/* ------------------------ CODESET ------------------------ */

Title: Geologic Map of the Eastern Half of the McGrath Quadrangle, Alaska
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I. UNCONSOLIDATED DEPOSITS

ALLUVIAL DEPOSITS

Qa: Stream alluvium, undifferentiated-Fluvial silt, sand, and gravel deposited by streams in Holocene floodplains, fans, and meandering to distributary stream channel deposits. Grain size, sorting, and degree of stratification vary according to stream size, bedrock source, gradient, and flow regime. Clasts of local and distal derivation indicate a mixture of local bedrock and glacial provenance.

Qaf: Alluvial-fan deposits-Poorly to moderately well sorted, gray to tan (oxidized), fluvial silt, sand, and gravel deposited where first- and second-order tributaries join third- and fourth-order streams. Unit appears as deltaic fans in the Alaska Range, and as extensive Piedmont aprons that flank foothills north of the Denali- Farewell fault zone, northwest of St. John's Hill.

Qat: Terrace alluvium-Moderately to well sorted, well stratified, gray to tan (oxidized), fluvial silt, sand, and gravel of varying ages deposited on former floodplains that now lie above or beyond the normal depositional regime of Holocene streams. Unit is generally preserved in larger third- and fourth-order stream valleys, covered by pioneer to climax vegetation, dissected by Holocene streams, and blanketed with eolian silt and sand.

COLLUVIAL DEPOSITS

Qca: Colluvial-alluvial deposits-Mixed or alternating, poorly to moderately sorted, silt, sand, gravel and diamicton of colluvial and alluvial origins. In study area unit appears in the Alaska Range and northeastern foothills within steep gullies, and at the intersection of first-order tributary and second- or higher-order streams.

Qct: Talus-Angular, unsorted debris derived from frost riving of bedrock followed by rapid gravity transport on steep slopes, cirque headwalls, steep gullies, and avalanche chutes. Unit forms most commonly as cones or aprons that lie at, or near, the angle of repose along valley walls; distal, upvalley ends may grade into rock glacier deposits.

Qcl: Landslide deposits-Chaotically deformed colluvium derived from relatively sudden mass movement of bedrock or surficial deposits along a plane of failure. Surface of deposit is characteristically hummocky and commonly lies below a well-defined failure scarp.

EOLIAN AND RELATED DEPOSITS

Qsp: Silt and peat-Poorly stratified, black to brown, organic rich, alluvial, eluvial, lacustrine, and bog silt and peat. Unit Qsp formed in extensive wetlands overlying outwash fan deposits (Qof) on the Piedmont plain in north-central portion of study area.

Qe: Eolian deposits-Well-sorted sand and silt transported and deposited by wind. Appears near cliff heads and bluffs where unit is up to 60 ft (18 m) thick.

GLACIAL AND RELATED DEPOSITS

Qg: Active glaciers-Occupy cirques having base levels above 4,800 to 6,100 ft (1,500 to 1,900 m) elevation; most glaciers exhibit a strong northerly aspect. Glaciers range in size from 0.4 to 5 square miles (1 km2 to about 12 km2); the largest are nested in Middle Fork and Windy Fork intrusive massifs.

Qrg: Rock glaciers and rock glacier deposits-Unsorted, angular, frost-shattered cobbles and boulders, commonly containing considerable interstitial ice (up to 55 percent in active rock glaciers). Unit generally originates at 3,500 to 5,000 ft (1,100 to 1,500 m) elevation in north-facing cirques or on steepened slopes of blocky-weathered, resistant bedrock; may transcend into true glaciers or talus.

Qof: Outwash fan deposits-Glaciofluvial sand and silt derived from streams originating near ancestral glacial margins. Anastomosing channel scars appear on many outwash-fan surfaces; the most prominent have become reactivated as modern alluvial deposits (Qa).

Qdo: Outwash-Stratified drift consisting of coarse subrounded gravel that contains sand and silt lenses deposited by sideglacial and proglacial meltwater streams. Anastomosing channel scars appear on many outwash surfaces that have otherwise little or no surface relief.

Qdot: Outwash terrace-Remnant of former outwash fan or plain deposit (Qof) that has been dissected by Wisconsin to Holocene streams (Qa). Terrace believed to be Early to middle Pleistocene in age, and may not be suitable for construction (sand and gravel) due to in situ weathering of clasts. Thickness unknown.

