 | Quartz diorite | K/Ar | Biotite; Hornblende | 65.6<br>68.7 | 1.8<br>2 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| 70AR 173 | Kqd | Kenai | 60.7483 | 152.8117 | Diorite | K/Ar | Biotite;<br>Hornblende | 67.2<br>71.5 | 1.9<br>2.1 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70AR 158 | Kqd | Kenai | 60.8317 | 152.5817 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 70.0<br>74.4 | 2.0<br>2.2 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |
| 70AR 179 | Kqd | Kenai | 60.985 | 152.28 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 71.3<br>70.6 | 2.0<br>2.1 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |
| 70AR-3-1 | Kqd | Talkeetna | 62.0767 | 152.45 | Diorite | K/Ar | Biotite | 69.2 | 2.0 | Kichatna pluton, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Reed and Nelson, 1977, 1980 |
| 99ARj 28 | Kqd | Talkeetna Mountains | 62.2988 | 149.1572 | Diorite | 40/39 plateau | Hornblende | 75.5 | 0.6 | Biotite-hornblende diorite. Isochron age 73.2 ± 1.3 | Drake and Layer, 2001 |
| 65AR 1034 | Kqms | Iliamna | 59.805 | 154.2467 | Quartz monzonite | K/Ar | Hornblende | 75.6 | | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 65AR 910 | Kqms | Iliamna | 59.8267 | 154.2067 | Quartz diorite | K/Ar | Biotite<br>Hornblende | 82.7<br>85.5 | | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 65AR 818 | Kqms | Iliamna | 59.8467 | 153.8583 | Quartz diorite | K/Ar | Biotite | 79.8 | | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 02PH 321A | Kqms | Tyonek | 61.9595 | 152.3774 | Syenite-monzonite | U/Pb | Zircon | 80.3 | 0.1 | 2 concordant, overlapping fractions; 4 run in all | Haeussler and others (written commun., 2008) |
| 69AR 388 | Kogr | Tyonek | 61.3417 | 152.7417 | Quartz diorite | K/Ar | Hornblende | 97.9 | 3.7 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 02PH 375A | Kogr | Talkeetna | 62.0007 | 151.4733 | Granite | 40/39 plateau | Biotite | 96.9 | 1.4 | Coarse biotite granite, 3 fractions, 83% 39Ar release | Haeussler and others (written commun., 2008) |
| 70AR 208 | Kogr | Tyonek | 61.4067 | 152.4117 | Syenite | K/Ar | Hornblende | 109.4 | 3.2 | Age recalculated using constants of Steiger and Jager (1977). Age likely reset by surrounding plutons | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |
| 74ASj 100a | Kum | Anchorage | 61.7342 | 149.3937 | Serpentinite | K/Ar | Actinolite | 91.0 | 4.6 | K2O by isotope dilution | Csejtey and others, 1978, Silberman and others, 1978a,b, Winkler, 1992 |
| 73ACy 17 | Kum | Anchorage | 61.7508 | 149.4188 | Serpentinite | K/Ar | Actinolite | 88.9 | 4.4 | K2O by isotope dilution | Csejtey and others, 1978, Silberman and others, 1978a,b, Winkler, 1992 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pavlis H | Klt | Anchorage | 61.575 | 148.7283 | Trondhjemite | K/Ar | Biotite;<br>Hornblende | 116<br>126 | 5<br>6 | Concordant | Pavlis, 1982, 1986, Winkler, 1992 |
| 85paw 7a | Klt | Anchorage | 61.5833 | 148.7000 | Trondhjemite? | 40/39 total fusion | Hornblende | 134.8 | 1.6 | Approximate location. Thought to contain excess argon, low temperature heating steps contaminated; age thought too old | Barnett and others, 1994 |
| 85paw 7a | Klt | Anchorage | 61.5833 | 148.7000 | Trondhjemite? | 40/39 total fusion | Biotite | 119.0 | 0.5 | Approximate location. No plateau, hence total fusion age | Barnett and others, 1994 |
| 85paw 7a | Klt | Anchorage | 61.5833 | 148.7000 | Trondhjemite? | Rb/Sr | Isochron | 130.0 | 1.0 | Approximate location. Whole-rock-plagioclase-biotite isochron | Barnett and others, 1994 |
| 85paw 27 | Klt | Anchorage | 61.5833 | 148.7417 | | 40/39 total fusion | Hornblende | 115.9 | 1.5 | Approximate location. Strongly discordant heating spectra | Barnett and others, 1994 |
| 85paw 71 | Klt | Anchorage | 61.5833 | 148.7583 | Trondhjemite? | Rb/Sr | Isochron | 132.6 | 2.6 | Approximate location. Whole-rock-plagioclase-biotite isochron | Barnett and others, 1994 |
| 85paw 38 | Klt | Anchorage | 61.5833 | 148.8000 | Trondhjemite? | Nd/Sm | Isochron | 121.5 | 9.5 | Approximate location | Barnett and others, 1994 |
| 85paw 75 | Klt | Anchorage | 61.5900 | 148.8000 | Trondhjemite? | 40/39 plateau | Hornblende | 126 | 2.3 | Approximate location | Barnett and others, 1994 |
| 85paw 102 | Klt | Anchorage | 61.6000 | 148.4333 | Tonalite? | 40/39 plateau | Hornblende | 125.4 | 0.7 | Approximate location | Barnett and others, 1994 |
| 85paw 93 | Klt | Anchorage | 61.6000 | 148.4333 | Trondhjemite? | 40/39 total fusion | Hornblende | 105.4 | 0.9 | Approximate location. Strongly disturbed argon spectra | Barnett and others, 1994 |
