3.13 GEOLOGY

3.13.1 Introduction

This section describes the baseline geology of the project area. Information provided here is based on field and desktop studies conducted for the project area by the applicant and others from 1985 to the present, as described in Appendix K3.13. Paleontological resources are also addressed in Appendix K3.13. Other sections that directly correspond to the geology discussion are Section 3.14, Soils; Section 3.15, Geohazards and Seismic Conditions; and Section 3.17, Groundwater Hydrology.

The Environmental Impact Statement (EIS) analysis area for geology includes the footprints for the mine (including material sites), port and ferry terminals, and transportation and pipeline corridors. The EIS analysis area is the same as the project area for this resource.

A definition for many technical terms applied in this section can be found in the glossary, available online on the project website (https://pebbleprojecteis.com/overview/glossary).

3.13.2 Regional Setting

The project area is approximately 250 miles northwest of the Alaska-Aleutian megathrust, where the Pacific tectonic plate subducts (i.e., sinks) beneath the North American plate. Section 3.15, Geohazards and Seismic Conditions, describes the tectonic setting, seismicity, faults, and volcanic activity. Tectonic activity at the plate boundary is the cause of the region's seismicity and volcanic activity and has promoted the growth of the Alaska landmass through the accretion of crustal blocks called terranes. Tectonic plate boundaries shifted throughout the Mesozoic (245 to 65 million years ago). These shifts produced igneous intrusives (magma) of Late Cretaceous age (about 90 million years old) responsible for the mineralization of the Pebble deposit (PLP 2011a).

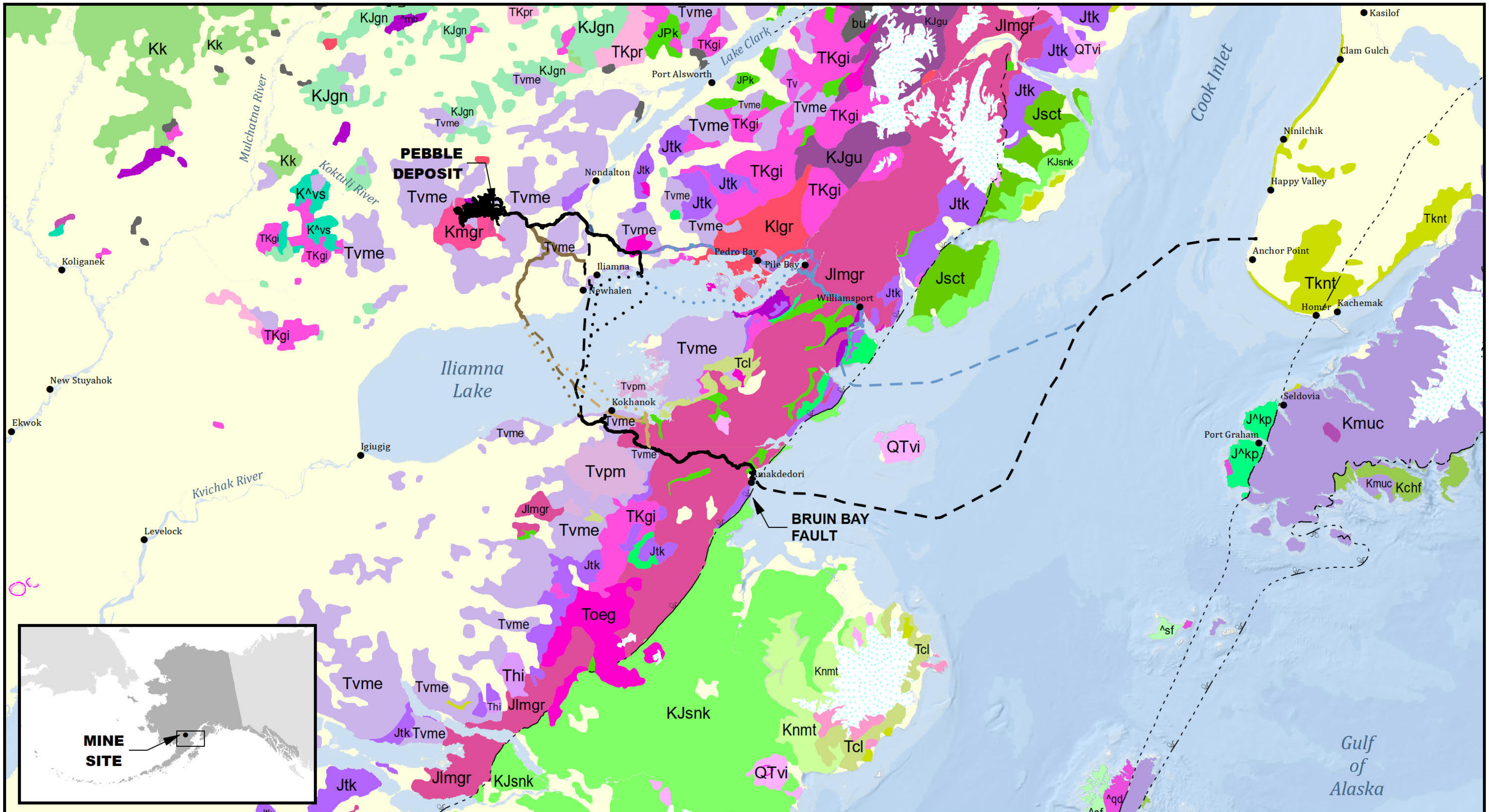
Over the last 2.6 million years (i.e., Quaternary), glaciers have repeatedly advanced over the landscape, causing erosion of glacial valleys, rounding landforms of hills and mountains, and depositing, which reworked materials throughout the region. The unconsolidated sediments occur in the valleys between bedrock hills and mountains. No glaciers exist in the project area.

3.13.3 Geologic Overview of the EIS Analysis Area

The geology of the mine site generally consists of bedrock hills with thin or no unconsolidated sediment with overburden in the wide valleys (Hamilton and Klieforth 2010). Overburden in this area is composed of glacial, glaciofluvial, and alluvial sediments. Iliamna Lake is in a basin generally filled with glacial sediments of Quaternary age that are exposed southwest, west, and north of the lake with occasional bedrock outcrops. The area between Iliamna Lake and Cook Inlet generally consists of exposed or near-surface bedrock, with limited sediments overlying the bedrock at the lower elevations (Wilson et al. 2015) (Figure 3.13-1).