Qdic: Ice-contact deposits-Stratified gravel, sand, and flowtill deposited on, against, or under stagnant masses of glacial ice by meltwater streams. Individual layers within the deposit are extremely variable in lateral extent, degree of sorting, and thickness.

Qdt: Till, undifferentiated-Unsorted to poorly sorted clay, silt, sand, and gravel deposited by glacial ice. Cobble and boulder clasts are commonly polyhedrally faceted, striated, and subangular to rounded.

Qdtf: Till of Farewell glaciations-Unsorted to poorly sorted clay, silt, gravel, and boulders deposited by glacial ice as ground, terminal, and lateral moraines. Unit Qdtf mainly comprises till of Farewell I and Farewell II glaciations (Femald, 1960) which are regarded as early and late Wisconsin in age, respectively (Kline and Bundtzen, 1986).

Qdts: Till of Selatna glaciation-Unsorted to poorly sorted clay, silt and gravel deposited by glacial ice in ground moraines. Unit is characterized by highly modified moraine along the South Fork and Windy Fork of the Kuskokwim River (Femald, 1960).

Qdtlm: Till of Lone Mountain glaciation-Isolated patches of unsorted to poorly sorted silt, gravel, and highly eroded erratics deposited by glacial ice. Named for till exposed along ridgelines of Lone Mountain west of study area (Kline and Bundtzen, 1986).

Qdtplm: Till of Pre-Lone Mountain glaciation-Isolated patches of unconsolidated to weakly cemented, diamicton largely recemented by calcite-forming tillite. Forms elongate, isolated patches of highly modified till up to 13 miles (20 km) beyond the known limits of Lone Mountain glaciation.

II. SEDIMENTARY AND VOLCANIC ROCKS

QTg: Consolidated till and outwash-Weakly to well cemented diamicton, interbedded with crudely stratified outwash, which contains local and exotic lithologies. Faceted cobbles and striations on some cobbles and boulders suggest glacial transport for some of unit.

Tcf: Felsite conglomerate-Thick-bedded, poorly indurated, orange-weathered, light brown granule, cobble conglomerate that contains up to 50 percent clasts of felsic igneous rocks. Unit is crossbedded in a few places and dips slightly to moderately northwest where exposed.

Tcg: Coal-bearing sandstone, shale, and conglomerate-Thin- to thick-bedded, poorly to moderately indurated, buff-weathered, gray-brown, granule, cobble conglomerate, minor sandstone, and interbedded dark gray carbonaceous shale and coal.

Ts: Sandstone and shale-Thin- to thick-bedded, moderately indurated, red-brown weathered, buff, medium- grained, lithoquartzose sandstone interbedded with poorly indurated, laminated, fissile, carbonaceous shale and fine sandstone.

Tcl: Limestone conglomerate-Thick- to thin-bedded, moderately indurated, green-gray granule conglomerate exposed in fault sliver near Khuchaynik Creek. Unit contains up to 80 percent limestone clasts; the remainder composed of basalt and lithic fragments.

SHEEP CREEK, WINDY FORK, AND TERRA COTTA VOLCANIC FIELDS Tvs: Volcaniclastic sandstone and lacustrine silt-Brown to gray, medium- to fine-grained volcaniclastic sandstone that has a distinctive 50 ft (15 m) thick section of flora-rich paleosols and finely laminated, varved shales of probable lacustrine origin.

Tvt: Intermediate to felsic air-fall tuff-Composite unit of light- to medium-green-gray, well laminated medium to very coarse grained, crystal-rich, air-fall tuff. Sheep Creek volcanic field includes at least four 50 to 80 ft (15 to 25 m) thick air-fall sequences consisting of a 10 ft (3 m) thick basal layer of angular, boulder-to-cobble-sized ejecta fining upward to well laminated, pebble- to sand-sized tuff.

Tva: Andesite flows and lapilli tuff-Dark-gray to green-gray andesite flows and locally banded (red, green, purple, bleached) lapilli tuff. Groundmass of flows is aphanitic to fine-grained intersertal and consists of andesine accompanied by abundant hornblende, clinopyroxene, opaque minerals, and rare quartz.

Tvd: Massive dacite-Light- to medium-gray, porphyro-aphanitic, hornblende-bearing massive dacite of

Terra Cotta volcanic field. Does not contain breccias and sedimentary rock fragments typical of underlying (Tvld and Tvvd) units.