| AK341 | Klt | Anchorage | 61.6167 | 149.6667 | Trondhjemite | U/Pb | Zircon | 103 | — | — | T.L. Hudson and J.G. Arth (USGS, unpub. data, 1989), Winkler, 1992 |
| C80-14 (Pavlis A) | Klt | Anchorage | 61.6283 | 148.5183 | Trondhjemite | K/Ar | Hornblende | 124 | 8 | — | Pavlis, 1982; 1983, Winkler, 1992 |
| 85puc 100 | Klt | Anchorage | 61.6583 | 148.4500 | Tonalite | 40/39 total fusion | Biotite | 122.1 | 0.4 | Approximate location. Total fusion age, no plateau | Barnett and others, 1994 |
| 86pac 12 | Klt | Anchorage | 61.6667 | 148.4500 | Tonalite | 40/39 total fusion | Biotite | 120.3 | 0.4 | Approximate location. Total fusion age, no plateau | Barnett and others, 1994 |
| 85pac 31a | Klt | Anchorage | 61.6833 | 148.4333 | Tonalite? | 40/39 plateau | Hornblende | 125.4 | 1.1 | Approximate location | Barnett and others, 1994 |
| 81AWk 44B | Klt | Anchorage | 61.7017 | 148.3633 | Trondhjemite | K/Ar | Muscovite | 110 | 3 | — | Winkler, 1992 |
| 85paw 40 | Klt | Anchorage | 61.6167 | 148.6667 | Trondhjemite? | Rb/Sr | Isochron | 133.0 | 0.2 | Approximate location. Whole-rock-plagioclase-biotite isochron | Barnett and others, 1994 |
| 81KMS 25 | Kvgs | Seward | 60.3974 | 149.2185 | Biotite semi-schist | K/Ar | Not reported | 51.5 | 1.5 | Metamorphic age or cooling age of Valdez Group schist unit (Kvgs) along Placer River Fault | Nelson and others, 1985 |
| 73ACy 85 | Kps | Anchorage | 61.7167 | 149.5417 | Schist | K/Ar | Muscovite | 59.0 | 1.8 | Muscovite schist, reset | Csejtey and others, 1978; Silberman and others, 1978a,b; Winkler, 1992 |
| 73ACy 27 | Kps | Anchorage | 61.7305 | 149.4347 | Schist | K/Ar | Muscovite | 65.9 | 3.0 | Muscovite schist, reset | Csejtey and others, 1978; Silberman and others, 1978a,b; Winkler, 1992 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 73ACy 11a | Kps | Anchorage | 61.7422 | 149.4245 | Schist | K/Ar | Muscovite | 59.6 | 1.8 | Muscovite schist, reset | Csejtey and others, 1978; Silberman and others, 1978a,b; Winkler, 1992 |
| W077 | Kps | Anchorage | 61.77 | 149.3183 | Schist | K/Ar | Muscovite;<br>Chlorite | 57.1<br>56.0 | | Muscovite-chlorite, Hatcher Pass | Silberman, M.L., written commun., 1978 |
| MLS 11 | Kps | Anchorage | 61.775 | 149.305 | Schist | K/Ar | Biotite;<br>Chlorite | 54.5<br>50.6 | 1.6<br>2.5 | Concordant, reset | Madden-McGuire and others, 1990; Winkler, 1992 |
| 90JK 191A | KJs | Tyonek | 61.9083 | 152.2871 | Conglomerate | 40/39 average | Hornblende | 97.7 | 2.0 | Igneous clast from conglomerate | Layer and Solie, 2008 |
| 90JK 191B | KJs | Tyonek | 61.9083 | 152.2871 | Conglomerate | 40/39 average | Hornblende | 101.0 | 2.0 | Igneous clast from conglomerate. Fair plateau showing some argon loss | Layer and Solie, 2008 |
| 90JK 191C | KJs | Tyonek | 61.9083 | 152.2871 | Conglomerate | 40/39 plateau | Hornblende | 94.8 | 1.4 | Igneous clast from conglomerate | Layer and Solie, 2008 |
| 70AR 184 | KJq | Lake Clark | 60.7367 | 153.1033 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 72.4<br>95.8 | 2.0<br>2.8 | Strongly discordant. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976 |
| 68AR 261 | KJq | Lake Clark | 60.8867 | 153.0317 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 58.8<br>97.5 | 1.7<br>3.8 | Strongly discordant. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1973; Magoon and others, 1976; Nelson and others, 1983 |
| 68AR 260 | KJq | Tyonek | 61.0833 | 152.8317 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 60.0<br>80.7 | 1.7<br>2.3 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973 |
| 62ALe 6e | Jnc | Kenai | 60.1133 | 152.585 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 156.6<br>159.7 | — | Rounded granitic boulders within the Chisik Conglomerate member of the Naknek Formation. Age recalculated using constants of Steiger and Jager (1977) | Detterman and others, 1965, Magoon and others, 1976; Wilson and others, 2006 |
| 2710M01 | Jp? | Anchorage | 61.6243 | 148.6905 | Metavolcanic-clastic rock | U/Pb | Zircon | 202.1 | 1.2 | Single grain analysis, 3 grains, first population | Rioux and others, 2007 |
| 2710M01 | Jp? | Anchorage | 61.6243 | 148.6905 | Metavolcanic-clastic rock | U/Pb | Zircon | 205.8 | 0.4 | Single grain analysis, 3 grains, second population | Rioux and others, 2007 |
| 65AR 905 | Jtr | Iliamna | 59.92 | 153.6083 | Trondhjemite | K/Ar | Muscovite | 148.0 | — | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980; Nelson and others, 1983 |