The geologic structure of the project area is broadly defined by the northeast- to southwest-trending Bruin Bay Fault (Figure 3.13-1) (see Section 3.15, Geohazards and Seismic Conditions).

Extensive surficial glacial deposits, similar to those near Iliamna Lake, overlie the southwestern portion of the Kenai Peninsula (Detterman and Reed 1973). There is no known permafrost in the project area, including the areas of all alternatives and variants (see Section 3.14, Soils, for a discussion of permafrost).



Sources: PLP 2020-RFI168;
PLP 2019-RFI153; Wilson et al. 2015

US Army Corps of Engineers

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Miles

Action Alternatives

- Ferry Routes
- Natural Gas Pipelines
- Alternative 1a
- Alternative 1
- Alternative 1 Kokhanok East Ferry Terminal Variant
- Alternative 2
- Alternative 2 Newhalen River North Crossing Variant
- Alternative 3

Note: The complete legend describing the map units is provided in Wilson et al. 2015.

PEBBLE PROJECT AREA GEOLOGY

PEBBLE PROJECT EIS

FIGURE 3.13-1

3.13.4 Alternative 1a

3.13.4.1 Mine Site

Unconsolidated sediments (overburden) in the mine site consist of glacial till, outwash, alluvium, alluvial fan and deltaic deposits, and glaciolacustrine (glacial lake) deposits (Figure 3.13-2). Sediment grain sizes vary from silt, sands, and gravels to boulders. Overburden ranges in thickness from a few feet to about 165 feet (Detterman and Reed 1973; Knight Piésold et al. 2011a).

When glaciers were present, lakes formed where glacial ice blocked the major drainage basins (Hamilton and Klieforth 2010), resulting in deposition of lacustrine deposits. Glacial lake deposits are mapped in the eastern half of the open pit area, extending south of Frying Pan Lake, and in the area of water treatment plant #1 discharge-south (Figure 3.13-2). The lake deposits are composed of stratified (layered) to weakly stratified silts, sands, and fine gravels, and display poorly drained surface morphology (Hamilton and Klieforth 2010). Glacial meltwater channels and a moraine ridges are also present (Figure 3.13-2).

Colluvium and felsenmeer occur along the flanks of Kaskanak Mountain, including the footprint of the bulk tailings storage facility (TSF) and on slopes surrounding the mine site. Solifluction lobes composed mostly of silt are present on isolated lower slopes in the mine site, including the footprint of the pyritic TSF (Knight Piésold et al. 2011a). Thin, organic soils less than 1 foot thick cover the mine site and are often intermixed with sands and gravels (Hamilton and Klieforth 2010) (see Section 3.14, Soils).

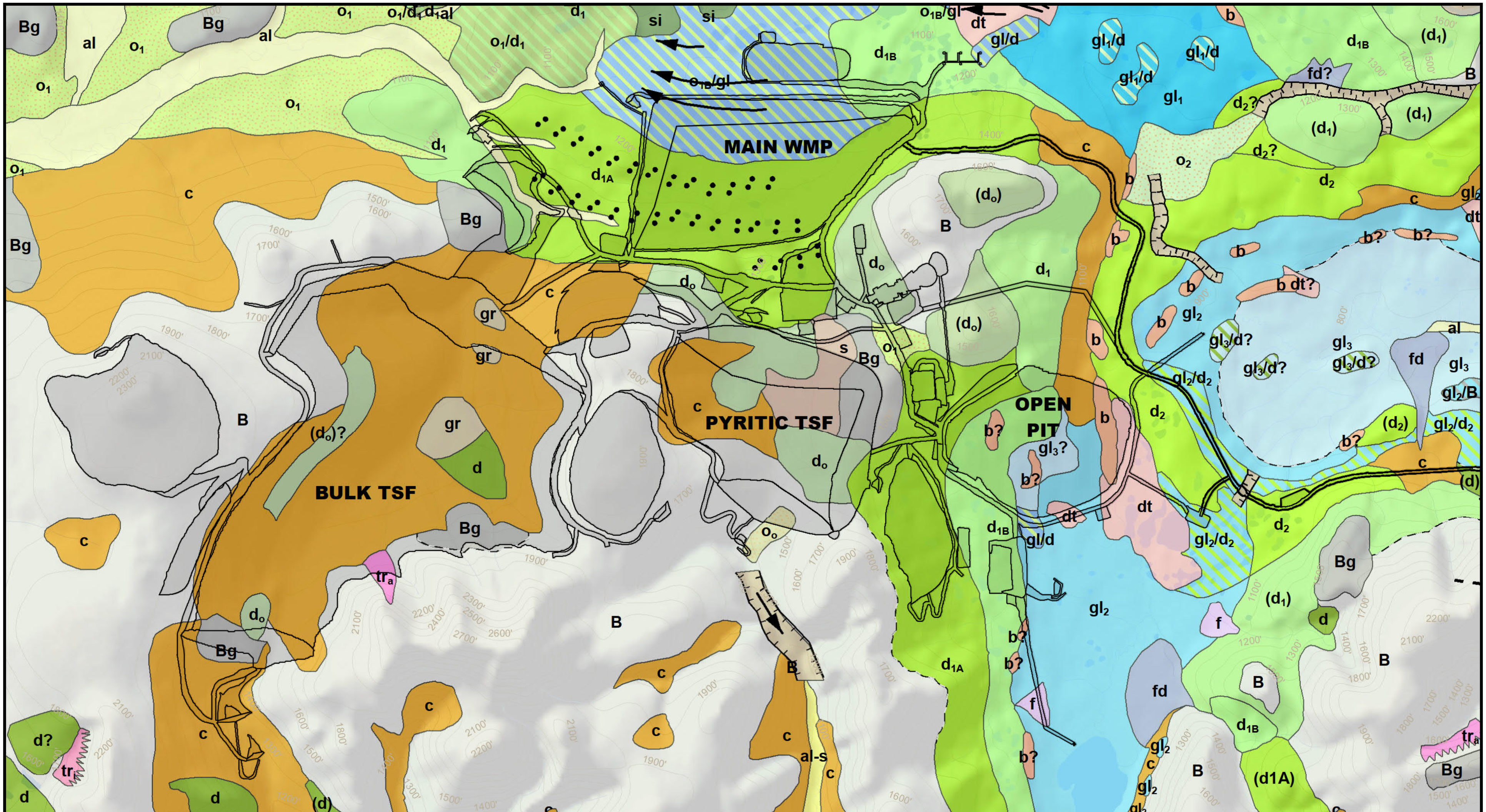
Bedrock occurs at the higher elevations (above about 1,400 feet above mean sea level) in the mine site area (Figure 3.13-2). The bedrock geologic map (Figure 3.13-3) shows the mine site's complex bedrock geology and is described below.

