

GEOLOGIC MAP OF THE WEST SUSITNA AREA, PARTS OF THE TYONEK C-3, C-4, D-4, AND D-5 QUADRANGLES, ALASKA

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Preliminary Interpretive Report 2026-1



Cutbank exposure on the eastern bank of the Talachulitna River; a 7.4-m sequence of gravel, well-sorted sand with organic layers and soft-sediment deformation, and underlying silty sand and clay with multiple possible seismites, <https://maps.dggs.alaska.gov/photodb/detail/39378>

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GEOLOGIC MAP OF THE WEST SUSITNA AREA, PARTS OF THE TYONEK C-3, C-4, D-4, AND D-5 QUADRANGLES, ALASKA

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INTRODUCTION

This report and accompanying map present surficial and bedrock geology for approximately 500 mi² of the Tyonek C-3, C-4, D-4, and D-5 quadrangles in western Cook Inlet. These products summarize findings of the West Susitna STATEMAP project, a 1:50,000-scale geologic mapping campaign across an area north of Cook Inlet that has attracted interest for resource development, alternative energy, and recreation. The map area includes approximately 50 miles of the West Susitna Access Corridor, which is proposed to connect Anchorage to the Happy River valley on the western margin of the Susitna Basin (Alaska Industrial Development and Export Authority, 2025). Previous surficial and bedrock geologic mapping in the region has primarily been reconnaissance-level and limited to 1:250,000-scale detail (Weber, 1961; Reger and others, 2003; Wilson and others, 2012), apart from a 1:63,360-scale bedrock map of the Canyon Creek area by Barnes (1966).

Field data were collected during a helicopter-supported program from July 16–28, 2024. Surficial geology, initially interpreted through a desktop study in ArcGIS, was verified in the field during the 2024 campaign. The desktop study incorporated new interpretations of remotely sensed imagery combined with previously published geologic mapping and relevant literature. Together, these datasets form the basis for updated geologic unit definitions, geomorphic interpretations, and structural observations presented in this map series.

This mapping offers stakeholders information about geologic hazards, including those associated with seismic activity, near the proposed corridor alignment. The resulting surficial and bedrock framework further supports refined interpretations of Quaternary and bedrock geologic history in the western Susitna Basin region. The map is published on two sheets to accommodate its scale and geographic extent. These data are provided as a Preliminary Interpretive Report under an open end-user license and are available on the DGGs website (<http://doi.org/10.14509/32075>).

Left: Field station 24SLW136, cutbank on the east bank of the Talachulitna River. Exposure is approximately 6 m high above river level. Outwash over lake deposits. <https://maps.dggs.alaska.gov/photodb/detail/38571>



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DESCRIPTION OF GEOLOGIC MAP UNITS