Tvld: Lapilli dacite-Light gray to bleached white with yellowish staining, locally banded (purple, white), lapilli dacite and tuff. Lapilli fragments are commonly chloritized.

Tvvd: Vent facies dacite-Very distinctive, light gray, distinctly tan weathering, hornblende and K-spar-rich, propylitically altered dacite containing very abundant angular clasts of sedimentary rocks (mainly Kahiltna terrane flysch) that comprise up to 30 percent of groundmass.

Tvab: Andesite breccia-Medium-gray, purple-hued weathering, porphyritic, pyroxene andesite containing distinctive zones of pyroclastic breccia consisting of in situ andesite fragments averaging 2 inches (5 cm) in diameter; exclusively mapped in Terra Cotta volcanic field. Some agglomerate interbedded in andesite breccia flows.

Tvlr: Lapilli rhyodacite-Light- to medium-gray, porphyro-aphanitic, K-spar-rich rhyodacite flows containing conspicuous layers of purple, green, and red lapilli tuff beds 5 to 15 ft (1.5 to 4.5 m) thick. Lapilli tuff is composed of chlorite-rich fragments 4 to 45 mm long of no preferred shape: matrix is mainly silt-sized K-spar and quartz.

Tvgt: Green tuff-Distinctly mid- to dark-green, fine to medium grained, ash flow(?) tuff containing very minor blocks of darker green, altered agglomerate composed of rounded clasts to 4 inches (10 cm) in diameter. Unit forms a useful marker bed in Terra Cotta volcanic field that can be traced throughout the lower portion of the volcanic succession stratigraphically above the basal andesite breccia flows for at least 2.5 miles (4 km) of strike.

Tvl: Lahar deposits-Medium- to dark-green-gray, very coarse grained lahar deposit. Unit consists of chaotic mixtures of volcanic-derived mud, andesite flow fragments, epiclastic breccia, and blocks of the Kahiltna terrane flysch.

Tvf: Felsic tuff and flows-Bleached to light-gray, locally banded, hypocrystalline rhyolite tuff and flows; consists of sericitic alkali feldspar and resorbed, fine-grained quartz phenoctysts in an aphanitic quartzofeldspathic groundmass. Devitrification sperulites common.

Tvm: Basalt and basaltic andesite-Dark gray to maroon, locally porphyritic, olivine bearing, augite basalt and basaltic andesite flows. Groundmass frequently altered to chlorite, epidote, and secondary opaque minerals. Columnar jointing readily expressed in outcrops.

VELESKA LAKE VOLCANIC FIELD

TKvd: Dacite flows and dikes-Light- to medium-gray, aphanitic to porphyro-aphanitic, chloritized hornblende dacite flows; flow banding uncommon. Located west of Veleska Lake, and intruded by numerous hornblende granodiorite dikes of similar appearance and hence lumped with TKvd.

TKvf: Rhyolite tuff-White- to light-gray, locally banded, hypocrystalline rhyolite; typically consists of sericitic alkali feldspar and resorbed fine-grained phenocrysts, and angular glassy shards. Occurs near the top of unit TKvd.

TKvm: Basaltic andesite-Medium-gray-green, fine-grained, augite-rich basaltic andesite and minor andesite flow breccia mapped near the base of Veleska Lake volcanic field near Veleska Lake. Similar to both Tvm and Tva of younger volcanic fields, except always more ubiquitously altered.

TKvt: Air-tuff of intermediate composition-Light- to medium-green-gray, well laminated, crystal tuff consisting of 3 to 14 ft (1 to 4 m) thick beds; deposits contain pebble- to sand-sized clasts.

KAHILTNA TERRANE

KJsh: Sandstone and shale-Medium- to very dark-gray, fine-grained, lithic sandstone, siltstone, and shale; comprises about 75 percent of the Kahiltna terrane. From a distance, color of unit is almost black-earning it the colloquial term “Black Crap” clastics.

KJs: Coarse sandstone and minor siltstone-Medium-gray to distinctly tan-weathered, lithic sandstone containing clasts of volcanic rocks (25 percent), sandstone and shale (25 percent), granitic(?) rocks (15 percent), quartz (20 percent), and lime-rich sediments (15 percent). Flute casts and ripple marks are common, and sand intervals contain cyclic graded Bouma Tabc intervals (after Mutti and Ricci Lucchi, 1972) up to 6.5 ft (2 m) thick.

