U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Aniakchak National Park and Preserve

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Aniakchak National Park and Preserve

ania_geology.pdf

Version: 3/29/2016

Geologic Resources Inventory Map Document for Aniakchak National Park and Preserve

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Geologic Resources Inventory Map Document

Aniakchak National Park and Preserve, Alaska

Document to Accompany Digital Geologic-GIS Data

ania_geology.pdf

Version: 3/29/2016

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Aniakchak National Park and Preserve, Alaska (ania).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

For information about the status of GRI digital geologic-GIS data for a park contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park

(s), enter “GRI” as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Aniakchak National Park and Preserve, Alaska (ania):

GRI Digital Bedrock Geologic Map of Aniakchak National Monument and Preserve and Vicinity, Alaska (*GRI MapCode ANIA*)

Wilson, F.H., 2008, Digital Surficial and Bedrock Geology for Aniakchak National Monument and Preserve and Vicinity, Alaska: U.S. Geological Survey unpublished digital data, scale 1:250,000 (Aniakchak Bedrock and Surficial Map) (*GRI Source Map ID 75171*)

Pilcher, S.H., 2000, Alaska Resource Data File - Sutwik Island Quadrangle: U.S. Geological Survey, Open-File Report OF-2000-120, 1:250,000 scale (Alaska Resource Data File) (*GRI Source Map ID 2221*)

Pilcher, S.H., 2000, Alaska Resource Data File - Ugashik Quadrangle: U.S. Geological Survey, Open-File Report OF-2000-122, 1:250,000 scale (Alaska Resource Data File) (*GRI Source Map ID 2222*)

Wilson, F.H., Detterman, R.L., and DuBois, G.D., 1999, Geologic Map of the Alaska Peninsula, Southwest Alaska (Chignik Sheet): U.S. Geological Survey, Open File Report OF-99-317, 1:500,000 scale (Alaska Peninsula Map) (*GRI Source Map ID 7417*)

Wilson, F.H., Detterman, R.L., and DuBois, G.D., 1999, Geologic Map of the Alaska Peninsula, Southwest Alaska (Ugashik Sheet): U.S. Geological Survey, Open File Report OF-99-317, 1:500,000 scale (Alaska Peninsula Map) (*GRI Source Map ID 7416*)

Detterman, R.L., Miller, T.P., Yount, M.E., and Wilson, F.H., 1981, Geologic Map of the Chignik and Sutwik Island Quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1229, p. 1 sheet, scale 1:250,000 (Chignik and Sutwik Quadrangles) (*GRI Source Map ID 1123*)

GRI Digital Quaternary Geologic Map of Aniakchak National Monument and Preserve and Vicinity, Alaska (*GRI MapCode ASUR*)

Wilson, F.H., 2008, Digital Surficial and Bedrock Geology for Aniakchak National Monument and Preserve and Vicinity, Alaska: U.S. Geological Survey unpublished digital data, scale 1:250,000 (Aniakchak Bedrock and Surficial Map) (*GRI Source Map ID 75171*)

Additional information pertaining to each source map is also presented in the GRI Source Map Information (ANIAMAP) table included with the GRI geology-GIS data.

Quaternary Geologic Map Unit List

The Quaternary geologic units present in the digital geologic-GIS data produced for Aniakchak National Park and Preserve, Alaska (ania) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qdu - Dune deposits). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (ANIAUNIT) table included with the GRI geology-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Surficial Deposits

- Qg - Glacier
- Qdu - Dune deposits
- Ql - Lacustrine deposits
- Qsw - Swamp deposits
- Qes - Estuarine deposits
- Qb - Beach deposits
- Qal - Alluvial deposits
- Qaf - Alluvial fan deposits
- Qt - Alluvial terrace deposits
- Qac - Abandoned channel deposits
- Qc - Colluvium
- Qls - Landslide deposits
- Qmt - Marine terrace deposits

Volcanic Deposits

- Qcs - Cinder and spatter cones
- Qafd - Ash-flow and ash-fall deposits
- Qmf - Mudflow deposits
- Qdf - Debris flow deposits
- Qed - Explosion debris
- Qv - Volcanic rocks, undivided
- Qd - Volcanic domes
- Qanp - Andesite plug domes
- Qba - Basalt and basaltic andesite flows
- Qda - Dacite flows
- Qdap - Dacite plugs

Glacial Deposits

- Qgl - Glacial lake deposits
- Qblu - Brooks Lake Glaciation, undivided, drift
- Qbln - Brooks Lake Glaciation, Newhalen Stade, drift
- Qblil - Brooks Lake Glaciation, Iliamna Stade, drift

Qblk - Brooks Lake Glaciation, Kvichak Stade, drift
Qblo - Brooks Lake Glaciation, outwash deposits
Qmhd - Mak Hill Glaciation, drift
Qmho - Mak Hill Glaciation, outwash

Mesozoic and Paleozoic Eras

Tertiary to Jurassic Periods

TJbu - Bedrock, undivided

Bedrock Geologic Map Unit List

The bedrock geologic units present in the digital geologic-GIS data produced for Aniakchak National Park and Preserve, Alaska (ania) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qs - Surficial Deposits, undivided). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (ANIAUNIT) table included with the GRI geology-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qg - Glacier
Qs - Surficial deposits, undivided
Qv - Younger volcanic rocks
Qpd - Pyroclastic and debris-flow deposits
Qm - Moraines and other glacial deposits

Tertiary Period

Ti - Dacite and andesite
Tvu - Volcanic rocks, undivided
Tiu - Intrusive rocks, undivided
Tm - Meshik Volcanics
Tt - Tolstoi Formation

Mesozoic Era

Cretaceous Period

Kh - Hoodoo Formation
Kc - Chignik Formation
Khe - Herendeen Formation
Kst - Staniukovich Formation

Jurassic Period

Jn - Naknek Formation, undivided
Jni - Naknek Formation, Indecision Creek Sandstone Member
Jns - Naknek Formation, Snug Harbor Siltstone Member
Jnn - Naknek Formation, Northeast Creek Sandstone Member

Quaternary Geologic Map Unit Descriptions

Descriptions of all Quaternary geologic map units, generally listed from youngest to oldest, are presented below.