| 82ARM 21 | Jtr | Anchorage | 61.8083 | 148.9083 | Trondhjemite | K/Ar | Biotite;<br>Muscovite | 136.2<br>142.5 | 2.2<br>4.1 | Concordant | Winkler, 1992 |
| 74ACy 151 | Jtr | Anchorage | 61.8272 | 148.8972 | Trondhjemite | K/Ar | Muscovite | 134.0 | 4.0 | — | Csejtey and others, 1978; Winkler, 1992 |
| 74ACy 146 | Jtr | Anchorage | 61.9463 | 148.6845 | Trondhjemite | K/Ar | Muscovite | 129 | 3.9 | — | Csejtey and others, 1978; Winkler, 1992 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1721M04 | Jtr | Talkeetna Mountains | 62.0177 | 148.5618 | Trondhjemite | U/Pb | Zircon | ~157 | — | Age given as range 157.1 to 159.9 Ma, no error reported. Interpreted as a mixing age of two similarly aged zircon populations | Rioux and others, 2007 |
| 1721M04 | Jtr | Talkeetna Mountains | 62.0177 | 148.5618 | Trondhjemite | U/Pb | Zircon | 155.6 | 2.6 | Weighted mean age | Rioux and others, 2007 |
| 73ACy 115 | Jtr | Talkeetna Mountains | 62.0803 | 148.508 | Trondhjemite | K/Ar | Biotite;<br>Muscovite | 99.4<br>135.0 | 3.0<br>4.0 | Reset, discordant | Csejtey and others, 1978 |
| 73ACy 114 | Jtr | Talkeetna Mountains | 62.0808 | 148.7662 | Trondhjemite | K/Ar | Biotite | 67.8 | 2.0 | Reset | Csejtey and others, 1978 |
| 62AE 4 | Jtr | Talkeetna Mountains | 62.3175 | 148.1692 | Trondhjemite | K/Ar | Biotite;<br>Muscovite | 143.0<br>146.0 | 4.3<br>4.4 | Concordant | Csejtey and others, 1978; U.S. Geological Survey, 1979 |
| 1723M12 | Jtr | Talkeetna Mountains | 62.3807 | 148.1555 | Trondhjemite | U/Pb | Zircon | 156.9 | 2.5 | Weighted mean age | Rioux and others, 2007 |
| TropS54 | Jtr | Talkeetna Mountains | 62.4103 | 147.9462 | Trondhjemite | U/Pb | Zircon | 152.7 | 1.3 | Weighted mean age | Rioux and others, 2007 |
| 73ASt 275 | Jtr | Talkeetna Mountains | 62.512 | 147.8763 | Trondhjemite | K/Ar | Biotite | 148.5 | 4.3 | Age recalculated using constants of Steiger and Jager (1977) | Csejtey and others, 1978, Turner and Smith, 1974 |
| 73ASt 256 | Jtr | Talkeetna Mountains | 62.5812 | 147.6978 | Trondhjemite | K/Ar | Biotite | 146.5 | 4.3 | Age recalculated using constants of Steiger and Jager (1977) | Csejtey and others, 1978 |
| 6-14-6 | Jqm | Iliamna | 59.9217 | 153.285 | Quartz monzonite | K/Ar | Whole-rock | 170<br>174 | 4<br>4 | — | Detterman and Reed, 1980 |
| 1723M07 | Jqm | Talkeetna Mountains | 61.8277 | 148.794 | Granodiorite | U/Pb | Zircon | 169.4 | 1.5 | Weighted mean age | Rioux and others, 2007 |
| 1723M07 | Jqm | Anchorage | 61.8277 | 148.794 | Granodiorite | U/Pb | Zircon | ~169 | — | Age given as 172.2 to 174.4, no error reported, ~best~ age assigned. Interpreted due to minor inheritance of older zircon | Rioux and others, 2007 |
| 1723M08 | Jqm | Anchorage | 61.8702 | 148.7488 | Quartz diorite | U/Pb | Zircon | ~169 | — | Age range given as 169.8 to 171.2. Interpreted as due to minor inheritance of older zircon | Rioux and others, 2007 |
| 1723M08 | Jqm | Anchorage | 61.8702 | 148.7488 | Quartz diorite | U/Pb | Zircon | 168.3 | 1.8 | Weighted mean age | Rioux and others, 2007 |
| 1723M04 | Jqm | Anchorage | 61.872 | 148.5598 | Granodiorite | U/Pb | Zircon | 176.9 | 0.4 | — | Rioux and others, 2007 |
| 82AWk 65A | Jqm | Anchorage | 61.9067 | 148.5083 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 169.0<br>173.2 | 3.5<br>2.3 | Concordant | Winkler, 1992 |
| 1721M03 | Jqm | Anchorage | 61.9655 | 148.3242 | Granodiorite | U/Pb | Zircon | 177.5 | 0.8 | — | Rioux and others, 2007 |
| 74ACy 149 | Jqm | Anchorage | 61.9925 | 148.4375 | Granodiorite | K/Ar | Biotite | 168.0 | 5.0 | — | Csejtey and others, 1978, Winkler, 1992 |
| 1721M01 | Jqm | Talkeetna Mountains | 62.0193 | 148.3187 | Granodiorite | U/Pb | Zircon | 175.5 | 0.3 | — | Rioux and others, 2007 |
| 01JS04A | Jqm | Talkeetna Mountains | 62.132 | 148.831 | Granodiorite | 40/39 | Biotite | — | — | Biotite granodiorite. Disturbed age, reported as 115 to 130 Ma, probably geologically meaningless | J.M. Schmidt, written commun., 2008 |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

[Samples listed by map units and ordered from south to north and east to west. Quadrangle is the 1:250,000-scale sheet. Methods: A, Lead-alpha, a largely discredited technique; K/Ar, conventional potassium-argon; 40/39, $^{40}Ar/^{39}Ar$; Rb/Sr, rubidium-strontium; Nd/Sm, neodymium-samarium, U/Pb, uranium-lead]

| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 59AGz M25-1 | Jqm | Talkeetna Mountains | 62.165 | 147.745 | Granodiorite | A | Zircon | 180 | — | Quartz diorite-granodiorite | Grantz and others, 1963 |