KJc: Pebble to boulder conglomerate and minor sandstone-Light-gray, tan weathered, pebble to boulder conglomerate. Pebbles are sub-angular to rounded clasts of granite and quartz diorite (30 percent), in situ lithic sandstone and shale (25 percent), quartz (20 percent), and mixed volcanic-lithics (25 percent).

MCKINLEY TERRANE

KJm: Slate and metasiltstone-Very thin-bedded, fissile, rusty-brown-weathered, black slate, metasiltstone, micaceous metasandstone, and rare silty limestone turbidite. Minor quartz-carbonate veinlets parallel cleavage.

PINGSTON TERRANES

Trls: Limestone and shale-Thin-bedded, medium gray quartzitic limestone; gray, silty limestone, and shale. Basal beds are predominantly fine-grained, gray sandstone and siltstone and subordinate cherty limestone that contains black chert clasts.

YUKON-TANANA TERRANES

uPzs: Volcanogenic phyllite-Dark gray-green to distinctly maroon, pyrite-rich volcanogenic phyllite cut by thin quartz-carbonate veins. Stratigraphic relationships imply that uPzs overlies uPzc; however, no age control is available.

uPzc: Phyllitic chert and siliceous phyllite-White-weathered, gray-green, banded phyllitic ribbon chert. Pennsylvanian through Permian radiolaria identified at one locality in map area (Kline and others, 1986).

FAREWELL COMPOSITE TERRANE

MYSTIC SUBTERRANE

Tatina River Volcanics

lJs: Phosphatic shale and green volcaniclastic sandstone-Medium- to very-dark-gray, distinctly bleached bluish-white, phosphatic shale (25 percent); green, medium grained, concretion-rich, volcaniclastic sandstone (60 percent); and minor tan chert-cobble pebble conglomerate (15 percent).

Trab: Pillow basalt and gabbro-Dark green-gray, massive, aphanitic to medium-grained, olivine-clinopyroxene rich, pillow basalt, olivine diabase and gabbro sills, and mafic agglomerate. Composition of mafic sills ranges from picrite to diabase, but all are titanium rich and tholeiitic.

Trs: Shale, coarse volcaniclastic sandstone and chert-Tan to greenish-gray, buff to orange weathered, pebble rich, immature conglomerate, coarse volcaniclastic sandstone, distinctly brown silty shale, and light gray, green, and black chert. Interbedded with pillow basalt and gabbro (Trab) described above.

Sheep Creek Formation

PDs: Sublithic sandstone, limestone-chert conglomerate and minor limestone-Medium-gray, distinctly brown-red weathered, medium- to coarse-grained, sublithic sandstone and pebble conglomerate that contains clasts of limestone (40 percent), chert (20 percent), lithic fragments (15 percent), volcanic clasts (5 percent), and polycrystalline quartz (20 percent). Clastic units lack detrital white mica and calcite cement that is abundant in Dillinger subterrane lithologies, but instead contains plant fossils, which are absent in the latter.

lDl: Massive algal limestone-Massive, thick-bedded, medium-gray limestone, rich in algal laminations and Amphipora sp. Varies greatly in thickness along strike from 33 to 660 ft (10 to 200 m) reflecting rapid thinning and thickening of a shallow water, lagoonal carbonate facies.

lDd: Dolomite-Light gray, dolomitized, algal(?) limestone similar in appearance to lD1; unit exhibits complete dolomitization. No age control available, but thought to be correlative with lD1 unit. Very resistant due to dolomitization.

St. Johns Hill Formation

uD1: Massive micritic limestone-Medium-gray, massive- to thick-bedded, micritic limestone that contains crypto-algal laminations, thin, black chert partings, and dolomitic nodules. Unit contains an abundant and diverse fauna of rugose corals, brachiopods, and pelecypods on St. Johns Hill and in the Farewell Mountain area, which indicate a Frasnian (early Late Devonian) age (Bundtzen and others, 1982).

Dls: Limestone and minor siltstone-Brown to terra cotta, micaceous, slightly pyritic, thinly laminated mudstone, siltstone, limestone, and medium-grained lithic sandstone that underlies uD1 on St. Johns Hill in McGrath B-2 Quadrangle. Locally contains thin black chert partings.