Qg - Glacier (Holocene)

Ice fields or glaciers. *(UG001)*

Qdu - Dune deposits (Holocene)

d - Dune Deposits (Holocene)
Fine sand and pumice forming dunes 10-20 m high; mainly in areas of thick ash and pumice flow deposits around Mount Veniaminof. Dune fields include both active and stabilized forms. *(SW003)*

du - Dune Deposits (Holocene)
Fine- to medium-grained sand and pumice, forming dunes up to 15 m high. Occurs mainly along beaches and terraces; locally near distal end of ash-flow deposits. Includes both active and stabilized forms. *(BB003)*

Ql - Lacustrine deposits (Holocene)

l - Lacustrine Deposits (Holocene)
Silt and fine sand deposited in drained or partly drained lake basins; includes sandy beach deposits too small to map separately. *(CG003, SW003)*

Qsw - Swamp deposits (Holocene)

sw - Swamp Deposits (Holocene)
Dark-brown to black highly organic silt and clay. Locally an accumulation of sedge and Sphagnum peat that locally forms quaking bogs. Largely formed between moraines of Brooks Lake and Mak Hill drift deposits. *(BB003, UG003)*

sw - Swamp Deposits (Holocene)
Dark-brown to black highly organic silt and clay. Mainly an accumulation of sedge and sphagnum peat that forms quaking bogs. Inorganic part of deposit largely volcanic ash and silt. Covers extensive areas of Bristol Bay Lowland. *(CG003, SW003)*

Qes - Estuarine deposits (Holocene)

es - Estuarine Deposits (Holocene)
Dark-gray laminated silt and clay with thin interbeds of fine sand; locally rich in organic material. Extensively developed along Bristol Bay coastline. *(CG003)*

Qb - Beach deposits (Holocene)

b - Beach Deposits (Holocene)
Moderately well-sorted and stratified sand and gravel. Beach deposits along Bristol Bay side of Alaska Peninsula mainly formed of fine pumiceous sand with some glacially derived volcanic cobbles and pebbles. Beaches along Pacific side of Alaska Peninsula formed mainly of locally derived bedrock cobbles and boulders; fragments are angular to well rounded. *(CG003, SW003)*

Qal - Alluvial deposits (Holocene)

al - Alluvium (Holocene)
Ranges from poorly sorted and poorly stratified, coarse angular fragments near head of valleys to moderately well-sorted, well-rounded, and stratified fine sand and gravel along slow-flowing streams on coastal plains. Deposits along streams draining volcanos consist mainly of pumice lapilli. Includes both active and inactive deposits. Inactive deposits commonly vegetated; may contain several low terrace levels. *(CG003, SW003)*

al - Alluvium (Holocene)
Ranges from poorly sorted and poorly stratified, coarse, angular fragments near head of valleys to moderately well-sorted, well-rounded, and stratified sand and fine gravel on the coastal plain. Deposits along streams draining volcanoes consist mainly of pumice lapilli; streams cutting glacial moraines contain many large rock fragments. Includes both active and inactive deposits. Inactive deposits commonly vegetated; may include low terrace gravels. *(BB003, UG003)*

Qaf - Alluvial fan deposits (Holocene)

af - Alluvial Fan Deposits (Holocene)
Ranges from coarse, poorly sorted debris near heads of fans to fine, moderately well-sorted fragments near toes of fans. Most fans vegetated and inactive. Fans deposited by streams draining volcanos consist of mostly well-sorted pumice fragments. *(CG003, SW003)*

af - Alluvial Fan Deposits (Holocene)
Range from coarse, poorly sorted rock debris near head of fans to moderately well-sorted and stratified fragments near margins. Most fans vegetated and inactive. *(BB003, UG003)*

Qt - Alluvial terrace deposits (Holocene and Pleistocene)

t - Terrace Deposits (Holocene and Pleistocene)
Moderately well-sorted and stratified sandy gravel forming both paired and unpaired terraces. *(CG003, SW003)*

Qac - Abandoned channel deposits (Holocene and Pleistocene)

ac - Abandoned Channel Deposits (Holocene and Pleistocene)
Poorly to moderately well-sorted and stratified sand, gravel, and pumice in channels fronting end moraines of Brooks Lake Glaciation and in Muddy River valley. *(CG003, SW003)*

ac - Abandoned Channel Deposits (Holocene and Pleistocene)
Poorly to moderately well-sorted and stratified sand and gravel in channels fronting and along moraine of the Kvichak and Iliamna advances of the Brooks Lake glaciation. Many channels formed as outlets for glacial lakes. *(UG003)*

Qc - Colluvium (Holocene and Pleistocene)

c - Colluvium (Holocene and Pleistocene)
Coarse angular rubble and talus mixed with fine-grained organic-rich solifluction deposits. Unsorted to weakly sorted or stratified; forms thin sheets along valleys walls generally no more than 1 to 2 m thick. (CG003, SW003)

co - Colluvium (Holocene and Pleistocene)
Coarse angular rubble and talus mixed with fine-grained organic-rich solifluction deposits. Unsorted to weakly sorted or stratified; forms thin sheets along valley walls and along lower slopes of mountains. *(UG003)*

Qls - Landslide deposits (Holocene and Pleistocene)

ls - Landslide Deposits (Holocene and Pleistocene)
Unsorted nonstratified coarse angular rubble forming lobate masses at base of steep rock walls. Common in areas underlain by poorly consolidated Tertiary and Quaternary rocks; also present in areas of soft Mesozoic shale, which is subject to rapid downslope movement when water saturated. *(CG003, SW003)*

ls - Landslide Deposits (Holocene and Pleistocene)
Unsorted nonstratified coarse, angular rubble forming lobate masses at base of steep rock walls. Common in areas underlain by poorly consolidated Tertiary rocks; also present in areas of soft Mesozoic shale. Particularly abundant in southwestern part of area. *(UG003)*

Qmt - Marine terrace deposits (Holocene and Pleistocene)

mt - Marine Terrace Depostis (Holocene and Pleistocene)
Stratified and well-sorted sand and gravel forming nearly level plains ending locally with prominent wave-cut scarps. Deposits along Bristol Bay side of Alaska Peninsula generally at about 15 m elevation, and wave-cut scarps can be traced inland 38 km along Meshik River valley. Deposits along Pacific side of Alaska Peninsula generally formed at about 28-30 m elevation. *(CG003, SW003)*

mt - Marine Terrace Depostis (Holocene and Pleistocene)
Stratified and moderately well sorted sand and gravel deposits that form nearly level plains that end locally at prominent wave-cut scarps. Terraces occur at 15 to 18 m elevation along Bristol Bay and between 40 and 45 m elevation on the Pacific Ocean side of Alaska Peninsula. *(BB003)*

Qcs - Cinder and spatter cones (Holocene)

cs - Cinder and Spatter Cones (Holocene)
Parasitic cones 30 to 300 m high, steep sided and commonly with small circular depressions at top.