Mine Site Bedrock Geology and Mineralization of the Pebble Deposit

The mine site bedrock geology is complex (Figure 3.13-3). Much of the bedrock in and around the open pit area is a type of Mesozoic sedimentary rock derived from eroded andesitic volcanic rock (Kahiltna flysch). Tertiary (Paleogene and Neogene, about 65 to 2.6 million years old) volcanic and sedimentary rocks outcrop at higher elevations on the southern end of the bulk TSF and in the southeastern corner of the mine site area. A variety of Cretaceous (about 145 to 65 million years old) intrusive rocks outcrop in the mine site, including the granodiorite of the Kaskanak batholith, which outcrops in the western portion of the mine site (Knight Piésold et al. 2011a) (Figure 3.13-3).

Other diverse magmas intruded in the flysch in a north-northeast-trending belt throughout the Cretaceous and were then folded by tectonic forces (Nokleberg et al. 1994). The mineralization that formed the Pebble deposit was likely caused by these diverse magma intrusions that comprise the rock in the open pit area (Knight Piésold et al. 2011a).

Offshoots of the magma injected into joints and fractures in the surrounding sedimentary bedrock, heating the rock and causing hot fluids to circulate in a large magmatic-hydrothermal system. The hot fluids carried dissolved metals from the magma, including copper, gold, and molybdenum. As the fluids cooled, the metals and associated sulfide minerals (such as iron sulfide [pyrite]) precipitated in the surrounding rock, concentrated in metal-rich quartz veins. These rocks make up the Pebble deposit, a copper, gold, molybdenum porphyry system.



Sources: PLP 2019-RFI153; Hamilton and Klieforth 2010

US Army Corps of Engineers

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Miles

Alternative 1a

Surficial Geology Linear Features

- Contact
- Crest of moraine ridge
- Drainage Channel
- Fault
- Meltwater channel

Surficial Geology Map Units

Alluvian
al, al-s

Bedrock, undifferentiated
B

Bedrock, glaciated
Bg

Beach deposits
b, b?

Colluvium
c

Glacial drift
d, d?, d1, d1A, d1B, d2, d2?, do, (d), (d1), (d1A), (d2), (do), (do)?

Deltaic deposits
dt, dt?

Fan deposits
f

Fan-delta deposits
fd, fd?

Glacial-lake deposits
gl/d, gl1, gl1/d, gl2, gl2/B, gl2/d2, gl3, gl3/d?, gl3?