| 59AGz M25-1 | Jqm | Talkeetna Mountains | 62.165 | 147.745 | Granodiorite | K/Ar | Biotite | 160 | — | Quartz diorite-granodiorite | Grantz and others, 1963 |
| 59AGz M25-2 | Jqm | Talkeetna Mountains | 62.165 | 147.745 | Quartz monzonite | K/Ar | Biotite | 155.0 | — | Granodiorite-quartz monzonite | Grantz and others, 1963 |
| 1723M09 | Jqm | Talkeetna Mountains | 62.2498 | 148.152 | Granodiorite | U/Pb | Zircon | 173.7 | 0.3 | — | Rioux and others, 2007 |
| 59AGz M57 | Jqm | Talkeetna Mountains | 62.3547 | 147.82 | Granodiorite | A | Zircon | 125 | 15 | — | Csejtey and others, 1978, Grantz and others, 1963 |
| 59AGz M58 | Jqm | Talkeetna Mountains | 62.3562 | 147.8217 | Granodiorite | A | Zircon | 165 | 20 | — | Grantz and others, 1963, Csejtey and others, 1978 |
| 59AGz M58 | Jqm | Talkeetna Mountains | 62.3562 | 147.8217 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 174.0<br>167.0 | —<br>6.0 | Age recalculated using constants of Steiger and Jager (1977); no error reported for biotite | Csejtey and others, 1978, Detterman and others, 1965, Grantz and others, 1963 |
| 83AR 46 | Jqd | Mount Katmai | 58.455 | 155.8933 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 166.0<br>167.0 | 5.0<br>5.0 | Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| 83AR 34 | Jqd | Mount Katmai | 58.7083 | 155.1217 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 164.0<br>153.0 | 4.9<br>4.6 | Discordant. Alaska-Aleutian Range batholith | Shew and Lanphere, 1992 |
| A126 | Jqd | Mount Katmai | 58.86 | 154.8917 | Quartz diorite | K/Ar | Hornblende | 173.0 | 5.2 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 69AR 1 | Jqd | Mount Katmai | 58.975 | 154.5483 | Quartz diorite | K/Ar | Hornblende | 174.7 | 8.8 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Shew and Lanphere, 1992 |
| 64AR 612 | Jqd | Iliamna | 59.3 | 154.305 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 167<br>158 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 64ADt 863 | Jqd | Iliamna | 59.3417 | 154.45 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 161<br>159 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 64ADt 420A | Jqd | Iliamna | 59.375 | 154.4667 | Quartz diorite | K/Ar | Biotite | 158 | — | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 66ALe 45 | Jqd | Iliamna | 59.3767 | 154.3217 | Quartz diorite | K/Ar | Biotite;<br>Muscovite | 158.0<br>160.0 | 4.6<br>4.7 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976 |

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[Samples listed by map units and ordered from south to north and east to west. Quadrangle is the 1:250,000-scale sheet. Methods: A, Lead-alpha, a largely discredited technique; K/Ar, conventional potassium-argon; 40/39, $^{40}Ar/^{39}Ar$; Rb/Sr, rubidium-strontium; Nd/Sm, neodymium-samarium, U/Pb, uranium-lead]

| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 64ADt 715 | Jqd | Iliamna | 59.3967 | 154.3083 | Quartz diorite | K/Ar | Biotite;<br>Muscovite | 156<br>164 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 66ALe 22 | Jqd | Iliamna | 59.4017 | 154.6333 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 135.0<br>151.0 | 5.0<br>4.5 | Discordant. Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, Magoon and others, 1976 |
| 66ALe 13 | Jqd | Iliamna | 59.4217 | 154.4433 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 156.0<br>157.0 | 4.6<br>4.6 | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976 |
| 6-26-1 | Jqd | Iliamna | 59.6083 | 153.5617 | Quartz diorite | K/Ar | Feldspar | 155 | — | — | Detterman and Reed, 1980 |
| 62ALe 1 | Jqd | Iliamna | 59.7017 | 153.7 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 163.0<br>172.0 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Detterman and Reed, 1980 |
| 62ALe 2 | Jqd | Iliamna | 59.7683 | 153.915 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 87.1<br>92.3 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 65AR 906 | Jqd | Iliamna | 59.8833 | 153.745 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 78.0<br>90.1 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 65AR 827 | Jqd | Iliamna | 59.7717 | 153.645 | Diorite | K/Ar | Biotite;<br>Hornblende | 161<br>160 | —<br>— | Alaska-Aleutian Range batholith, 1976 constants, Detterman and Reed, 1980 | Detterman and others, 1965, Reed and Lanphere, 1969, 1972; Magoon and others, 1976 |