Rocks are mainly dacite which is highly scoriaceous and porphyritic glassy and in cinder-size fragments to bombs up to 1 m in size. *(CG003)*

Qafd - Ash-flow and ash-fall deposits (Holocene)

afd - Ash-Flow and Ash-Fall Deposits (Holocene)
Ash-fall and ash-flow tuffs, typically unconsolidated and nonwelded. Ash-flow tuff unsorted, poorly stratified, and composed mainly of pumice and scoria bombs as much as 60 cm in diameter in a matrix of coarse ash and pumice. Range in composition from basaltic andesite to rhyodacite, but most are dacitic; compositional zoning common. Ash-fall tuff moderately well sorted, well stratified, and composed chiefly of fine- to medium-grained dacitic ash. *(CG003, SW003)*

aft - Ash-Flow Tuff and Air Fall of Aniakchak Caldera (Holocene)
Ash-flow sheet and associated air fall from the climactic eruption of Aniakchak caldera in the Chignik quadrangle (Detterman and others, 1981); dated 3300-3700 ka (Miller and Smith, 1977). Ash-flow tuff unsorted, poorly stratified, and composed mainly of pumice and scoria bombs as much as 60 cm in diameter in a matrix of coarse ash and lapilli; juvenile material of high-silica andesite and dacite (Smith, 1979). Ash-fall tuff moderately well sorted, well stratified, and composed chiefly of fine- to medium-grained dacitic ash. *(BB003, UG003)*

Qmf - Mudflow deposits (Holocene)

mf - Mudflow Deposits (Holocene)
Volcanic mudflows, in part lahars. Unsorted nonstratified mixture of fine volcanic ash and large coarse angular volcanic debris. Well-indurated to poorly consolidated. Locally includes reworked glacial moraine and Jurassic to Tertiary bedrock. *(CG003, SW003)*

Qdf - Debris flow deposits (Holocene)

df - Debris Flow Deposits (Holocene)
Coarse angular volcanic rock fragments with matrix of fine volcanic ash, mud, and lava. Formed in part as a basal flow rubble and in part as an agglutinate. *(CG003)*

ba - Block and Ash Flows (Holocene)
Small volume, andesitic to dacitic block- and ash-flow deposits associated with domes. Block and ash flows at Mount Peulik, Yantarni volcano, and southeast of Mount Chiginagak are not glacially modified suggesting an age younger than drift of Iliuk age; the block and ash flow at Yantarni overlies glacial moraine. The matrix-poor, dacitic, block and ash flow west of Mount Peulik in part overlies terminal moraine of Iliamna age. Block and ash flows at Mount Kialagvik and northwest of Mount Chiginagak partly overlie drift of Iliamna age and possibly may be younger than drift of Newhalen age. *(UG003)*

Qed - Explosion debris (Holocene)

ed - Explosion Debris (Holocene)
Volcanic bombs and scoria angular to rounded, mixed with nonvolcanic lithic fragments blown out by volcanic eruptions. Most deposits within few kilometers of crater but bombs to 5 cm scattered to 30 km from craters. *(CG003, SW003)*

va - Volcanic Avalanche Deposits (Holocene)
Irregularly-shaped mounds 10-20 m high, composed of unconsolidated volcanic rock debris. Avalanche northwest of Mount Peulik covers an area of 74 square kilometers; dominant rock type varies from mound to mound, ranging from andesite to biotite-bearing rhyodacite. Avalanche at Yantarni volcano originated from the south rim of the present crater and traveled southward, probably into ice; main volume of avalanche is to the south in the Sutwik Island quadrangle (mapped as explosion debris, Detterman and others, 1981). *(UG003)*

Qv - Volcanic rocks, undivided (Holocene and Pleistocene)

vb - Volcanic Breccia (Holocene and Pleistocene)
Coarse, angular volcanic rock fragments in a matrix of mud and ash; often oxidized to bright orange-brown. Includes well-consolidated volcanic avalanche deposits older than those included in unit Qva and (or) blast deposits, debris flow, lahars, and, at Aniakchak, basal rubble flows and agglutinate; may locally include lava flows. One of the main constructional units of the Chiginagak, Yantarni, Kialagvik, and Kejulik stratocones. *(BB003, UG003)*

vu - Volcanic Rocks, Undivided (Holocene and Pleistocene)
Flows and volcaniclastic rocks. *(BB003, UG003)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

vu - Volcanic Rocks, Undivided (Holocene and Pleistocene)
Andesite, dacite, and leucobasalt lava flows, volcanic breccia, lahar deposits, and debris-flow deposits. Lava flows and clasts in other volcanic deposits of unit are porphyritic, typically glassy, gray to black, and commonly vesicular. Andesite is overwhelmingly dominant composition and probably constitutes 60 percent or more of rocks. Includes basalt of Black Point, Arch Point Basalt, and Dushkin Basalt (Kennedy and Waldron, 1955), and Frosty Peak Volcanics (Waldron, 1961). Also includes lava flows, breccias, and older pyroclastic deposits of Yantarni Volcano (Riehle and others, 1987). Unit typically forms volcanic edifices; it also forms isolated outcrops that cap ridges, providing a good example of topography reversal caused by erosion. Individual flows are locally as thick as 30 m and are laterally continuous over large areas. Unit also includes basaltic, basaltic andesite, and dacite parasitic cinder and spatter cones. Cones are commonly 30 to 300 m high, are steep sided, and have small crater at top. Rocks at Mount Veniaminof are mainly basaltic andesite, whereas those at Aniakchak Crater are mainly dacite (T.P. Miller, oral commun., 1990). Basaltic scoria cones occur at three separate locations in the Mount Katmai 1:250,000-scale quadrangle (Riehle and others, 1993). Rocks are highly scoriaceous to vitrophyric, ranging in size from cinder-size fragments to 1-m-long bombs (Detterman and others, 1981b; T.P. Miller, oral commun., 1991). Primarily located in vicinity of Mount Veniaminof, Aniakchak Crater, in Mount Katmai area, and on Unimak Island. *(CG003, SW003)*

****Note: The above unit description differs from the description listed on the referenced source map. This description was generated by the USGS Alaska Science Center.*

Qd - Volcanic domes (Holocene and Pleistocene)

d - Volcanic Domes (Holocene and Pleistocene)
Light- to dark- to pinkish-gray, holocrystalline, porphyritic domes of high-silica andesite, dacite, and rhyolite (F.H. Wilson, written commun., 1985; Miller, 1984). *(BB003, UG003)*

Qanp - Andesite plug domes (Holocene and Pleistocene)

anp - Andesite Plug Domes (Holocene and Pleistocene)
Dark-gray to black, fine to coarsely crystalline, generally porphyritic andesite with hornblende, pyroxene, and plagioclase phenocrysts. *(CG003)*

Qba - Basalt and basaltic andesite flows (Holocene and Pleistocene)

b - Basalt and Basaltic Andesite Flows (Holocene and Pleistocene)
Medium- to dark-gray, fine to coarsely crystalline; porphyritic with plagioclase, olivine, clinopyroxene and orthopyroxene as common phenocrysts; hornblende and quartz rare. Individual flows to 20 m thick; locally with columnar jointing. Includes some interlayered tuff and volcanic rubble. *(UG003)*