Unconsolidated Map Units

Alluvial Deposits

- Qa** UNDIFFERENTIATED ALLUVIUM (Holocene) — Stratified and poorly to well-sorted polymictic gravel, sand, and silt comprising channel and overbank deposits of generally small streams. Deposit characteristics vary based on stream gradient, sediment source, sediment composition, and stream size. Overbank surfaces typically lie less than 2 m above the modern Stream. Deposits are too small to differentiate further at the map scale, but may include small terraces, fans, and floodplain surfaces
- Qaa** ACTIVE ALLUVIUM (Holocene) — Stratified, moderately well-sorted polymictic gravel and sand comprising active channels, river bars, and floodplain deposits subject to recurrent inundation every 5 years or less (Chapin and others, 2006; Reger and others, 2021). Subaerial surfaces commonly include a pebble-and-cobble lag and are mostly unvegetated. Exposed river bars and channel courses are subject to rapid change, especially in braided streams. The unit was mapped, in part, based on the extent of exposed bars and channel locations observed in imagery and will typically shift from year to year due to erosion and water-level fluctuations.
- Qai** INACTIVE ALLUVIUM (Holocene) — Stratified, moderately well-sorted polymictic gravel and sand with a thin, discontinuous cover of overbank silty sand. Sediments are deposited by modern streams, and surfaces are often inundated, with periodic inundation occurring as often as two to ten times per century (Mason and Beget, 1991; Yarie and others, 1998; Chapin and others, 2006; Reger and others, 2021). Deposits commonly include abandoned channels at multiple levels. Vegetation is typically sparse on more frequently inundated surfaces. Less frequently inundated surfaces may contain dense alder stands and scattered spruce.
- Qab** ABANDONED FLOODPLAIN ALLUVIUM (Holocene) — Stratified, moderately well-sorted polymictic gravel and sand, with a mantle of silty overbank deposits generally 0.5 to 1 m thick. The deposits, subject to flooding about once every 500–1,000 years (Mann and others, 1995; Reger and others, 2021), may include multiple surface levels that typically do not exceed 1 m in elevation above the modern stream level. Overbank deposits may include crevasse splays, natural levees, organic silt, and channel fill in distinct abandoned stream channels. Vegetation varies, from tall cottonwood stands on higher surfaces adjacent to the Skwentna River, to dense concentrations of spruce, birch, and aspen between distinct swampy channels on lower surfaces adjacent to the Skwentna River and other smaller streams.
- Qat** ALLUVIAL TERRACE DEPOSITS (Holocene) — Stratified, moderately to well-sorted polymictic gravel and sand with 0.5-3 m of silty overbank deposits. Overbank deposits may include features such as crevasse splays, natural levees, and channel-fill composed of organic-rich silt. The terrace surfaces, at elevations between 1 and 5 m above the modern stream, are no longer subject to inundation by the stream that deposited the alluvium (Kreig and Reger, 1982; Reger and others, 2021). May include some low-level outwash terraces. Terraces are generally densely vegetated with spruce, aspen, and birch.

Younger terraces may have more open spruce-dominated forests and include indistinct, swampy oxbows.

Qad

DELTA DEPOSITS (Holocene) — Well-sorted sand and silt deposited where streams abruptly decrease in gradient when entering Alexander Lake, approximately 15 km northeast of Beluga Mountain. Alexander Lake and its deltas likely formed as a result of water impoundment by the hanging wall of the Bulchitna Lake Fault.

Qaf

ALLUVIAL FAN DEPOSITS (Upper Pleistocene – Holocene) — Fan-shaped deposits at the base of steep slopes where stream gradients decrease abruptly. Deposits consist of stratified, poorly to well-sorted gravel, sand, and silt with cobbles and boulders. Clast size decreases and the degree of sorting increases down-fan.

Colluvial Deposits

Qc

COLLUVIUM (Upper Pleistocene – Holocene) — Loose, heterogeneous deposits of subangular to angular rock fragments and poorly sorted silt- to boulder-sized sediment that have moved downhill under gravity-driven falling, sliding, flowing, and frost creep. Typically deposited as blankets, aprons, and cones near cirque headwalls and along steep valley slopes. May locally include, or be complexly mixed with, modified drift, talus, landslide, and debris flow deposits. In high-elevation alpine areas, deposits are commonly unvegetated or have local short vegetation and moss.

Qca

MIXED COLLUVIUM-ALLUVIUM (Upper Pleistocene – Holocene) — Heterogeneous, poorly stratified mixtures of subangular to angular rock fragments and silt- to boulder-sized sediments. Locally includes glacial drift modified by colluvial and alluvial processes, as well as debris cones and elongate debris flows deposited in narrow gullies and glacially steepened valleys during extreme precipitation or runoff events. Colluvial processes are dominant over fluvial. Commonly unvegetated or with local short vegetation and moss.

Qcl

LANDSLIDE DEPOSITS (Upper Pleistocene – Holocene) — Heterogeneous mixtures of bedrock blocks, angular rock fragments, and rounded to angular silt to boulder-sized sediments deposited by the sliding, toppling, or flowing of failed bedrock and unconsolidated deposits. Landslides are common along streams flowing through the Kenai Group and flysch bedrock. In unconsolidated deposits, landslides are most numerous on steep slopes within glacial drift.

Qcg

ROCK GLACIER DEPOSITS (Holocene) — Angular, unsorted fragments of local bedrock overlying deformed ice with increasing gravel, sand, and silt at depth; where an active, blocky surface layer is disrupted on steep marginal slopes and core debris is exposed; deposits accumulated on floors and lower walls of cirques and glaciated valleys by flow of rock glaciers derived from shrinking of former glaciers (ice-cored) or from deposition, cementation, and deformation of precipitation-derived ground ice (ice-cemented); surface typically has furrows, nested arcuate ridges arranged convexly down-valley, and pits, and may have prominent lateral ridges (Reger and others, 2021).