DILLINGER TERRANE

Barren Ridge Limestone

DSl: Calcarenite, calcareous siltstone, and laminated limestone-Thin- to thick-bedded, buff to orange-weathered, light- to medium-gray, phyllitic calcarenite, thin-bedded orange to buff siltstone, and light gray silty limestone all in approximately equal amounts. Basal portion of unit is more limestone rich.

Terra Cotta Mountains Sandstone

uSsl: Thin-bedded calcareous sandstone, graptolitic shale, and silty limestone-Thin-bedded, gray to tan, micaceous sandstone, silty limestone, and dark gray graptolitic shale. Clast compositions indicate feldspathic litharenite (Folk, 1968), containing up to 6 percent white mica.

mSvs: Phyllite, volcaniclastic sandstone, and chert-Thin-bedded, complexly folded, maroon to green phyllite, medium-green, medium-grained volcaniclastic sandstone, and green-gray chert. Appears to be stratigraphically above mS1 unit, and under uSs1 unit on Tunis Mountain near Veleska Lake.

mSl: Argillaceous graptolitic limestone-Medium- to dark-gray and brown weathered limestone containing graptolite-bearing silty sandstone intervals. Unit forms distinctive wall-like outcrops throughout map area, and is interbedded with the larger mSs clastic unit.

mSs: Feldspathic-lithic sandstone, limey siltstone, and argillite-Medium olive gray to terra cotta, medium- to coarse-grained, thin-bedded to massive, calcareous lithic sandstone, and siltstone containing local gray shale intervals and minor pebble conglomerate beds. Major components are polycrystalline quartz (25 percent), chert (20 percent), detrital carbonate (15 percent), matrix (15 to 20 percent), altered feldspar (10 percent), and white mica and opaques (10 percent).

Post River Formation

lSl: Boundary Limestone-Thin, dark gray, fetid, laminated limestone with thin (3 cm thick) silty sand layers, and thin interbeds of black cherty argillite.

SOsh: Graptolitic shale, siltstone, and chert-Medium- to dark-gray, fetid, fissile, isoclinally folded, carbonaceous shale, siltstone, and black bioturbated, siliceous siltstone and chert. Very thin Bouma Tcde intervals (after Mutti and Ricci Lucchi, 1972) up to 10 cm thick occur locally but only make up a few percent of the unit.

Lyman Hills Formation

OCls: Silty limestone and shale-Rhythmically layered, thin-bedded, orange to buff, light gray when fresh, limestone, silty shale, and light olive shale. Individual lime units range from 5 to 25 cm thick, and exhibit parallel and cross laminations.

MINCHUMINA SUBTERRANE

PzpCs: Metaquartzite and calcareous phyllite-Light- to medium-gray, fine- to coarse-grained, metaquartzite, quartz-feldspar “grit”, calcareous phyllite, and minor metachert exposed in extreme northeast comer of map area. Presence of quartz+albite+chlorite mineral assemblage in phyllite

indicates PzpCs experienced lower greenschist metamorphic conditions.

III. INTRUSIVE ROCKS AND HORNFELS

TERTIARY INTRUSIVE ROCKS AND HORNFELS

Tia: Andesite-trachyandesite sills and dikes-Green-gray, fine-grained, hypidiomorphic-granular, porphyritic andesite dikes less than 65 ft (~20 m) thick; local variety-granodiorite. Consists of variable amounts of hornblende, alkali feldspar, biotite, and clinopyroxene.

Tif: Felsic sills and dikes-Felsic dikes and sills up to 16 ft (5 m) thick cut layered rocks in Bowser Creek and Sheep Creek areas. Generally light pinkish tan to white; aphanitic- to fine-grained; rarely medium-grained.

Tim: Mafic sills and dikes-Mafic sills and dikes up to 34 ft (10 m) thick cut stratigraphy throughout map area. Consist of dark brown, pandiomorphic-granular, locally porphyritic basalt, gabbro and diabase.

Tid: Undifferentiated sills and dikes-Undifferentiated sills and dikes composed of dikes ranging from mafic to felsic compositions. Usually distinguished by extensive alteration and multiple compositions of dikes.

Tids: Dike swarm and hornfels-Large linear zones of multiple dikes of variable composition and size that create extensive hornfels aureole and includes fragments of layered country rocks. Includes compositions of dikes described above (Tid, Tim, Tia, Tif).