Qda - Dacite flows (Holocene and Pleistocene)

da - Dacite Flows (Holocene and Pleistocene)
Light-gray to black, porphyritic, vesicular to glassy dacite. Commonly with phenocrysts of hornblende and quartz. Individual flows 10-30 m thick. Forms post-caldera eruptive episodes at Aniakchak, Black Peak, Veniaminof, and Kupreanof Volcanos, Locally includes interlayered units of volcanic rubble and breccia. Dacite commonly columnar jointed. *(CG003, SW003)*

Qdap - Dacite plugs (Holocene and Pleistocene)

dap - Dacite Plugs (Holocene and Pleistocene)
Medium- to coarse-grained, light- to dark-gray hypabyssal rocks with euhedral quartz and hornblende crystals. Shallow intrusive, probably source for some vents; also includes dikes and sills. *(CG003)*

Qgl - Glacial lake deposits (Holocene and Pleistocene)

gl - Glacial Lake Deposits (Holocene and Pleistocene)
Highly organic silt and clay locally with stratified sand and pebbles near moraine fronts. Enclosed by moraine of Kvichak age. Associated with terrace levels cut into bedrock and moraine at about 22 to 25 m elevation. Terraces extend inland 58 km along Dog Salmon River valley. Most of the area poorly drained with numerous lakes, ponds, and quaking bogs. *(UG003)*

Qblu - Brooks Lake Glaciation, undivided, drift (Pleistocene)

blu - Drift, Undivided (Pleistocene)
Unsorted and nonstratified till in irregular knob and kettle topography; fresh to moderately weathered. Moraine of older stades commonly engulfed and partly buried by outwash from younger advances. *(CG003, SW003)*

Qbln - Brooks Lake Glaciation, Newhalen Stade, drift (Pleistocene)

bln - Drift of Newhalen Stade (Pleistocene)
Unsorted till and stratified ice-contact deposits forming well-developed nested arcuate end moraines and lateral moraines. Moraine irregular with prominent knob and kettle topography only slightly modifies by erosion. Formed by major stillstand or readvance of glaciers. *(CG003)*

bln - Drift of Newhalen Advance (Pleistocene)
Unsorted till and stratified ice-contact deposits forming well-developed arcuate end and lateral moraines with prominent knob and kettle topography little modified by erosion. Found mainly in mountain valleys and formed by a major glacial stillstand or minor readvance. *(UG003)*

Qblil - Brooks Lake Glaciation, Iliamna Stade, drift (Pleistocene)

blil - Drift of Iliamna Stade (Pleistocene)
Large arcuate, in part lobate, end moraines with locally at least two prominent recessional moraines. Mainly unstratified, with minor sorted and stratified ice-contact deposits; extends as much as 75 km from source areas. Know and kettle topography considerably weathered; many kettles filled, streams integrated, and knobs broadly rounded. Moraines enclose large glacial lakes and are fronted by broad outwash plains. *(BB003, UG003)*

Qblk - Brooks Lake Glaciation, Kvichak Stade, drift (Pleistocene)

blk - Drift of Iliuk Advance (Pleistocene)
Large arcuate in part lobate, end moraines with locally at least two prominent recessional moraines. Mainly unstratified, with minor sorted and stratified ice-contact deposits; extends as much as 75 km from source areas. Knob and kettle topography considerably weathered; many kettles filled, streams integrated, and knobs broadly rounded. Moraines enclose large glacial lakes and are fronted by broad outwash plains. *(BB003, UG003)*

Qblo - Brooks Lake Glaciation, outwash deposits (Pleistocene)

blo - Outwash Deposits (Pleistocene)
Moderately well-sorted and stratified sand, silt, and gravel forming flat to gently sloping plains in front of end moraines of the Brooks Lake Glaciation. Commonly with well-developed anastomosing pattern of channels. Vegetated but little altered by erosion. *(CG003, SW003)*

blo - Outwash Deposits (Pleistocene)
Moderately well-sorted sand and gravel forming nearly flat to gently sloping plains in front of end moraines of Brooks Lake age; slightly modified by erosion. *(BB003, UG003)*

Qmhd - Mak Hill Glaciation, drift (Pleistocene)

mhd - Drift (Pleistocene)
Unsorted and non stratified till forming highly modified knob and kettle topography near Bristol Bay coast. Knobs rounded and much reduced in size by solifluction and covered by marine terrace deposits and outwash from Brooks Lake glaciation; kettle ponds mostly filled and reduced in size; end moraine

highly segmented. Stratified ice-contact and glaciomarine deposits present in some beach-cliff exposures along Bristol Bay. *(BB003)*

Qmho - Mak Hill Glaciation, outwash (Pleistocene)

mho - Outwash Deposits (Pleistocene)
Moderately well-sorted, stratified, and consolidated deposits forming flat to gently sloping plains in front of end moraines of Mak Hill age. Deposits generally small and segmented by streams. *(BB003)*

TJbu - Bedrock, undivided (Tertiary to Jurassic)

TJsi - Sedimentary and Igneous Rocks (Tertiary to Jurassic)
Consists of sedimentary rocks of Jurassic, Cretaceous, and Tertiary age, and volcanic and intrusive rocks of Eocene to Pliocene age. *(CG003, SW003)*

TPsi - Sedimentary and Igneous Rocks (Tertiary to Permian)
Includes sedimentary rocks of Permian, Triassic, Jurassic, Cretaceous, and Tertiary age and volcanic and intrusive rocks of Triassic and Tertiary age (Detterman and others, in press). *(UG003)*

Bedrock Geologic Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

Qg - Glacier (Quaternary)

Ice fields or glaciers. *(UG001)*

Qs - Surficial deposits, undivided (Quaternary)

Typically unconsolidated, poorly sorted to well sorted, poorly to moderately well-stratified sand, gravel, and silt. Includes alluvial, colluvial, glacial, marine, lacustrine, and eolian deposits, as well as locally reworked volcanic-ash and debris-flow deposits. *(BB004, CG004, SW004, UG004)*

Qv - Younger volcanic rocks (Quaternary)