Gravel
gr

Glacial outwash
o1, o1/d1, o1B/gl, o2, oo

Solifluction deposits
s

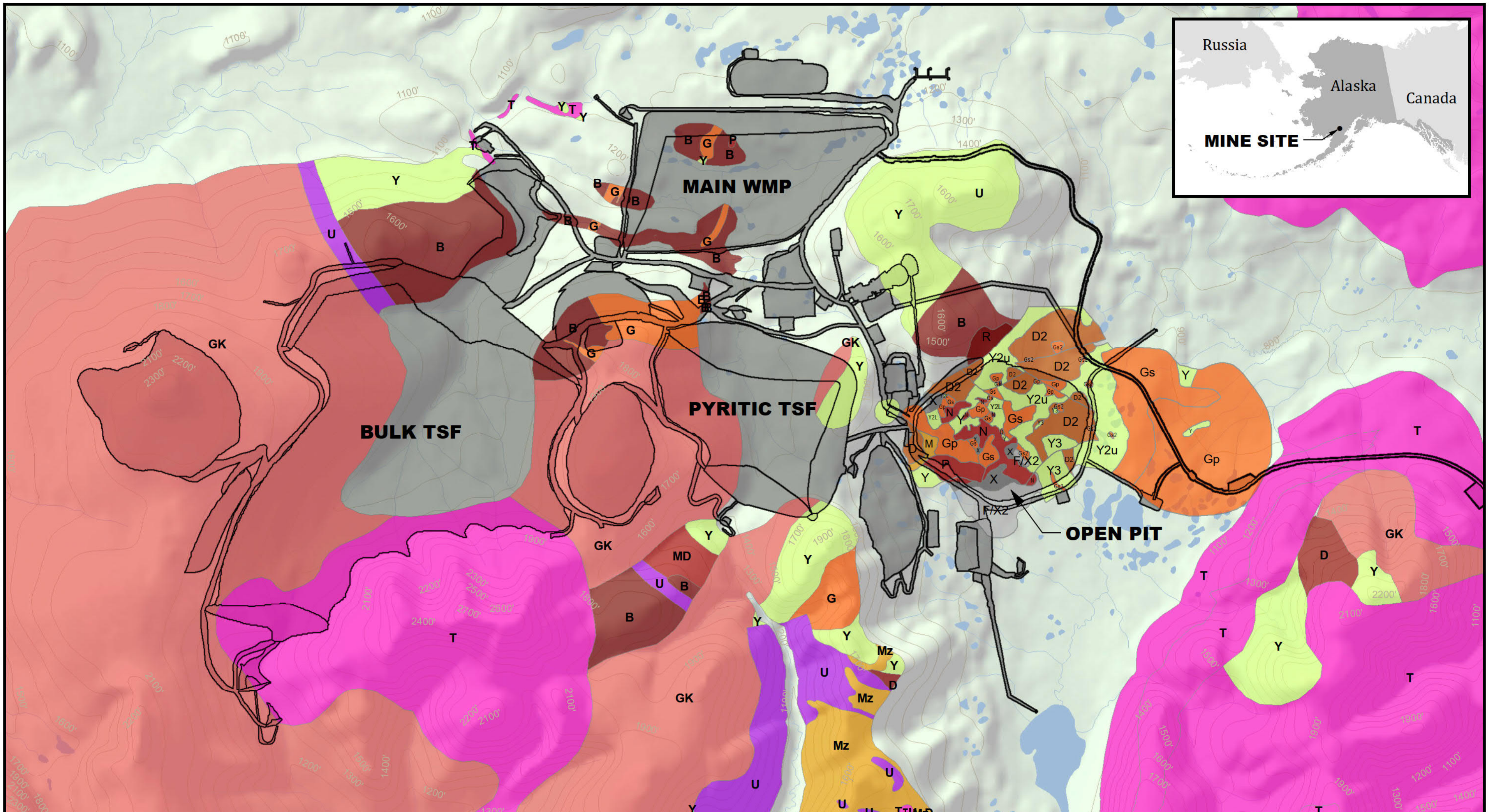
Silt, ice-rich
si

Talus rubble
tra, tri

MINE SITE SURFICIAL GEOLOGY

PEBBLE PROJECT EIS

FIGURE 3.13-2



Sources: PLP 2019-RFI153;
Knight Piesold 2011d

US Army Corps of Engineers

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Alternative 1a

Bedrock Geology

- F/X2; Fault breccia
- X; Intrusion breccia
- Y, Y2L, Y2u, Y3; Mesozoic andesitic sedimentary flysch
- C; Mesozoic conglomerate
- M, Mz; Cretaceous monzonite
- G, Gp, Gs2, Gs3, Gs; Cretaceous quartz monzodiorite, granodiorite sill
- D, D2; Diorite sill
- GK; Cretaceous granodiorite (Kaskanask batholith)
- MD, N, P; Cretaceous monzodiorite
- D; Cretaceous diorite
- B; Mesozoic basalt and gabbro
- R; Gabbro
- U; Cretaceous pyroxenite
- T; Tertiary volcanic and sedimentary rocks

MINE SITE BEDROCK GEOLOGY

PEBBLE PROJECT EIS

FIGURE 3.13-3

Table 3.13-1 presents the estimated deposit resource for copper, gold, and molybdenum; and compares the total deposit to the amount that would be mined over the 20-year lifespan of the project (PLP 2018d). The project would mine approximately 10 percent of the total estimated Pebble deposit resource.

Table 3.13-1: Estimated Pebble Deposit Resource (Measured, Indicated, and Inferred)

Resource	Total Deposit		20-Year Open Pit	
	Weight	Grade	Weight	Grade
Copper	81.5 Blb	0.34%	7.4 Blb	0.29%
Gold	107.3 MMoz	0.31 g/t	12.1 MMoz	0.27 g/t
Molybdenum	5.64 Blb	234 ppm	398 MMlb	154 ppm

Notes:
Blb: billion pounds
g/t: grams per ton
MMlb: million pounds
MMoz: million ounces
ppm: parts per million
Source: PLP 2018d

Construction Materials

Material to construct the embankments would be sourced from quarries A, B, and C, with granodiorite rock at these locations. Granodiorite is a competent (e.g., strong and resistant) rock that is suitable for use as rockfill. Construction would also use the overburden removed from the open pit area that is determined to be suitable as rockfill (Figure 3.13-3).

3.13.4.2 Transportation Corridor

Roads

Bedrock and surficial geology vary somewhat across the transportation corridor (see Chapter 2, Alternatives), but is generally composed of the same rock types and overburden present at the mine site, without the diverse magmatic intrusions that resulted in the mineralization of the Pebble deposit. Few bedrock exposures exist north of Iliamna Lake, and glacial sediments cover most of the terrain (Detterman and Reed 1973, 1980).

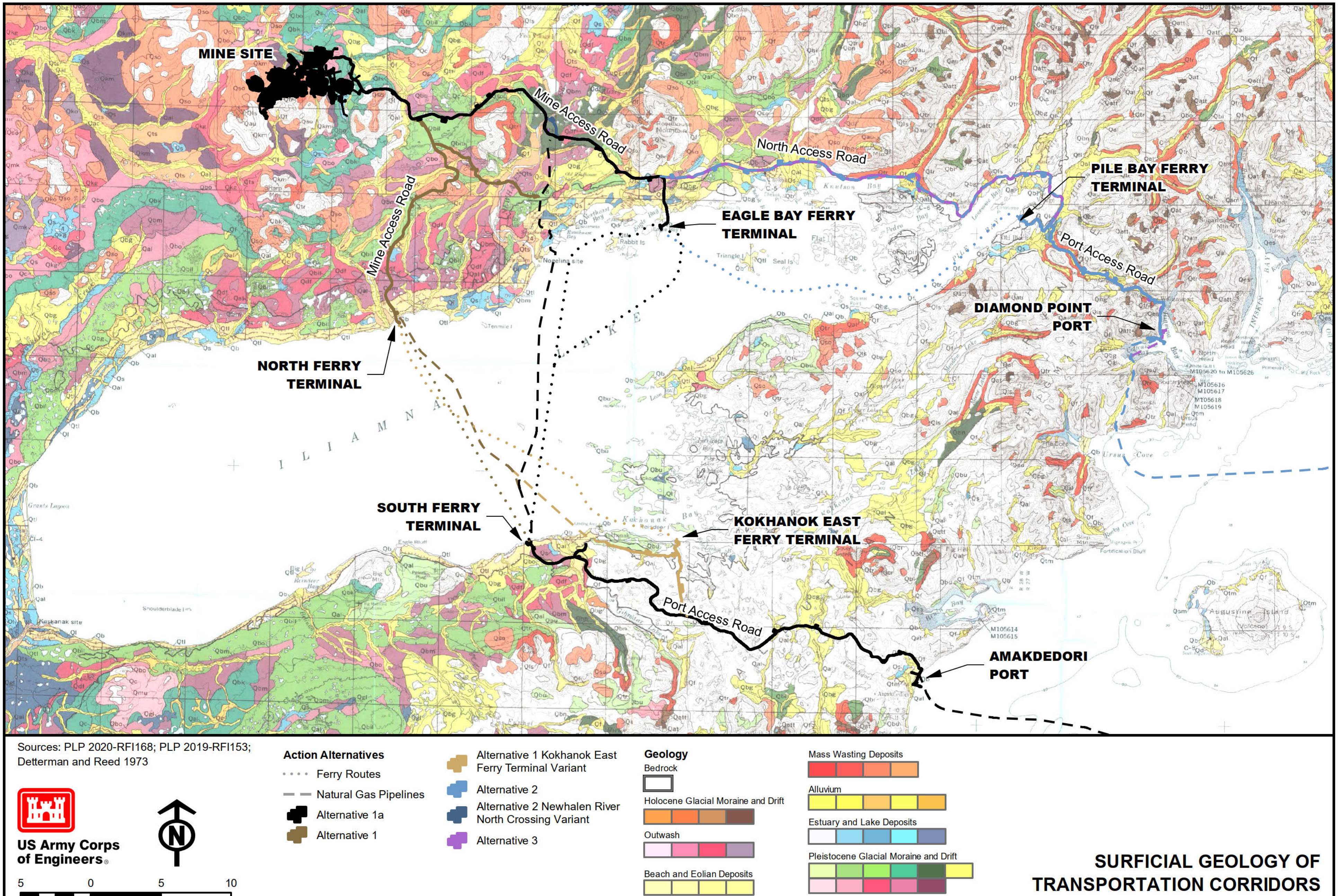
Near the Amakdedori port site, the transportation corridor would be on outcrops of Jurassic (200 to 145 million years ago) metamorphic rock and marine sedimentary rock that are locally abundant in marine invertebrate fossils (Detterman and Reed 1980; Wilson et al. 2015).