| 62ALe 5 | Jqd | Kenai | 60.2533 | 152.886 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 174.0<br>171.9 | —<br>— | Alaska-Aleutian Range batholith, recalculated using constants of Steiger and Jager (1977) | Detterman and others, 1965; 1976; Reed and Lanphere, 1969, 1972; Magoon and others, 1976 |
| 70AR 175 | Jqd | Kenai | 60.59 | 152.78 | Granodiorite | K/Ar | Biotite | 97.8 | 2.8 | Age recalculated using constants of Steiger and Jager (1977). Age suspect, may be reset by younger plutonism | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |
| 70AR 177 | Jqd | Kenai | 60.615 | 152.6283 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 163.0<br>161.0 | 4.7<br>4.7 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |
| 70AR 178 | Jqd | Kenai | 60.6767 | 152.4517 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 165.0<br>162.0 | 4.8<br>4.8 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |
| 66AR 1464 | Jqd | Kenai | 60.8033 | 152.355 | Quartz monzonite | K/Ar | Biotite | 159 | — | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70AR 156 | Jqd | Kenai | 60.805 | 152.4917 | Diorite | K/Ar | Hornblende | 146.0 | 4.3 | Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1972, 1973; Magoon and others, 1976; Detterman and others, 1976 |
| 66AR 1 | Jqd | Tyonek | 61.0967 | 151.48 | Quartz diorite | K/Ar | Biotite;<br>Hornblende | 167<br>166 | —<br>— | Stedatna Creek well, depth 7452ft-7459ft, recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976 |
| L & N 5 | Jqd | Anchorage | 61.7167 | 147.8383 | Tonalite | Fission-track | Zircon | 186 | 29 | — | Little and Naeser 1989, Winkler, 1992 |
| 81AWk 14 | Jqd | Anchorage | 61.7183 | 147.8417 | Tonalite | K/Ar | Biotite;<br>Hornblende | 172<br>181 | 5<br>8 | — | Winkler, 1992 |
| L & N 4 | Jqd | Anchorage | 61.7367 | 147.9067 | Tonalite | Fission-track | Zircon | 170 | 23 | — | Little and Naeser, 1989, Winkler, 1992 |
| 82AWk62 | Jqd | Anchorage | 61.9233 | 148.4933 | Tonalite | K/Ar | Biotite;<br>Hornblende | 169.1<br>154.2 | 2.9<br>4.5 | Reverse discordant | Winkler, 1992 |
| 1723M01 | Jqd | Anchorage | 61.941 | 148.627 | Quartz diorite | U/Pb | Zircon | 168.9 | 0.3 | — | Rioux and others, 2007 |
| 1721M05 | Jqd | Anchorage | 61.9672 | 148.5283 | Quartz diorite | U/Pb | Zircon | ~169 | — | Age given as 169.1 to 172.0, no reported error, interpreted to have minor inherited zircon | Rioux and others, 2007 |
| 1721M05 | Jqd | Anchorage | 61.9672 | 148.5283 | Quartz diorite | U/Pb | Zircon | 168.9 | 3.3 | Weighted mean age | Rioux and others, 2007 |
| 82SK 305 | Jqd | Anchorage | 61.97 | 148.5033 | Quartz diorite | K/Ar | Hornblende | 168.7 | 1.0 | — | Winkler, 1992 |
| 59AGz M25-3 | Jqd | Talkeetna Mountains | 62.165 | 147.745 | Quartz diorite | A | Zircon | 150 | — | — | Grantz and others, 1963 |
| 59AGz M25-3 | Jqd | Talkeetna Mountains | 62.165 | 147.745 | Quartz diorite | K/Ar | Biotite | 160 | — | — | Grantz and others, 1963 |
| 59AGz M26 | Jqd | Talkeetna Mountains | 62.2138 | 148.1097 | Quartz diorite | K/Ar | Biotite | 161 | — | Age recalculated using constants of Steiger and Jager (1977), no error reported | Csejtey and others, 1978, Grantz and others, 1963 |
| 59AGz M26 | Jqd | Talkeetna Mountains | 62.2138 | 148.1097 | Quartz diorite | K/Ar | Biotite | 173 | — | Age recalculated using constants of Steiger and Jager (1977), no error reported | Csejtey and others, 1978; Evernden and others, 1961 |
| 59AGz M26 | Jqd | Talkeetna Mountains | 62.2138 | 148.1097 | Quartz diorite | K/Ar | Biotite<br>Hornblende | 170.0<br>163.0 | 6<br>6 | Age recalculated using constants of Steiger and Jager (1977) | Csejtey and others, 1978, Detterman and others, 1965 |
| 2724M01 | Jqd | Talkeetna Mountains | 62.2317 | 148.8497 | Tonalite | U/Pb | Zircon | ~192 | — | Age given as range, 191.5 to 192.9, no error reported. Probably includes inherited Carboniferous to Triassic zircon | Rioux and others, 2007 |
| 2724M01 | Jqd | Talkeetna Mountains | 62.2317 | 148.8497 | Tonalite | U/Pb | Zircon | 187.4 | 2.2 | Weighted mean age | Rioux and others, 2007 |
| 2712M06 | Jqd | Talkeetna Mountains | 62.2523 | 148.7028 | Tonalite | U/Pb | Zircon | ~191 | — | Age given as range, 190.0 to 192.0 no error reported. Analysis indicates inclusion of Paleozoic xenocrystic zircon | Rioux and others, 2007 |
| 2712M06 | Jqd | Talkeetna Mountains | 62.2523 | 148.7028 | Tonalite | U/Pb | Zircon | 188.3 | 2.2 | Weighted mean age. | Rioux and others, 2007 |
| 2712B2A | Jqd | Talkeetna Mountains | 62.3727 | 148.2543 | Tonalite | U/Pb | Zircon | 190.5 | 6.8 | Weighted mean age | Rioux and others, 2007 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 73ACy 109 | Jqd | Talkeetna Mountains | 62.4578 | 148.3095 | Quartz diorite | K/Ar | Biotite<br>Hornblende | 144.0<br>154.0 | 4.3<br>4.6 | Discordant | Csejtey and others, 1978 |