Qv - Younger Volcanic Rocks (Quaternary)
Andesite, dacite, and leucobasalt lava flows, volcanic breccia, lahar deposits, and debris-flow deposits. Lava flows and clasts in other volcanic deposits of unit are porphyritic, typically glassy, gray to black, and commonly vesicular. Andesite is overwhelmingly dominant composition and probably constitutes 60 percent or more of rocks. Includes basalt of Black Point, Arch Point Basalt, and Dushkin Basalt (Kennedy and Waldron, 1955), and Frosty Peak Volcanics (Waldron, 1961). Also includes lava flows, breccias, and older pyroclastic deposits of Yantarni Volcano (Riehle and others, 1987). Unit typically forms volcanic edifices; it also forms isolated outcrops that cap ridges, providing a good example of topography reversal caused by erosion. Individual flows are locally as thick as 30 m and are laterally continuous over large areas. Unit also includes basaltic, basaltic andesite, and dacite parasitic cinder and spatter cones. Cones are commonly 30 to 300 m high, are steep sided, and have small crater at top. Rocks at Mount Veniaminof are mainly basaltic andesite, whereas those at Aniakchak Crater are mainly dacite (T.P. Miller, oral commun., 1990). Basaltic scoria cones occur at three separate locations in the Mount Katmai 1:250,000-scale quadrangle (Riehle and others, 1993). Rocks are highly scoriaceous to vitrophyric, ranging in size from cinder-size fragments to 1-m-long bombs (Detterman and others, 1981b; T.P. Miller, oral commun., 1991). Primarily located in vicinity of Mount Veniaminof, Aniakchak Crater, in Mount Katmai area, and on Unimak Island. *(CG004, SW004, UG004)*

Qyc - Deposits of Yantarni Cone (Quaternary)
Interbedded breccias, lava flows, and pyroclastic deposits consisting dominantly of two-pyroxene andesite. Local fumarolic alteration. Unit typically forms volcanic edifices; it also forms isolated outcrops that cap ridges, providing a good example of topography reversal caused by erosion. *(SW005)*

****Note: The above source unit description has been modified by the USGS Alaska Science Center.*

Qdy - Dome of Yantarni Volcano (Quaternary)
Porphyritic, two-pyroxene hornblende bearing andesite. *(UG005)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

cs - Cinder and Spatter Cones (Holocene)

Parasitic cones 30 to 300 m high, steep sided and commonly with small circular depressions at top. Rocks are mainly dacite which is highly scoriaceous and porphyritic glassy and in cinder-size fragments to bombs up to 1 m long. Pahoehoe-type flow fragments associated with some cones. Large concentration of cones associated with Veniaminof Volcano; approximately 40 cones form a belt 6 km wide with a N. 40 W. strike. *(CG002, SW002)*

Qpd - Pyroclastic and debris-flow deposits (Holocene and late Pleistocene?)

Qpd - Pyroclastic and debris-flow deposits (Holocene and late Pleistocene?)
Dacite and rhyolite ash-flow tuff and debris-flow, block-and-ash-flow, explosion debris, and air-fall deposits. Mapped near Pavlof Volcano, Mount Dana, Kupreanof Volcano and other nearby unnamed volcanoes (Wilson, 1989), Mount Veniaminof (Detterman and others, 1981b), Aniakchak Crater (Miller and Smith, 1977), Ugashik Caldera (Detterman, Wilson, and others, 1987), and Valley of Ten Thousand Smokes (Riehle and others, 1987 and 1993). Pyroclastic deposits "typically are composed of pumice and scoria bombs *** and subordinate lithic fragments in a matrix of fine to coarse ash, pumice, and lithic material" (Miller and Smith, 1977, p. 174). Miller and Smith (1977) reported that composition ranges from basaltic andesite to rhyolite, although most are dacite. Valley of Thousand Smokes is well known for its compositionally zoned rhyolite to andesite ash flows erupted in 1912 (see, for example, Hildreth, 1983). Hildreth (1987) estimated composition of lavas from 1912 Katmai eruption to have been roughly 54 to 59 percent rhyolite, 35 to 43 percent dacite, and 3 to 5 percent andesite. *(BB004, CG004, SW004, UG004)*

df - Debris Flow Deposits (Holocene)
Coarse angular volcanic rock fragments with matrix of fine volcanic ash, mud, and lava. Formed in part as a basal flow rubble and in part as an agglutinate. *(SW003)*

ed - Explosion Debris (Holocene)
Volcanic bombs and scoria, angular to rounded, mixed with volcanic lithic fragments blown out by volcanic eruptions. Most deposits within few kilometers of craters but bombs up to 5 cm scattered up to 30 km from craters. *(SW003)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

vb - Volcanic Breccia (Holocene and Pleistocene)
Coarse angular volcanic rock fragments in a matrix of mud and ash; often oxidized to bright orange-brown. Includes well-consolidated volcanic avalanche deposits older than those included in unit va and (or) blast deposits, debris flows, lahars, and, at Aniakchak, basal rubble flows and agglutinate; may locally include lava flows. One of the main constructional units of the Chiginagak, Yantarni, Kialagvik, and Kejulik stratocones. *(UG003)*

Qp - Pyroclastic Flow Deposits (Quaternary)
Crudely stratified beds ranging from moderately sorted blocks to poorly sorted block-and-ash deposits. Juvenile clasts have 55 to 63 percent SiO2. *(UG005)*

Qm - Moraines and other glacial deposits (Pleistocene)

blil - Drift of Iliamna Advance, Brooks Lake Glaciation (Pleistocene)
Large arcuate, in part lobate, end moraines with locally at least two prominent recessional moraines.

Mainly unstratified, with minor sorted and stratified ice-contact deposits; extends as much as 75 km from source areas. Know and kettle topography considerably weathered; many kettles filled, streams integrated, and knobs broadly rounded. Moraines enclose large glacial lakes and are fronted by broad outwash plains. *(BB003, UG003)*

blk - Drift of Kvichak Stade, Brooks Lake Glaciation (Pleistocene)
Large arcuate in part lobate, end moraines with locally at least two prominent recessional moraines. Mainly unstratified, with minor sorted and stratified ice-contact deposits; extends as much as 75 km from source areas. Knob and kettle topography considerably weathered; many kettles filled, streams integrated, and knobs broadly rounded. Moraines enclose large glacial lakes and are fronted by broad outwash plains. *(BB003, UG003)*

mhd - Drift, Mak Hill Glaciation (Pleistocene)
Unsorted and non stratified till forming highly modified knob and kettle topography near Bristol Bay coast. Knobs rounded and much reduced in size by solifluction and covered by marine terrace deposits and outwash from Brooks Lake glaciation; kettle ponds mostly filled and reduced in size; end moraine highly segmented. Stratified ice-contact and glaciomarine deposits present in some beach-cliff exposures along Bristol Bay. *(BB003)*

bln - Drift of Newhalen Stade, Brooks Lake Glaciation (Pleistocene)
Unsorted till and stratified ice-contact deposits forming well-developed arcuate end and lateral moraines with prominent knob and kettle topography little modified by erosion. Found mainly in mountain valleys and formed by a major glacial stillstand or minor readvance. *(UG003)*