From the port to the south ferry terminal, the port access road would traverse Tertiary (Paleogene and Neogene) volcanic rocks, similar to those north of the lake; and Jurassic intrusive bedrock outcrops at higher elevations, with sparse surficial deposits (Figure 3.13-4) (Detterman and Reed 1973, 1980; Wilson et al. 2015).

Geology of the transportation corridor from the Eagle Bay ferry terminal to the mine site is composed of bedrock overlain by glacial moraine, beach deposits, solifluction, stream channels, and terrace deposits (Figure 3.13-4) (Detterman and Reed 1973).

Ferry Terminals

The Eagle Bay ferry terminal would be underlain by glacial deposits (Detterman and Reed 1973, 1980). The south ferry terminal would be underlain by Tertiary (Paleogene and Neogene) volcanic rock near the shoreline, and by Pleistocene terrace deposits farther upslope (Detterman and Reed 1973, 1980).



SURFICIAL GEOLOGY OF TRANSPORTATION CORRIDORS

Construction Material Sources

Material sites along the transportation corridor would supply earthen materials (e.g., rock, gravel) for construction and maintenance of the transportation corridor. Material sites of bedrock would likely require blasting along the mine access road west of the Newhalen River and from the south ferry terminal to Amakdedori port (Figure 3.13-5). The remaining material sites would likely be developed in surficial glacial deposits and could be excavated without blasting (Detterman and Reed 1973; Hamilton and Klieforth 2010). Appendix K2, Alternatives, provides figures depicting the material sites.

3.13.4.3 Amakdedori Port

The footprint of Amakdedori port would be on marine terrace and beach deposits consisting of sand, pebbles, and cobbles (Detterman and Reed 1973). Alluvial fan-delta deposits from Amakdedori Creek extend about 1,000 feet offshore into Kamishak Bay (PLP 2018-RFI 039). Seafloor sediment at and around the Amakdedori port site is primarily composed of subtidal gravel and beach complex, with sub-bottom sediments consisting primarily of fine silty sand, occasional coarse gravel and shell fragments, and a fines content ranging from 14 to 19 percent (GeoEngineers 2018a).

Bedrock is not exposed in the port footprint, but is exposed in the bluffs to the northeast, and consists of Jurassic igneous and metamorphic rock, and fossiliferous marine sedimentary rocks (Detterman and Reed 1973, 1980; Wilson et al. 2015).

Rock to be used in construction of the port would be supplied from material site (MS) MS-A08 (PLP 2018-RFI 035). MS-A08 is in an area of thin or absent surficial deposits underlain by bedrock (Detterman and Reed 1973).