| KA431 | Jqd | Talkeetna Mountains | 62.6417 | 147.3833 | Diorite | K/Ar | Biotite | 169 | — | Oshetna River | Evernden and others, 1961 |
| 64AE 98 | Jmu | Iliamna | 59.2683 | 154.49 | Gabbro | K/Ar | Hornblende | 183 | — | Alaska-Aleutian Range batholith, hornblende gabbro. Age recalculated using constants of Steiger and Jager (1977) | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| 65ADt 1084 | Jmu | Iliamna | 59.73 | 153.8483 | Hornblendite | K/Ar | Hornblende | 160 | | Alaska-Aleutian Range batholith. Age recalculated using constants of Steiger and Jager (1977). Minimum age? | Reed and Lanphere, 1969, 1972; Magoon and others, 1976; Detterman and Reed, 1980 |
| ANCH-1 | Jeqd | Anchorage | 61.4633 | 149.36 | Quartz diorite | K/Ar | Biotite | 161 | 5 | — | Magoon and others, 1976; Clark, 1972; 1973 |
| SClark 1 | Jeqd | Anchorage | 61.465 | 149.3617 | Quartz diorite | K/Ar | Biotite | 165 | 5 | — | Clark, 1972, Winkler, 1992 |
| AK316 | Jeqd | Anchorage | 61.5967 | 148.92 | Quartz diorite | K/Ar | Hornblende | 167 | 9 | — | Winkler, 1992 |
| AK319 | Jeqd | Anchorage | 61.645 | 148.745 | Quartz diorite | U/Pb | Zircon | 183 | — | Concordant, no error reported | Winkler, 1992 |
| W80-48 (Pavlis F) | Jeqd | Anchorage | 61.6467 | 148.7317 | Quartz diorite | K/Ar | Hornblende | 194 | 7 | — | Pavlis, 1982; 1983; Winkler, 1992 |
| W80-25B (Pavlis E) | Jeqd | Anchorage | 61.6533 | 148.685 | Quartz diorite | K/Ar | Hornblende | 191 | 7 | — | Pavlis, 1982; 1983; Winkler, 1992 |
| 2714M02 | Jeqd | Anchorage | 61.6562 | 148.7982 | Tonalite | U/Pb | Zircon | 186.1 | 0.3 | — | Rioux and others, 2007 |
| 0719P05B | Jeqd | Anchorage | 61.6588 | 148.6835 | Trondhjemite | U/Pb | Zircon | 193.3 | 0.4 | — | Rioux and others, 2007 |
| 81AWk 34 | Jeqd | Anchorage | 61.66 | 148.6883 | Granodiorite | K/Ar | Biotite;<br>Hornblende | 174<br>175 | 5<br>8 | Concordant | Winkler, 1992 |
| C80-43B (Pavlis C) | Jeqd | Anchorage | 61.67 | 148.5233 | Diorite | K/Ar | Hornblende | 135 | 6 | — | Pavlis, 1982, 1983 |
| 2717M04 | Jeqd | Anchorage | 61.6968 | 148.5352 | Diorite | U/Pb | Zircon | 193.9 | 0.5 | — | Rioux and others, 2007 |
| AK320 | Jeqd | Anchorage | 61.72 | 148.4867 | Quartz diorite | K/Ar | Hornblende | 165 | 10 | — | Winkler, 1992 |
| 0729G02 | Jeqd | Anchorage | 61.7243 | 147.576 | Quartz diorite | U/Pb | Zircon | 186.1 | 0.8 | — | Rioux and others, 2007 |
| 0717B03 | Jeqd | Anchorage | 61.726 | 147.0935 | Trondhjemite | U/Pb | Zircon | 184.1 | 1.9 | — | Rioux and others, 2007 |
| 0716P01 | Jeqd | Anchorage | 61.7268 | 147.0928 | Trondhjemite | U/Pb | Zircon | 185.1 | 0.5 | — | Rioux and others, 2007 |
| AK338 | Jeqd | Anchorage | 61.7733 | 147.2467 | Quartz diorite | K/Ar | Hornblende | 167 | 10 | — | Winkler, 1992 |
| W80-17 (Pavlis G) | Jum | Anchorage | 61.6367 | 148.6583 | Diorite | K/Ar | Hornblende | 189 | 8 | | Pavlis, 1982; 1983; Winkler, 1992 |
| AK317 | Jum | Anchorage | 61.645 | 148.675 | Quartz diorite | U/Pb | Zircon | 171 | — | Concordant, no error reported | Winkler, 1992 |
| AK332 | Jum | Anchorage | 61.6933 | 148.5383 | Diorite | K/Ar | Hornblende | 172 | 11 | — | Winkler, 1992 |
| 82AWk59 | Jum | Anchorage | 61.715 | 148.4933 | Tonalite | K/Ar | Hornblende | 176.4 | 3.7 | — | Winkler, 1992 |

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AK336 | Jum | Anchorage | 61.74 | 147.22 | Gabbro | K/Ar | Hornblende | 177 | 11 | Hornblende gabbro | Winkler, 1992 |
| V5C | Jsch | Afognak | 58.145 | 153.1867 | Schist | K/Ar | Muscovite | 196.4 | 5.8 | Quartz-mica schist. Age recalculated using Steiger and Jager, 1977 constants | Carden and others, 1977, Connelly and Moore, 1979 |
| R83M | Jsch | Afognak | 58.2167 | 153.0333 | Schist | Rb/Sr | Isochron | 212 | — | Five whole rock samples, 4 Raspberry sch., 1 Seldovia sch., R83Ml08, MlN11, Ml05, SlU3, 7-24-S6 | Roeske and others, 1989 |
| ML-08 | Jsch | Afognak | 58.23 | 153.0317 | Blueschist | Rb/Sr | Isochron | 207 | — | Whole rock-phengite date from micaceous quartzite, Raspberry schist | Roeske and others, 1989 |
| ML-05 | Jsch | Afognak | 58.23 | 153.0333 | Blueschist | Rb/Sr | Isochron | 189 | — | Whole rock-phengite date from quartzite, Raspberry schist | Roeske and others, 1989 |
| M-26-88 | Jsch | Afognak | 58.23 | 153.0367 | Schist | Fission-track | Apatite;<br>Zircon | 77<br>148 | — | Raspberry schist, elevation 0 m | Clendenen, 1991 |