****Note: The above four units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

bln - Drift of Newhalen Stade, Brooks Lake Glaciation (Pleistocene)
Unsorted till and stratified ice-contact deposits forming well-developed nested arcuate end moraines and lateral moraines. Moraine irregular with prominent knob and kettle topography only slightly modifies by erosion. Formed by major stillstand or readvance of glaciers. *(CG003)*

blu - Drift, Undivided, Brooks Lake Glaciation (Pleistocene)
Unsorted and nonstratified till in irregular knob and kettle topography; fresh to moderately weathered. Moraine of older stades commonly engulfed and partly buried by outwash from younger advances *(CG003, SW003)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

Ti - Dacite and andesite (Pliocene and Miocene)

Td - Dacite and andesite (Pliocene and Miocene)
Several hypabyssal bodies on south boundary of map area, including felsite sills, plugs and dacite dikes. Sericitic alteration common. *(UG004)*

Tvu - Volcanic rocks, undivided (Pliocene to Oligocene)

Tda - Dacite (Pliocene to Oligocene)
Finely crystalline to glassy, light to dark gray and black, dacite . Porphyritic with euhedral quartz,

amphibole, and rare pyroxene crystals. *(CG002, SW002)*

Ta - Andesite (Pliocene to Oligocene)
Porphyritic to glassy, dark gray to black, fine to coarsely crystalline andesite. Contains phenocrysts of plagioclase, hornblende, and pyroxene. Flows 10 to 30 m thick; commonly columnar jointed. Locally includes volcanic breccia, lahars, and tuff. *(SW002)*

Tbp - Basalt Plug Domes (Oligocene)
Small plug domes and associated dike and sill swarms. Commonly with surrounding volcanic rubble, flows and lahars. Fine to coarse crystalline, porphyritic to glassy basalt with pyroxene phenocrysts; rarely with hornblende or olivine phenocrysts. Commonly with well-developed columnar jointing. K-Ar ages of 30 to 35 m.y. (F. H. Wilson, unpub. data, 1979) *(SW002)*

****Note: The above three units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

Tvu - Volcanic rocks, undivided (Pliocene to Oligocene)
Andesite, dacite, and basalt lava flows, tuffs, lahar deposits, volcanic breccia, and hypabyssal intrusions, all locally hydrothermally altered or hornfelsed. No potassium-argon ages are available and little stratigraphic control exists for these rocks, but outcrop and erosional patterns are similar to other Tertiary volcanic rocks. Includes volcanic rocks of Thinpoint Lagoon of Waldron (1961). *(SW004)*

Tau - Andesite (Pliocene? to Oligocene?) Hyapbyssal hornblende andesite exposed in southern third of study area, mainly as small plugs and stocks. Fine to medium grained; sparse biotite. Porphyritic alteration and disseminated pyrite common. *(UG004)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

Tiu - Intrusive rocks, undivided (Oligocene to Eocene)

Td - Diorite (Oligocene and Eocene)
Small plutons of medium- to coarse-grained, hornblende-bearing equigranular rocks with some small biotite crystals. Commonly altered and mineralized (Yount and others, 1978). Some of the rocks are porphyritic with hornblende crystals to 1 cm. K-Ar dates of 32 to 40 .my. (F. H. Wilson, unpub.data, 1979) *(CG002, SW002)*

Td - Diorite (Oligocene to Eocene)
Small plutons of medium-grained, hornblende-bearing diorite. Commonly altered and mineralized. On boundary with Sutwik Island quadrangle. *(UG004)*

Ti - Intrusive Rocks (Oligocene to Eocene)
Small, typically hypabyssal dikes, sills, and stocks of fine- to medium-grained rocks. No potassium-argon ages are available for these rocks; unit may include rocks of other Tertiary intrusive rock units. *(SW004)*

Tiu - Intrusive Rocks, Undivided (Oligocene to Eocene)
Small, typically hypabyssal dikes, sills, and stocks of andesite, quartz diorite, or diorite containing phenocrysts of pyroxene or hornblende in fine-grained groundmass. No potassium-argon ages are available for these rocks; unit may include rocks of other Tertiary intrusive rock units. *(UG004)*

****Note: The above three units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

Tm - Meshik Volcanics (early Oligocene and late Eocene)

Consists of coarse andesitic and basaltic volcanic rubble, lahar deposits, andesite and basalt lava flows, tuff, hypabyssal basalt and andesite plugs, and minor amounts of volcaniclastic sedimentary rocks. Volcaniclastic sedimentary rocks are equivalent in age and in lithology to Stepovak Formation (Ts). In Stepovak Bay region, Meshik gradationally interfingers with Stepovak Formation; unit shown on map depends on which lithology dominates. On Unga Island, volcanic rocks of Meshik also include dacite and rare rhyolite flows and domes. As mapped, unit includes informally defined Popof volcanic rocks of Wilson and others (1995), and also is herein geographically extended to include volcanic rocks of equivalent age, composition, and stratigraphic position mapped by Riehle and others (1987) as units Tvb and Tvm in Mount Katmai and Naknek 1:250,000-scale quadrangles. *(CG004, SW004, UG004)*

Tt - Tolstoi Formation (middle Eocene to late Paleocene)

In type section, sandstone is dominant lithology of formation; sandstone intervals grade upward from light gray to olive gray and tend to become more thin bedded. Siltstone intervals in section are consistently thin bedded and are usually light olive gray. Plant debris is present throughout type section, whereas megafauna is only reported from lower 280 to 290 m. In reference section, proportion of sandstone and siltstone thickness is sub-equal; additionally, conglomerate and conglomeratic sandstone intervals make up roughly 15 percent of section. Sandstone intervals tend to be massive or thick bedded, medium grained, and various shades of gray and brown. Siltstone intervals in reference section are usually thin bedded and consistently dark gray. Conglomerate and conglomeratic sandstone intervals are typically pale yellowish brown and massive. Lithic clasts in conglomerate and conglomeratic sandstone are dominantly granitic and arkosic detritus but also include as much as 30 percent volcanic clasts. Lithology is characteristic of shallow marine environment that is succeeded northward (stratigraphically upward) by rocks characteristic of nonmarine delta-plain and fluvial deposits, mainly of braided-stream character. Much thicker (1,319 m) reference section has lithology that is typical of nonmarine fluvial flood-plain, delta sequence, which is common in main part of Tolstoi Formation. Marine rocks are not known in Tolstoi north of Ivanof Bay (C.M. Molenaar, written commun., 1991). *(CG004, SW004, UG004)*

Kh - Hoodoo Formation (Late Cretaceous)