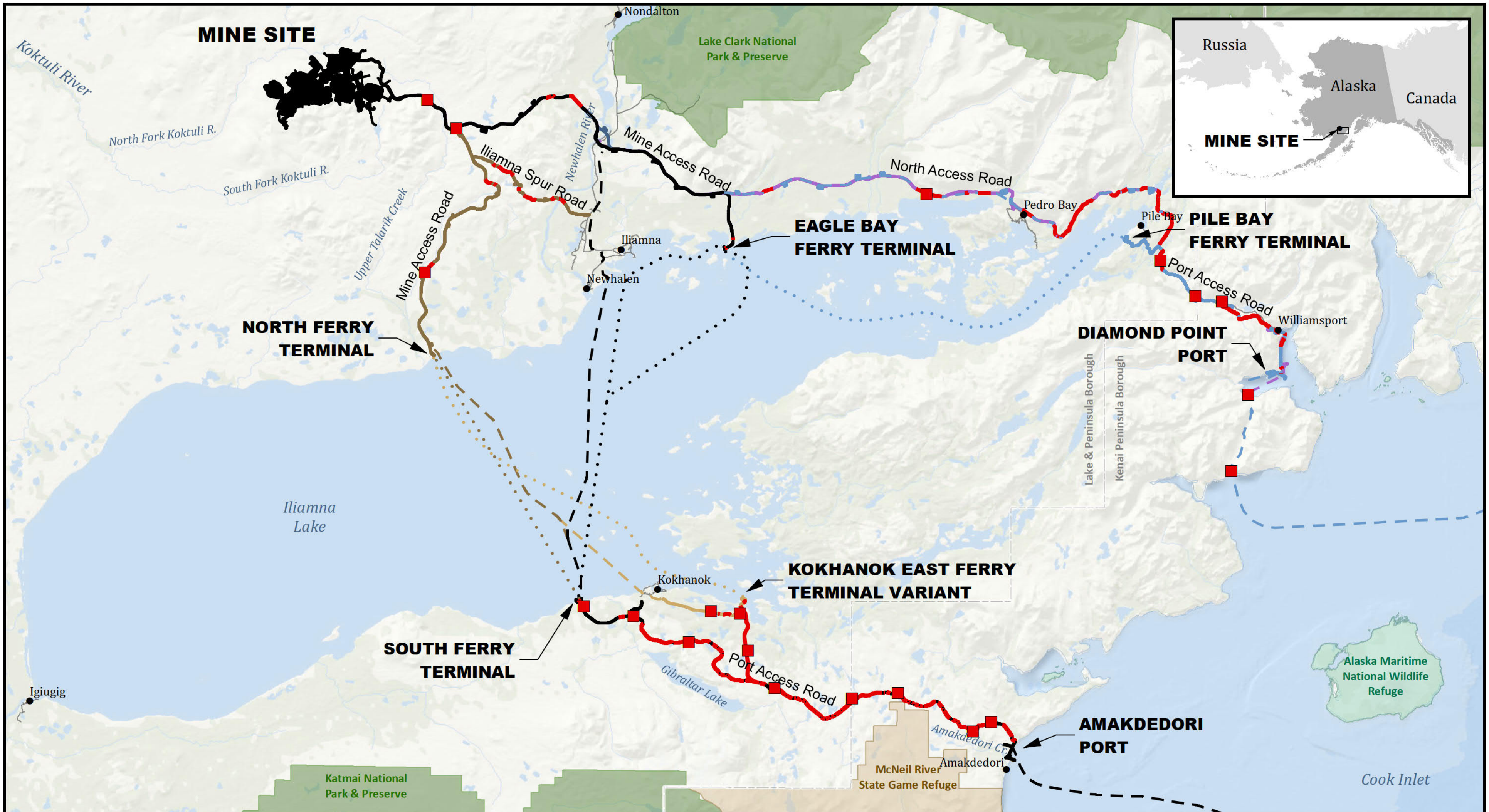
3.13.4.4 Natural Gas Pipeline Corridor

Surficial deposits along the Kenai Peninsula segment of the pipeline corridor include Quaternary glacial outwash sediments and minor alluvial deposits (Wilson et al. 2015). Bedrock on the Kenai Peninsula segment is almost entirely buried by deep glacial deposits, but limited outcrops in the lower bluffs along Cook Inlet reveal late Tertiary (Neogene) estuarine and non-marine sedimentary bedrock (Wilson et al. 2015). No material sites would be required on the Kenai Peninsula portion of the pipeline route (PLP 2018-RFI 035).

The Cook Inlet pipeline segment from the Kenai Peninsula to Amakdedori port crosses a relatively shallow sedimentary basin filled with actively migrating, sand- to boulder-sized material. Materials consist of stratified glaciofluvial, glaciomarine, and marine sediments (BOEM 2016a). The seafloor gradient is generally less than 10 degrees and contains sedimentary features such as ripples and wave forms, dunes, compound and complex bedforms, and scours. Boulder fields, lineaments, spur features, and outcropping rock were reported by IntecSea (2019) (Figure 3.13-6). Section 3.18, Water and Sediment Quality, describes the seafloor sediments and sediment distribution in the area of Cook Inlet that includes the pipeline corridors for Alternative 1a and other action alternatives. Seafloor sediment distribution is shown in Figure 3.18-9 (see Section 3.18, Water and Sediment Quality).

The geology along the natural gas pipeline corridor from Amakdedori port to the south ferry terminal is the same as described above for the transportation corridor.

The pipeline corridor crosses Iliamna Lake from the south ferry terminal west of Kokhanok to landfall just east of Newhalen on the north shore. Geology beneath Iliamna Lake is buried bedrock overlain by glacial and alluvial sediments. The substrate of the lake is described in Section 3.18, Water and Sediment Quality.