| ML-N11 | Jsch | Afognak | 58.2317 | 153.0367 | Blueschist | Rb/Sr | Isochron | 193 | — | Whole rock-phengite date from metavolcanic, Raspberry schist | Roeske and others, 1989; Clendenen, 1991 |
| M1D | Jsch | Afognak | 58.2417 | 153.0467 | Schist | K/Ar | Amphibole;<br>Mica | 172.8<br>191.9 | 5.1<br>5.6 | White mica-crossite schist, crossite date, recalculated using Steiger and Jager, 1977 constants | Carden and others, 1977, Connelly and Moore, 1979, Connelly, 1978 |
| 7AF23-9 | Jsch | Seldovia | 59.0033 | 151.7067 | Schist | K/Ar | Muscovite | 194.7 | 5.7 | Quartz-mica schist, approximate location, recalculated using Steiger and Jager, 1977 constants | Carden and others, 1977 |
| 74PG79 | Jsch | Seldovia | 59.37 | 151.81 | Schist | K/Ar | Muscovite | 196.1 | 5.8 | Quartz-mica schist, approximate location, recalculated using Steiger and Jager, 1977 constants | Carden and others, 1977 |
| 92ATi 316D | Jsch | Seldovia | 59.4479 | 151.7145 | Schist | 40/39 plateau | White mica | 190.98 | 0.3 | Seldovia metamorphic complex, Plateau age | Bradley and Karl, 2000, A. Till (per. commun., 2007) |
| 92ATi 309B | Jsch | Seldovia | 59.4547 | 151.7153 | Schist | 40/39 plateau | Barroisite;<br>Muscovite | 191.92<br>191.7 | 0.6<br>0.3 | Seldovia metamorphic complex, Plateau age, quartz-white mica-chlorite schist | Bradley and Karl, 2000, A. Till (per. commun., 2007) |
| SD3-3 | Jsch | Seldovia | 59.4617 | 151.7067 | Greenschist | K/Ar | Actinolite;<br>Chlorite;<br>Mica | 195.0<br>185.1<br>192.3 | 11.0<br>8.3<br>10.0 | Approximate location. Age recalculated using constants of Steiger and Jager (1977) | Forbes and Lanphere, 1973; Magoon and others, 1976; Carden and others, 1977 |
| 74AF4B.1 | Jsch | Seldovia | 59.4617 | 151.7067 | Schist | K/Ar | Amphibole | 166.8 | 4.9 | Blueschist, crossite date, approximate location, recalculated using Steiger and Jager, 1977 constants | Carden and others, 1977 |
| 74AF23-10 | Jsch | Seldovia | 59.4617 | 151.7067 | Schist | K/Ar | Amphibole;<br>Amphibole;<br>Muscovite | 188.6<br>188.3<br>196.6 | 5.5<br>5.5<br>5.8 | Amphibole-mica schist, approximate location, replicate amphibole analyses. Age recalculated using constants of Steiger and Jager (1977) | Carden and others, 1977 |
| SD9-3 | Jsch | Seldovia | 59.4667 | 151.7333 | Schist | K/Ar | Crossite;<br>Phengite | 157.8<br>192.9 | 4.8<br>5.7 | Blueschist, possible argon loss, approximate location. Age recalculated using constants of Steiger and Jager (1977) | Forbes and Lanphere, 1973; Magoon and others, 1976; Carden and others, 1977 |
| JD-1 (76181) | Jsch | Anchorage | 61.4883 | 149.2317 | Greenschist | K/Ar | Actinolite | 177 | 7 | Actinolite epidote schist greenschist. Age recalculated using constants of Steiger and Jager (1977) | Carden and Decker, 1977, Winkler, 1992 |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

[Samples listed by map units and ordered from south to north and east to west. Quadrangle is the 1:250,000-scale sheet. Methods: A, Lead-alpha, a largely discredited technique; K/Ar, conventional potassium-argon; 40/39, $^{40}Ar/^{39}Ar$; Rb/Sr, rubidium-strontium; Nd/Sm, neodymium-samarium, U/Pb, uranium-lead]

| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F80-6A (Pavlis B) | Jsch | Anchorage | 61.6083 | 148.595 | Amphibolite | K/Ar | Hornblende | 107 | 5 | Impure hornblende separate | Pavlis, 1982, 1983; Winkler, 1992 |
| C80-28 (Pavlis D) | Jsch | Anchorage | 61.6633 | 148.5183 | Amphibolite | K/Ar | Hornblende | 121 | 8 | Reset | Pavlis, 1982; 1983; Winkler, 1992 |
| R2Y | TRqd | Afognak | 58.06 | 153.4133 | Dioritic migmatite | K/Ar | Hornblende | 187.5 | 5.5 | Dioritic migmatite, mean of 2 determinations. Age recalculated using constants of Steiger and Jager (1977) | Carden and others, 1977; Connelly, 1978; Connelly and Moore, 1979; Roeske and others, 1989 |
| R4A | TRqd | Afognak | 58.1467 | 153.2517 | Diorite | K/Ar | Hornblende | 192.7 | 5.7 | Hornblende diorite, approximate location. Age recalculated using constants of Steiger and Jager (1977) | Carden and others, 1977; Connelly and Moore, 1979; Roeske and others, 1989 |
| M2-1Z | TRqd | Afognak | 58.2017 | 153.2067 | Intrusive rock | Fission-track | Zircon | 153 | — | Afognak pluton, elevation 0m | Clendenen, 1991 |
| M2-1Z | TRqd | Afognak | 58.2017 | 153.2067 | Intrusive rock | 40/39 | Feldspar | 134.5 | — | 40/39 incremental heating, integrated age, range 150-120 Ma | Clendenen, 1991 |
| ML-I1 | TRqd | Afognak | 58.2150 | 153.1650 | Quartz diorite | U/Pb | Zircon | 217<br>203.5 | —<br>— | Coarse fraction<br>Fine fraction | Roeske and others, 1989; Clendenen, 1991 |