Unit is typically dark-gray to black, thin-layered and rhythmically bedded, splintery to pencil-fracturing shale, siltstone, and fine sandstone, becoming more sandy stratigraphically upwards. At Hoodoo Mountain, section contains ammonite-bearing channel conglomerate composed of clasts of plutonic and volcanic rocks, chert, and quartz. Sandstone beds are 0.3 to 1 m thick and siltstone and shale beds are 1 to 2 m thick, although individual layers are as thin as 1 cm (Detterman and others, 1981a). Depositional environment for most of unit is characteristic of lower slope of a submarine fan; structures imply submarine slumping and turbidity current flow. Locally, thick sandstone and conglomerate in upper part of unit imply upper fan-regime environment. *(CG004, SW004)*

Kc - Chignik Formation (Late Cretaceous)

Kc - Chignik Formation (Late Cretaceous)
Chignik is cyclic, nearshore-marine, tidal-flat, and nonmarine flood-plain and fluvial deposit (Fairchild, 1977; Detterman, 1978); its thickness is as much as 600 m in area between Port Moller and Chignik Bay. Unit consists dominantly of light-olive-gray to olive-gray sandstone containing interbedded olive-gray to olive-black siltstone and conglomerate. Conglomerate intervals are composed of multicolored chert, white quartz, felsic plutonic, and minor volcanic clasts. Nonmarine part locally contains coal beds as much as 2-m-thick, that were mined at Mine Harbor on Herendeen Bay around turn of twentieth century. As mapped, includes rocks mapped as undivided Chignik and Hoodoo Formations in Ugashik 1:250,000-scale quadrangle by Detterman, Case, and others (1987). *(CG004, UG004)*

Kc - Chignik Formation (Late Cretaceous)
Chignik is cyclic, nearshore-marine, tidal-flat, and nonmarine flood-plain and fluvial deposit (Fairchild, 1977; Detterman, 1978) consisting of sandstone, pebble-cobble conglomerate, siltstone, shale, and coal; its thickness is as much as 600 m in area between Port Moller and Chignik Bay. Unit consists dominantly of light-olive-gray to olive-gray sandstone containing interbedded olive-gray to olive-black siltstone and conglomerate. Conglomerate intervals are composed of multicolored chert, white quartz, felsic plutonic, and minor volcanic clasts. Nonmarine part locally contains coal beds as much as 2-m-thick, that were mined at Mine Harbor on Herendeen Bay around turn of twentieth century. *(SW004)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

Khe - Herendeen Formation (Early Cretaceous)

Originally described as limestone, rocks of formation are actually an unusually uniform calc-arenaceous sandstone. Rocks are thin bedded, medium grained, and dusky yellow to pale yellowish brown on freshly broken surfaces and weather to conspicuous light gray. They have distinct platy fracture upon weathering and strong petroliferous odor when freshly broken. *(CG004)*

Kst - Staniukovich Formation (Early Cretaceous)

Composed of 246 m of light-olive-gray siltstone containing two light-olive-brown sandstone intervals, overlain by shaly olive-gray siltstone containing numerous calcareous nodules and concretions (Detterman and others, 1996) in type section. *(CG004)*

Jn - Naknek Formation, undivided (Late Jurassic)

Jn - Naknek Formation, undivided (Late Jurassic)
Originally named Naknek Series by Spurr (1900, p. 169-171, 179, 181) for exposures at Naknek Lake. Detterman and others (1996; see also, Detterman and Hartsock, 1966; Martin and Katz, 1912) have subdivided unit into five members on Alaska Peninsula. *(CG004)*

Jn - Naknek Formation, undivided (Late Jurassic)
Consists of two unnamed member 1500 to 1800 m thick. Lower member is arkosic sandstone and conglomerate; upper member is primarily sandy siltstone and shale. (Note units later subdivided and mapped separately on Alaska Peninsula map.) *(SW004)*

****Note: The above two units, from the same source map, were lumped together for this project by the USGS Alaska Science Center.*

Jni - Naknek Formation, Indecision Creek Sandstone Member (Late Jurassic)

Consists of medium-gray, fine- to medium-grained arkosic sandstone and siltstone. It is thin bedded to massive; where bedded, it is locally crossbedded. Fresh biotite and hornblende are minor, but important, components of sandstone, as they are interpreted to indicate first-cycle erosion from Alaska-Aleutian Range batholith. *(CG004, SW004, UG004)*

Jns - Naknek Formation, Snug Harbor Siltstone Member (Late Jurassic)

Reference section consists of more than 638 m of dark-yellowish-brown and dark-gray, thin-bedded siltstone and minor amounts of thin- to medium-bedded olive-gray sandstone. Limestone nodules are locally abundant, and limestone beds are present in some siltstone intervals. Depositional environment was interpreted by Detterman and others (1996) to have been moderately deep water, well below wave base and above carbonate compensation depth, in a basin that had restricted circulation. *(CG004, SW004, UG004)*

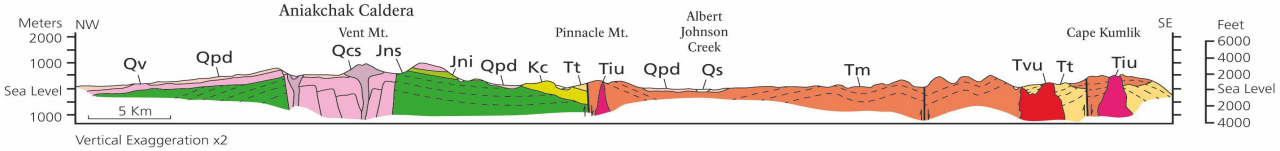
Jnn - Naknek Formation, Northeast Creek Sandstone Member (Late Jurassic)

Type section consists of 624 m of fine- to coarse-grained, light-brownish-gray arkosic sandstone and minor amounts of olive-gray to dark-gray, thin-bedded siltstone in lower part of section. Sandstone is typically thick bedded and crossbedded and contains magnetite laminae and thin beds of conglomerate. Depositional environment is mainly nonmarine. Some sand beds are channeled with lag gravel at bases of channels. Crossbedding is mostly high-angle and variable directional eolian type, some is small-scale, tabular crossbedding with clay drapes characteristic of point bar deposits (Detterman and others, 1996). Lower contact is conformable on underlying Chisik Conglomerate Member and is placed where thick sandstone replaces conglomerate in section. Upper contact is sharp and conformable with overlying Snug Harbor Siltstone Member. At this contact, depositional environment shifts from mainly nonmarine to marine; position of contact varies temporally depending on local conditions. *(SW004, UG004)*

Geologic Cross Section

The geologic cross section present in the GRI digital geologic-GIS data produced for Aniakchak National Park and Preserve, Alaska (ANIA) is presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section C-C'



Modified from: (Chignik and Sutwik Quadrangles).

Note: This cross section was modified by the GRI to more closely resemble the geology depicted in the GRI GIS data.