Paludal Deposits

Qp

SWAMP DEPOSITS (Holocene) — Peat with interlayered organic-rich silt, sand, and tephra. Deposits are typically waterlogged. Found in low-lying areas or depressions. In the Susitna Lowlands, east of Beluga Mountain, extensive paludal deposits may overlie glacioestuarine deposits (Wilson and others, 2015). Within these deposits, string bogs and sedge meadows are predominant, along with sparse stunted spruce.

Glacial Deposits

Alaskan Glaciation (MIS 1)

Qgdh

UNDIFFERENTIATED HOLOCENE DRIFT (Holocene; MIS 1) — Modern glacial deposits and Alaskan Glaciation deposits; discontinuous to continuous, heterogenous, nonstratified deposits of angular to subangular, polymictic, pebble-cobble gravel with sand, silt and boulders, deposited in upper mountain valleys by glacial ice and subsequently modified by fluvial and colluvial processes; deposits on steep valley slopes are dominated by scree and talus; ice cores may be present, especially in younger moraines; rock fragment lithology reflects local bedrock. Older drift is sparsely vegetated with short shrubs, mosses, and lichen, while younger drift often has a patchy to nonexistent vegetative cover. In high-elevation alpine valleys, the drift of Alaskan glaciation may include colluvial deposits and drift of the Elmendorf Stade, especially where slopes are steep and primary morphology is obscured.

Naptowne Glaciation (MIS 2)

Qgd3

DRIFT OF ELMENDORF STADE (Upper Pleistocene; late MIS 2) — Discontinuous to continuous sheets of heterogeneous, angular to subangular, polymictic pebble-cobble gravel with sand and silt and scattered¹ boulders, deposited by glacial ice and associated fluvial and colluvial processes. Widely overlain by up to 1.5 m of clay, silt, and sand. North of the Skwentna River, Elmendorf Stade deposits are characterized by crevasse-squeezed ridges atop drumlinoid ground moraine. Swales between drumlinoid ridges are swampy and may contain thin outwash-channel deposits. This ground moraine terminates in an arcuate hummocky end moraine north of Beluga Mountain, where the deposits have a distinct knob-and-kettle morphology and distinct, lightly modified ice-stagnation features. In high-elevation alpine valleys, Elmendorf Stade deposits may include colluvium, drift of Skilak/Kiley stades, and drift of the Alaskan Glaciation, especially where slopes are steep and primary morphology is obscured.

Qgd2

DRIFT OF SKILAK/KILLEY STADES (Upper Pleistocene; middle MIS 2) — Discontinuous to continuous sheets of heterogeneous, angular to subangular, polymictic, pebble-cobble gravel with sand, silt, and scattered boulders deposited by glacial ice and associated fluvial and colluvial processes. Morainal topography of Skilak/Kiley stades is relatively subdued and has been moderately modified by colluvial and fluvial processes, especially on steep slopes where deposits are thin. Paludal deposits occupy

¹ "Scattered" indicates that drilling would encounter approximately two boulders within a 3–4.5 m interval (Reger and others, 2021).

swales between drumlinoid ground moraine east of Beluga Mountain. Subtle, hummocky topography is present southeast of Beluga Mountain. The map unit designation of these deposits is supported by the relative position of Qgd2 drift with respect to Qgd3, along with its more subdued morphology. In high-elevation alpine valleys drift of Skilak/Kiley stade deposits may be complexly mixed with, and include, colluvial deposits and Elmendorf Stade deposits, especially where slopes are steep and primary morphology is obscured.