| B10-9Z | TRqd | Afognak | 58.375 | 152.7817 | Diorite | K/Ar | Hornblende | 197.0 | 5.8 | Hornblende diorite, recalculated using Steiger and Jager, (1977) constants | Carden and others, 1977, Connelly and Moore, 1979, Connelly, 1978, Roeske and others, 1989 |
| BARREN | TRqd | Afognak | 58.9433 | 152.2067 | Quartz diorite | K/Ar | Hornblende | 191 | 1.3 | Ushagat Island, approx. location using Steiger and Jager (1977) constants | Cowan and Boss, 1978, Roeske and others, 1989 |
| 91DW 87 | Mzg | Seldovia | 59.6075 | 151.1378 | Gabbro | U/Pb | Zircon | 227.7 | 0.6 | Gabbro of Halibut Cove | Bradley and Karl, 2000; Bradley and Miller, 2006, and Dwight Bradley (written commun., 2007) |
| 72ASt 290 | JPam | Talkeetna Mountains | 62.76 | 147.3083 | Diorite | K/Ar | Hornblende | 176.6 | 5.1 | Diorite or amphibolite | Csejtey and others, 1978, Turner and Smith, 1974 |
| Unknown rock units | | | | | | | | | | | |
| 76JF 649 | — | Iliamna | 59.3167 | 154.0667 | Unknown | K/Ar | Whole-rock | 29.0 | 1.5 | Estimated latitude and longitude. Location given as SE1/4 Sec. 7 T10S R2W, however location must be in R28W. Location near Contact Point. Age recalculated using constants of Steiger and Jager (1977) | R.G. Hickman, UNOCAL, written commun., 1996. |
| n.a. | — | Seldovia | 59.5392 | 150.478 | Not reported | 40/39 plateau | Sericite | 55.6 | 0.1 | Valdez Group, Beauty Bay Mine, altered rock, clear sericite | Haeussler and others, 1995 |
| n.a. | — | Seldovia | 59.5392 | 150.478 | Not reported | 40/39 | Sericite | 55.9 | 0.1 | Valdez Group, Beauty Bay Mine, altered rocks, gold-colored sericite. Preferred date based on 37.2 percent of gas, disturbed spectra | Haeussler and others, 1995 |

**Table 1.** Radiometric age data for the map of the Cook Inlet Region, south central Alaska—continued.

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| Sample | Map unit | Quadrangle | Latitude °N | Longitude °W | Rock type | Method | Mineral | Age (Ma) | Error (m.y.) | Comment | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n.a. | — | Seldovia | 59.5428 | 150.18 | Vein | 40/39 plateau | White mica | 52.9 | 0.1 | Thunder Bay gold occurrence, polymetalllic gold-sulfide vein | Haeussler and others, 1995 |
| GT13 | — | Iliamna | 59.73 | 154.72 | Andesite | K/Ar | Whole-rock | 36.4 | | Rabbit Island, Iliamna Lake | Thrupp and Coe, 1986 |
| RG075 | — | Anchorage | 61.043 | 149.1038 | Not reported | 40/39 plateau | White mica | 54.3 | 0.1 | Hydrothermal alteration at Jewel Mine, Valdez Group | Haeussler and others, 1995 |
| 02PH 394A | — | Tyonek | 61.4372 | 150.6489 | Tuff | U/Pb | Zircon | ~32 | | Andesite tuff, 1 concordant fraction | Haeussler and others (written commun., 2008) |
| 2710M01 | — | Anchorage | 61.6243 | 148.6905 | Metavolcanic / clastic | U/Pb | Zircon | 202.1 | 1.2 | | Rioux and others, 2007 |
| 88pac 24 | — | Anchorage | 61.6417 | 148.6333 | Not reported | 40/39 total fusion | Hornblende | 180.4 | 1.0 | Approximate location | Barnett and others, 1994 |
| W32W | — | Anchorage | 61.7817 | 149.4017 | Vein | K/Ar | Muscovite | 66.3 | | Lucky Shot Mine, gold bearing vein | Silberman and others, written comm., 1978 |
| MLS 8 | — | Anchorage | 61.7833 | 149.405 | Vein | K/Ar | Muscovite | 66.3 | 2.0 | Gold-bearing quartz vein in tonalite | Madden-McGuire and others, 1990, Winkler, 1992 |
| 99Pe 66 | — | Talkeetna Mountains | 62.2960 | 149.0562 | Diorite | 40/39 plateau | Hornblende | 251.1 | 2.1 | Sample thought to contain significant excess argon. Isochron age was 241 ± 10.9 | Drake and Layer, 2001 |
| 99MBW 529 | — | Talkeetna Mountains | 62.3583 | 149.0070 | Schist | 40/39 plateau | Sericite | 145.7 | 1.0 | Quartz-sericite-pyrite schist | Drake and Layer, 2001 |
| 99MBW 541B | — | Talkeetna Mountains | 62.3699 | 149.2170 | Hornblendite | 40/39 isochron | Hornblende | 63.0 | 8.4 | Sample has had complex thermal history and significant excess argon. Age thought to be "reset." "Saddle" plateau age was 84.0 ± 1.2 may be too old | Drake and Layer, 2001 |
| CC36-659 | — | Talkeetna Mountains | 62.993 | 149.861 | Greisen | 40/39 plateau | Muscovite | 53.4 | 0.2 | Coal Creek tin deposits. Plateau equals isochron age. Integrated age 53.7 ± 0.2 | Clautice and others, 2001 |
| N.A. | — | Talkeetna Mountains | n.a. | n.a. | Rhyolite | U/Pb | Zircon | 45.2 | 1.1 | Weighted mean age, based on selected analysis of a suite of zircon; inclusion of all samples in weighted mean calculation yielded 45.5 ± 1.1 Ma | Oswald, 2006 |