GRI Source Map Information

Aniakchak Unpublished Bedrock and Surficial Digital Data

Wilson, F.H., 2008, Digital Surficial and Bedrock Geology for Aniakchak National Monument and Preserve and Vicinity, Alaska: U.S. Geological Survey unpublished digital data, 1:250,000 scale (*GRI Source Map ID 75171*)

Note: Data from the above mapping source was checked against its mapping sources below and modified by the GRI, where needed, to correlate better with the GRI report.

Map References

USGS geologic spatial data for the Alaska region maintains geologic source information as an attribute attached to each geologic feature. Although the GRI considers the USGS to the be mapping source for this project, sources used and referenced by the USGS have been utilized by GRI, in some cases, to alter the data so that it correlates better with the GRI geologic report for this park. USGS source and reference information has been preserved in the GRI GIS product to allow users to reference back to USGS mapping databases if needed. Geologic features in the GRI GIS data and the unit descriptions listed in this document have references to the sources listed here.

BB001 USGS 1:250,000 quadrangle topographic map, Bristol Bay, Alaska, 1963, Limited Revision 1987

BB002 Detterman, R.L., Case, J.E., Wilson, F.H., and Yount, M.E., 1987, Geologic map of the Ugashik, Bristol Bay, and western part of Karluk quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1685, scale 1:250,000.

BB003 Detterman, R.L., Wilson, F.H., Yount, M.E., and Miller, T.P., 1987, Quaternary geologic map of the Ugashik, Bristol Bay and western part of Karluk quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1801, scale 1:250,000.

BB004 Wilson, F.H., Detterman, R.L., and DuBois, G.D., in press, Geologic framework of the Alaska Peninsula, southwest Alaska, and the Alaska Peninsula terrane: U.S. Geological Survey Bulletin 1969-B, approx. 80 ms pages, 1 oversize figure, 1 plate, scale 1:500,000.

CG001 USGS 1:250,000 quadrangle topographic map, Chignik, Alaska, 1963, Limited Revision 1993

CG002 Detterman, R.L., Miller, T.P, Yount, M.E., and Wilson, F.H., 1981, Geologic map of the Chignik and Sutwik Island quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1229, scale 1:250,000.

CG003 Detterman, R.L., Miller, T.P, Yount, M.E., and Wilson, F.H., 1981, Quaternary geologic map of the Chignik and Sutwik Island quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1292, scale 1:250,000.

CG004 Wilson, F.H., Detterman, R.L., and DuBois, G.D., in press, Geologic framework of the Alaska Peninsula, southwest Alaska, and the Alaska Peninsula terrane: U.S. Geological Survey Bulletin 1969-B, approx. 80 ms pages, 1 oversize figure, 1 plate, scale 1:500,000.

CG005 Riehle, J.R., Yount, M.E., and Miller, T.P., 1987, Petrography, chemistry, and geologic history of Yantarni volcano, Aleutian volcanic arc, Alaska: U.S. Geological Survey Bulletin 1761, 27 p., 1 plate, scale 1:63,360.

SW001 USGS 1:250,000 quadrangle topographic map, Sutwik Island, Alaska, 1963

SW002 Detterman, R.L., Miller, T.P, Yount, M.E., and Wilson, F.H., 1981, Geologic map of the Chignik and Sutwik Island quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1229, scale 1:250,000.

SW003 Detterman, R.L., Miller, T.P, Yount, M.E., and Wilson, F.H., 1981, Quaternary geologic map of the Chignik and Sutwik Island quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1292, scale 1:250,000.

SW004 Wilson, F.H., Detterman, R.L., and DuBois, G.D., in press, Geologic framework of the Alaska Peninsula, southwest Alaska, and the Alaska Peninsula terrane: U.S. Geological Survey Bulletin 1969-B, approx. 80 ms pages, 1 oversize figure, 1 plate, scale 1:500,000.

SW005 Riehle, J.R., Yount, M.E., and Miller, T.P., 1987, Petrography, chemistry, and geologic history of Yantarni volcano, Aleutian volcanic arc, Alaska: U.S. Geological Survey Bulletin 1761, 27 p., 1 plate, scale 1:63,360.

UG001 USGS 1:250,000 quadrangle topographic map, Ugashik, Alaska, 1963, Minor Revisions 1975

UG002 Detterman, R.L., Case, J.E., Wilson, F.H., and Yount, M.E., 1987, Geologic map of the Ugashik, Bristol Bay, and western part of Karluk quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1685, scale 1:250,000.

UG003 Detterman, R.L., Wilson, F.H., Yount, M.E., and Miller, T.P., 1987, Quaternary geologic map of the Ugashik, Bristol Bay and western part of Karluk quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1801, scale 1:250,000.

UG004 Wilson, F.H., Detterman, R.L., and DuBois, G.D., in press, Geologic framework of the Alaska Peninsula, southwest Alaska, and the Alaska Peninsula terrane: U.S. Geological Survey Bulletin 1969-B, approx. 80 ms pages, 1 oversize figure, 1 plate, scale 1:500,000.

UG005 Riehle, J.R., Yount, M.E., and Miller, T.P., 1987, Petrography, chemistry, and geologic history of Yantarni volcano, Aleutian volcanic arc, Alaska: U.S. Geological Survey Bulletin 1761, 27 p., 1 plate, scale 1:63,360.

Extracted from: (Aniakchak Bedrock and Surficial Map).

Radiocarbon Age Date Reference

Radiocarbon age date data contained within the GRI bedrock geodatabase is referenced to the following citation:

Miller, T. P., and Smith, R. L., 1987, Late Quaternary caldera-forming eruptions in the eastern Aleutian arc, Alaska: Geology, v. 15, n. 5, p. 434-438.

Radiometric Age Date References

Radiometric age date data contained within the GRI bedrock geodatabase is referenced to one or more of the following citations:

Smirnoff, Leonid, and Connelly, William, 1980, Axes of elongation of petrified stumps in growth position as possible indicators of paleosouth, Alaska Peninsula: Geology, v. 8, p. 547-548.

Wilson, F.H., 1982, Map and tables showing preliminary results of K-Ar age studies in the Ugashik quadrangle, Alaska Peninsula: U.S. Geological Survey Open-File Report 82-140, 1 sheet, scale 1:250,000.

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Note: Fault and fold symbols and a cross section line (C-C') were extracted from this map to supplement USGS unpublished data for Aniakchak National Monument and Preserve (Aniakchak Bedrock and Surficial Map).

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Note: Fold axis lines and fault and fold symbol points were captured from this map to supplement USGS unpublished data for Aniakchak National Monument and Preserve (Aniakchak Bedrock and Surficial Map).

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GRI finalization by James Chappell (Colorado State University).

GRI program coordination and scoping provided by Bruce Heise and Tim Connors (NPS GRD, Lakewood, Colorado).