Qgd1

DRIFT OF MOOSEHORN STADE (Upper Pleistocene; early MIS 2) — Discontinuous to continuous sheets of heterogeneous, angular to subangular, polymictic, pebble-cobble gravel with sand and silt and scattered boulders, deposited by glacial ice and associated fluvial and colluvial processes. Drift of Moosehorn Stade (Qgd1) forms a relatively thin, featureless cover on hillsides south of Beluga Mountain. Elsewhere, deposits have likely been overridden by subsequent readvances of the Naptowne Glaciation. Correlation of Qgd1 with the Moosehorn Stade is suggested by the relative positioning of these deposits, which lie between the drift of apparent Skilak/Killey age and higher elevation pre-Naptowne deposits on Mount Susitna (Wilson and others, 2012).

Glaciofluvial Deposits

Qgo

UNDIFFERENTIATED OUTWASH (Upper Pleistocene – Holocene) — Polymictic gravel and sand deposited by glacial meltwater in plains, valley trains, channels, and fans. Deposits often form high-level terrace surfaces above modern streams and along former alluvial surfaces. Outwash deposits may be complexly mixed with, and thinly cover, glacial drift. Channels are often segmented and sometimes developed in bedrock along former glacial margins. As glaciers thinned and retreated, alternative drainage routes may have developed rapidly, leaving channels or portions of channels with small underfit streams or with streams entirely absent. Deposits may be thin and include paludal deposits or lakes.

Alaskan Glaciation (MIS 1)

Qgoh

UNDIFFERENTIATED HOLOCENE OUTWASH (Holocene; MIS 1) — Modern glacial deposits and Alaskan Glaciation deposits; Up to 1 m of stratified, well-sorted sand and silt over stratified pebble-cobble sand. Sediments deposited as valley trains during the Alaskan Glaciation (MIS 1), now forming high-level terrace surfaces no longer subject to inundation. Subangular clasts largely reflect local bedrock.

Naptowne Glaciation (MIS 2)

Qgic

ICE-CONTACT DEPOSITS OF ELMENDORF STADE (Upper Pleistocene; late MIS 2) — Heterogeneous gravel, sand, and silt of complex ice-contact deposits; eskers and kame terraces may include poorly- to well-sorted and stratified sediment; eskers are anastomosing and form a complex network of ridges. Deposited during the retreat of the same glaciers that deposited the end and ground moraine of the Elmendorf Stade (late MIS 2).

Qgo3

OUTWASH OF ELMENDORF STADE (Upper Pleistocene; late MIS 2) — Well-bedded polymictic gravel and sand, covered by up to 1 m of well-sorted sand and silt. Outwash deposited during the Elmendorf Stade in the map area (Qgo3) are proximal to and inset into the arcuate end moraine of

Qgd3. The stagnated ice front of Qgd3 diverted the ancestral Talachulitna River to the east, causing a deep, sinuous ravine to be cut through the northern flank of Beluga Mountain. Distal reaches of the outwash plain northeast of Beluga Mountain are interfingered with paludal deposits.

Qgo2 OUTWASH OF SKILAK/KILLEY STADES (Upper Pleistocene; middle MIS 2) — Well-bedded polymictic gravel and sand, covered by up to 1 m of well-sorted sand and silt. Southeast of Beluga Mountain, a series of Skilak/Killey stades (Qgo2) outwash plains emanate from the mountain front and extend southwestward.

Bedrock Map Units

Tsc TERTIARY NONMARINE COAL-BEARING STRATA (middle to late Miocene) — Sandstone, siltstone, mudstone, and coal. Sandstone is gray to tan, medium- to coarse-grained and friable with interstratified granules and small pebble horizons. Contains common floating woody fragments. Sandstones are trough cross-stratified with bed sets commonly 10-40 cm thick and bed packages up to 9 m thick. Common interstratified lignitic to subbituminous coals are a few cm to 9 m thick and overlay light gray to grayish brown claystone 1 to 5 m thick. The strata yield early late Miocene palynomorphs (Zippi and others, 2025), and a reworked tephra yields a zircon U-Pb maximum stratigraphic age of 13.7 ± 0.3 Ma (Gillis and others, 2026). Tks of Wilson and others (2012). This unit is potentially correlative to the Tyonek Formation of the Cook Inlet Kenai Group.

Tsl TERTIARY NONMARINE VARVED STRATA (middle to late Miocene) — Claystone. Medium-gray and varved claystone successions reach 7 m or more in thickness. Horizons of disrupted, contorted varves, 10 to 40 cm thick, are continuous for tens to over 100 m and resemble fluid-escape features that could have a seismogenic origin. Observed only in cutbanks on the Talachulitna River. Palynomorph assemblages indicate a late middle to early late Miocene age.