Sources: PLP 2020-RFI168; PLP 2019-RFI153; PLP 2019-RFI084a; ADNR

US Army Corps of Engineers

5 0 5 10
Miles

Bedrock Blasting Intervals
- Material Site
- Transportation Corridor

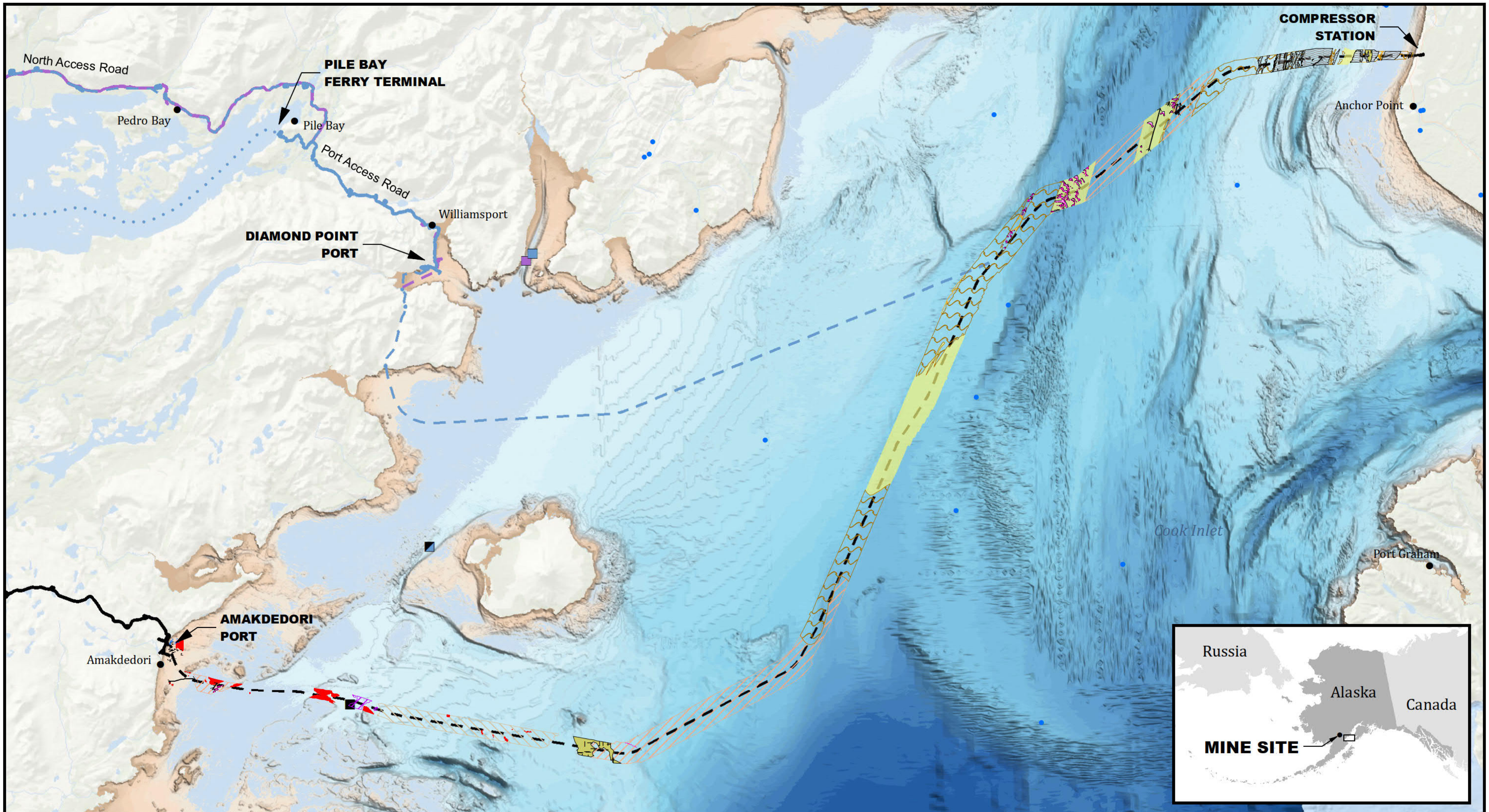
Action Alternatives
- Ferry Routes
- Natural Gas Pipelines
- Alternative 1a
- Alternative 1
- Alternative 1 Kokhanok East Ferry Terminal Variant
- Alternative 2
- Alternative 2 Newhalen River North Crossing Variant
- Alternative 3

Other Features
- Local Roads
- Borough Boundary
- National Park
- National Wildlife Refuge
- State Game Refuge/Sanctuary

BEDROCK BLASTING INTERVALS

PEBBLE PROJECT EIS

FIGURE 3.13-5



Sources: PLP 2020-RFI168; PLP 2019-RFI153; IntecSea 2019

US Army Corps of Engineers

5 0 5 10

Miles

Geologic Features
- Wells
- Lineation
- Ridge Axis
- Spur
- Dune Crest
- Potential Shallow Gas
- Area of Possible Diffuse Shallow Gas
- Boulder Field
- Ripples
- Waves
- Compound Bedforms
- Dunes
- Complex Bedforms
- Scour
- Outcropping Rock
- Outcropping Strata

Action Alternatives
- Lightering Locations
- Ferry Routes
- Natural Gas Pipelines
- Alternative 1a
- Alternative 2
- Alternative 3

SEABED GEOLOGIC FEATURES IN THE VICINITY OF THE COOK INLET PIPELINE CORRIDOR

PEBBLE PROJECT EIS

FIGURE 3.13-6

Along the pipeline-only (no associated road) segment from the north shore of Iliamna Lake to the Newhalen River crossing, buried bedrock would be mostly the same Tertiary (Paleogene and Neogene) volcanic rock present in the mine site, overlain by Quaternary deposits including glacial and alluvial deposits and sand at the pipeline landfall near Newhalen.

Geology from the Newhalen River crossing to the mine is the same as described above under transportation corridor—bedrock overlain by Quaternary sediments.

3.13.5 Alternative 1

This section describes the geology relative to Alternative 1 and variants.

3.13.5.1 Mine Site

The geology and material sites at the mine site would be the same as those for Alternative 1a.

3.13.5.2 Transportation Corridor

Roads

From Amakdedori port to the south ferry terminal, the geology would be the same as Alternative 1a. Along the mine access road from the north ferry terminal to the mine site, the buried bedrock would be mostly the same Tertiary (Paleogene and Neogene) volcanic rock present in the mine site. The entire Iliamna spur road would be underlain by Quaternary glacial deposits, with no apparent exposed bedrock (Detterman and Reed 1973, 1980).

Ferry Terminals

Geology at the south ferry terminal would be the same as Alternative 1a. The north ferry terminal would be underlain by Pleistocene glacial deposits consisting mostly of sand.

Construction Material Sources

Materials sites are generally described under Alternative 1a. For Alternative 1, blasting would be required at some material sites on the mine access road north of the north ferry terminal, along Iliamna spur road, and along the south ferry terminal to Amakdedori, as described for Alternative 1a (Figure 3.13-5).

3.13.5.3 Amakdedori Port

The geology at Amakdedori port would be the same as Alternative 1a.

3.13.5.4 Natural Gas Pipeline Corridor

The surficial and bedrock geology of the natural gas pipeline corridor from the Kenai Peninsula to Amakdedori port and the south ferry terminal would be the same as described for Alternative 1a. The geology of the pipeline corridor across Iliamna Lake would be similar to Alternative 1a. The geology of the pipeline corridor from the north ferry terminal to the mine site is the same as described for the transportation corridor.

Construction material sources for the natural gas pipeline corridor would be the same as those identified for the transportation corridor between the mine site and Amakdedori port.

3.13.5.5 Alternative 1—Summer-Only Ferry Operations Variant

The Summer-Only Ferry Operations Variant is not relevant to the geology affected environment and is therefore not addressed in this section.

3.13.5.6 Alternative 1—Kokhanok East Ferry Terminal Variant

The Kokhanok east ferry terminal would be underlain by Quaternary beach deposits near the Iliamna Lake shoreline, and by Tertiary (Paleogene and Neogene) volcanic bedrock farther upslope (Detterman and Reed 1973, 1980).