Tmu NEOGENE UNDIVIDED NONMARINE STRATA IN THE SUSITNA BASIN SUBSURFACE (early Miocene to Pliocene) — Up to 7,740 ft (2,300 m) of sandstone, conglomerate, subordinate siltstone and claystone, and minor coal penetrated in the Trail Ridge Unit 1, Pure Kahiltna Unit 1, and Sheep Creek 1 wells. Early Miocene to late Pliocene age constrained by palynomorphs. The unit is unconformably overlain by Quaternary (undivided) deposits and unconformably overlies Paleogene strata (Tpu) (Stanley and others, 2013).

Tpu PALEOGENE UNDIVIDED VOLCANIC-BEARING NONMARINE STRATA IN THE SUSITNA BASIN SUBSURFACE (late Paleocene to early Eocene) — Up to 3,200 ft (980 m) of sandstone, claystone, subordinate conglomerate, and coal penetrated in the Trail Ridge Unit 1, Pure Kahiltna Unit 1, and Sheep Creek 1 wells that overlies interstratified basaltic to andesitic volcanics, volcanic conglomerate, claystone, and subordinate coal and sandstone. The unit's age is constrained by palynomorphs and $^{40}\text{Ar}/^{39}\text{Ar}$ dates of volcanic lithologies that range from 57.3 ± 0.2 to 54.3 ± 0.4 Ma. The unit is unconformably overlain by Neogene strata (Tnu) (Stanley and others, 2013). The lower

volcanic-bearing succession may be correlative to unit Tpv in the upthrown block of the Beluga Mountain fault.

Tg TERTIARY HORNBLLENDE LEUCOGRANITE (early Eocene) — Tg is fine- to coarse-grained, commonly equigranular with euhedral to subhedral grains 2 to 3 mm. Chief constituents include plagioclase (50–60%), quartz (30–35%), and hornblende ± biotite (5–10%). Locations in the Dickason Highlands produced zircon U-Pb intrusive ages of 55.9 ± 1.2 Ma to 54.3 ± 1.2 Ma (Gillis and others, 2026). Thg and Tpg of Wilson and others (2012) and TKdgp of Solie and others (1991).

Tdg TERTIARY PYROXENE GABBRO DIKE (latest Paleocene) — Fine-grained hypabyssal intrusive rock composed of subequal plagioclase and hornblende and minor pyroxene. An isolated dike in the southern Dickason Highlands may correlate to a prominent dike swarm exposed approximately along strike on a ridge to the northwest. A zircon U-Pb analysis produced an intrusive age 57.6 ± 1.3 Ma (Gillis and others, 2026).

Tpv TERTIARY PYROCLASTIC AND VOLCANICLASTIC DEPOSITS AND DACITIC LAVAS (late Paleocene to early Eocene) — Tpv ranges from grayish brown to medium to dark gray to maroon or green. The rock is characterized by moderately to strongly welded aphanitic ash-flow tuff with common plagioclase lathes (~15%), 0.5 to 3mm, thin fiamme layers, and common coherent lava flows. The unit contains rare, very poorly sorted volcanoclastic lithologies with abundant subrounded-to-subangular beige tuff lithics, similar in character to Tvc (see below), and subangular-to-subrounded tuff and gray porphyritic volcanic clasts up to 5 cm. Tpv is a local cliff-forming unit at Beluga Mountain, where weak bedding is defined by fiamme. In the southern Dickason Highlands, ash-flow tuffs have a distinctly chocolate brown appearance in outcrop and form a multi-story subhorizontal succession of thick ledge-forming flows at ridge-scale. The contact between Tpv and the underlying Tvc is conformable to potentially disconformable and is marked locally by flaky charcoal-gray siltstone, 1 to 2 m thick. Locations at Beluga Mountain produced zircon U-Pb eruptive and maximum depositional ages of 59.3 ± 1.3 Ma to 55.9 ± 1.2 Ma (Gillis and others, 2022; Gillis and others, 2026). Tpv may correlate to flow-banded volcanic successions within late Paleocene to early Eocene nonmarine strata penetrated by Susitna basin wells in the downthrown block of the Beluga Mountain fault (e.g., Stanley and others, 2013).

Tvc TERTIARY DACITIC TO RHYOLITIC VOLCANICLASTIC STRATA (Paleocene) — Tvc ranges from gray to greenish gray to grayish tan and rarely maroon. The unit is fine- to very coarse-grained, granular, and volcanolithic. Finer-grained facies contain common subangular-to-subrounded plagioclase grains up to 4 mm in diameter.

Coarser-grained facies are poorly sorted with common to abundant floating angular to subrounded beige colored tuff granules and pebbles up to 5 cm and rare cobbles up to 10 cm. Contains rare matrix-supported tuff pebble-cobble conglomerate with clasts 5 to 15 cm and an outsized boulder at 80 cm. The presence of tuff lithics is a distinguishing characteristic that gives weathered surfaces a distinctive peach

hue. Few intercalated porphyritic lavas and welded pyroclastic beds are present with ~5 to 10% small equant feldspar and fiamme. Contains rare buff-to-white reworked tuff beds up to several meters thick. The unit is indistinctly bedded to weakly stratified and principally structureless. Rare examples of bedding 1 to 40 cm thick contain plane-parallel, low-angle, and rarer cross stratification. It most commonly forms low, poorly expressed outcrops and rounded knobs of thinly parted and irregular slabs of rock.

Boundaries between volcanoclastic, lava, and tuff beds are difficult to identify due to poor outcrop character. Locations in the northern Dickason Highlands and Beluga Mountain produced zircon U-Pb maximum depositional ages of 63.8 ± 1.4 Ma and 56.8 ± 1.3 Ma, respectively, that overlap with Tpv deposition (Gillis and others, 2022; Gillis and others, 2026). Kivs of Wilson and others (2012) and TKff of Solie and others (1991).

KJs

KAHILTNA ASSEMBLAGE (Upper Jurassic–Upper Cretaceous) — Metasandstone, metapelite, and metavolcanic rock. KJs sandstone is principally medium to dark greenish gray and very fine-grained with minor coarse-grained to granular lithic sandstone and rare floating pebbles composed of relatively abundant sub-rounded to rounded black and gray chert and minor quartz. Metapelite is locally charcoal gray to black. The metavolcanic rocks are composed of mafic volcanoclastics containing lithic fragments, plagioclase, hornblende, and minor quartz grains. Local grayish green porphyritic mafic lava packages up to 5 m thick contain plagioclase and hornblende phenocrysts, particularly along the northern Talachulitna River. Bedding is generally poorly expressed and massive, although locally medium, uniformly stratified tabular beds contain plane-parallel, low-angle and ripple laminations and rare vertical burrows. A distinguishing feature of the unit is its very high degree of induration. On the eastern flank of Beluga Mountain, an outcrop of fine-grained hornblende-rich volcanoclastic rocks has a basaltic geochemistry (Walser and others, 2025) and produced a zircon U-Pb maximum depositional age of 143.4 ± 3.1 Ma (Gillis and others, 2026). Kes and Kjs of Wilson and others (2012).

LIMITATIONS

Relative glacial timing and deposit ages are mainly based on surface morphology and the spatial relationships of glacial deposits. We recommend that future work utilize quantitative dating techniques to further constrain the ages of glacial deposits in the map area. Wilson and others (2015) map glacial drift and glacioestuarine deposits throughout the Susitna Lowlands north of Mount Susitna, citing unpublished data. Alternatively, Weber (1961) and Reger and others (2003) map this area as glacial moraine/drift and bog/swamp deposits, with Reger and others (2003) restricting estuarine deposits to lower elevations west of Mount Susitna. Owing to time constraints, we were unable to conduct field checks for the presence of glacioestuarine deposits within the map area. We retain the paludal deposits mapped north of Mount Susitna as indicated by Weber (1961) and Reger and others (2003), while acknowledging the possibility of underlying glacioestuarine deposits. Further investigation may be prudent, particularly to evaluate the presence of Bootlegger Cove deposits in the Susitna Lowlands.

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