3.13.5.7 Alternative 1—Pile-Supported Dock Variant

Marine sediments at the Amakdedori port site that are relevant to the Pile-Supported Dock Variant are the same as those addressed above for the port.

3.13.6 Alternative 2—North Road and Ferry with Downstream Dams

3.13.6.1 Mine Site

The geology and material sites at the mine site would be the same as those for Alternative 1a.

3.13.6.2 Transportation Corridor

Roads

Geology of the transportation corridor between the mine site and the Eagle Bay ferry terminal would be the same as Alternative 1a.

From the Pile Bay ferry terminal to Williamsport, the transportation corridor would largely follow the existing road underlain by Jurassic igneous rock and Quaternary alluvium, talus, and rubble deposits (Detterman and Reed 1980; Wilson et al. 2015).

From Williamsport to Diamond Point port, the road would cross a slope underlain by Jurassic to Triassic (251 to 200 million years old) igneous volcanic rock, intrusive granodiorite and quartz monzonite, and slightly metamorphosed basaltic flows and sedimentary rocks (Detterman and Reed 1980; Wilson et al. 2015).

Ferry Terminals

The geology at the Eagle Bay ferry terminal would be the same as Alternative 1a. The Pile Bay ferry terminal area would be on Jurassic igneous rocks and possibly isolated glacial beach deposits (Detterman and Reed 1973, 1980).

Construction Material Sources

Material sources for construction of the transportation corridor from the mine site to the Eagle Bay ferry terminal would be supplied by material sites in mostly glacial deposits (Detterman and Reed 1973). Construction of the transportation corridor between Williamsport and Diamond Point might also use bedrock that would be removed (excavated or drilled/blasted) to support construction of the roadbed (Detterman and Reed 1980; Wilson et al. 2015).

3.13.6.3 Diamond Point Port

The geology of Diamond Point port is mapped as Jurassic igneous intrusive rocks (Detterman and Reed 1980; Wilson et al. 2015). Construction of a port facility at Diamond Point would likely require drilling and blasting.

3.13.6.4 Natural Gas Pipeline Corridor

The pipeline would originate on the Kenai Peninsula as described for Alternative 1a, cross beneath Cook Inlet, and make landfall on the shore of Ursus Cove. The corridor would then follow a possible geological bedding and/or linear structural feature that is largely overlain by glacial deposits between Ursus Cove and Cottonwood Bay. Then the corridor crosses Cottonwood Bay to Diamond Point. Cretaceous to Jurassic igneous and volcanic rocks are mapped in the bedding/ structural feature between Ursus Cove and Cottonwood Bay (Detterman and Reed 1973, 1980).

In Cook Inlet, the Alternative 2 pipeline segment would diverge from the Alternative 1a route about midway from Anchor Point to the west across the inlet; it would be routed north of Augustine Island then north to the landfall on the shore of Ursus Cove. The lease sale (Lease Sale 244) area described in BOEM (2016a) includes the area of the Alternative 2 pipeline corridor that diverges from the Alternative 1a pipeline corridor. Based on the description of geology for this area in BOEM (2016a), the seafloor sedimentary deposits are similar to those described for the Alternative 1a pipeline corridor and include fine- to medium-grained sand sculptured into bedforms. Sediment distribution is shown in Figure 3.18-9 (see Section 3.18, Water and Sediment Quality). Based on bathymetric features and geologic trends, scattered areas of outcropping rock may occur at the seafloor in the vicinity of Augustine Volcano and Ursus Cove (Figure 3.16-6).

Between Cottonwood Bay and Pile Bay, the geology of the pipeline corridor is the same as the geology of the transportation corridor. From Pile Bay to near Pedro Bay, the corridor is underlain by mostly Cretaceous to Jurassic igneous rocks (Detterman and Reed 1973, 1980).

From Pedro Bay to the western portion of Knutson Bay, the geology mostly consists of surficial glacial deposits and bedrock similar to those found near Pedro Bay. From Knutson Bay to the mine site, the geology consists of surficial glacial deposits similar to the geology of Alternative 1a from the Eagle Bay ferry terminal to the mine site (Detterman and Reed 1973, 1980).

3.13.7 Alternative 2—Summer-Only Ferry Operations Variant

The Summer-Only Ferry Operations Variant is not relevant to geology affected environment and is therefore not addressed in this section.

3.13.7.1 Alternative 2—Pile-Supported Dock Variant

Marine sediments at the Amakdedori port site that are relevant to the Pile-Supported Dock Variant are addressed above under Alternative 1, Amakdedori port.

3.13.7.2 Alternative 2—Newhalen River North Crossing Variant

The geology of the Newhalen River North Crossing Variant would be similar to the south crossing under Alternative 1a.

3.13.8 Alternative 3—North Road Only

3.13.8.1 Mine Site

The geology and construction materials would be the same as those for Alternative 1a.

3.13.8.2 Transportation Corridor

The geology of the road from the mine site to near the western portion of Knutson Bay consists of surficial glacial deposits, similar to the geology of the Alternative 2 transportation corridor to the Eagle Bay ferry terminal (Figure 3.13-4). From Knutson Bay to Pedro Bay, the geology mostly consists of surficial glacial deposits and then bedrock, including Cretaceous and Jurassic igneous rocks.

From Pedro Bay to Pile Bay, the geology consists of Cretaceous and Jurassic intrusive igneous rocks. From the Pile Bay to the Diamond Point port site, the transportation corridor would largely follow the existing road, as described under Alternative 2 (Detterman and Reed 1973, 1980).

3.13.8.3 Diamond Point Port

The geology and construction material sources for the Diamond Point port site (north of Diamond Point) would be similar to Alternative 2, except the Alternative 3 location is essentially all bedrock composed of Cretaceous and Jurassic igneous rock.

3.13.8.4 Natural Gas Pipeline Corridor

The geology and construction material sources would be similar to those for Alternative 2. The pipeline landfall under Alternative 3 would be north of Diamond Point.

3.13.8.5 Alternative 3—Concentrate Pipeline Variant

The concentrate pipeline corridor from the mine site to the port would follow the same alignment as for Alternative 3; therefore, the geology would be the same.