Twg: Windy Fork Granite-White to pink and locally blue-gray, medium- to coarse-grained, peralkaline arfvedsonite granite of Windy Fork pluton. Composed of perthite, quartz, and arfvedsonite, and lesser riebeckite, plagioclase, and red-brown biotite. Accessory minerals include zircon, fluorite, apatite, monazite, uranothorite, and eudialyte (Gunter and others, 1993).

Tgd: Hartman Pluton Granodiorite-Medium- to coarse-grained, equigranular, hornblende-biotite granodiorite; CI=35 and plagioclase has An 60 composition. A strong hornfels aureole up to 1.25 mile (2 km) wide rings the intrusion.

Tqm: Quartz monzonite, monzonite breccia, and quartz porphyry-Composite unit of mainly light gray, fine- to medium-grained hypidiomorphic to equigranular, biotite quartz monzonite, aegirine-rich monzonite, and altered biotite quartz porphyry.

Tgr: South Fork Granite-Light gray, pink, medium- to coarse-grained, equigranular, biotite (muscovite) granite that forms small 1.2 square mile (3 km2) body on west side of South Fork flanking Terra Cotta volcanic field.

Thf: Hornfels and Skarn-Brown to gray, massive to locally porphyroblastic, garnet-chlorite-biotite hornfels derived from carbonate and clastic rocks. Locally develops into polymetallic skarns containing introduction of garnet, wollastonite, epidote, grossularite, and johannsenite.

Middle Fork Plutonic Complex

Tgqm: Granite, quartz monzonite, and monzodiorite-Fine- to medium-grained, biotite- and hornblende- bearing plutonic rocks with variable quartz contents and feldspar ratios: predominantly quartz monzonite and monzodiorite.

Tgb: Alkali gabbro-Dark green-brown, fine- to medium-grained, biotite-olivine-pyroxene gabbro. Composed of andesine, clinopyroxene, biotite, olivine, and green to brown hornblende after pyroxene. Minor constituents include opaque minerals, alkali feldspar, orthopyroxene, and accessory apatite.

Tgsy: Granite to quartz syenite-Fine- to coarse-grained, granite to quartz syenite. Contains hornblende, clinopyroxene, and biotite, and minor opaque minerals, apatite, and zircon; arfvedsonite and riebeckite present locally.

Tsy: Syenite-Green-gray, white-gray weathering, medium- to coarse-grained, olivine-clinopyroxene syenite; locally iron stained. Composed of perthitic alkali feldspar, green-brown hornblende after pyroxene, clinopyroxene, plagioclase, olivine and magnetite alteration rims, and interstitial quartz.

LATE CRETACEOUS INTRUSIVE ROCKS AND HORNFELS

TKqm: Mount Estelle granodiorite-Fresh, medium-gray, medium-grained, equigranular, hornblendebiotite granodiorite and locally contains plagioclase(?) phenocrysts to 5 mm long.

TKm: Gabbro-granodiorite-Heterogeneous dike swarms consisting of augite gabbro, hornblende granodiorite, and monzodiorite. Euhedral hornblende and piokilitic biotite phenocrysts are unusually fresh; unit is not hydrothermally altered like younger Tim dikes in map area.

TKhf: Hornfels and skarn-Brown to gray, massive to locally porphyroblastic, garnet-chlorite-biotite hornfels derived from carbonate and clastic rocks. Locally develops into polymetallic skarns with introduction of garnet, wollastonite, epidote, grossularite, and johannsenite.

PRE-CRETACEOUS INTRUSIVE ROCKS

KJg: Gabbro and diorite-Buff-weathered, dark green-gray gabbro and diorite that intrude both Upper Paleozoic cherts and volcaniclastic rocks (uPzs) of the Yukon-Tanana terrane and Triassic limestone (Trls) of the Pingston terrane.

Trum: Ultramafic to diorite sills-Dark green-gray, fine- to coarse-grained, ultramafic (picrite and ankaramite) sills, olivine gabbro, and diorite usually 50 to 66 ft (15 to 20 m) thick but some thinner intrusions also observed. Sills in Sheep Creek area differentiated into mafic or ultramafic bases and dioritic tops.

MzPzi: Gabbro and diorite sills and dikes-Brownish weathered, dark green-gray, very fine- to medium-grained phaneritic, locally micropegmatoidal, olivine, aegirine-augite, gabbro, diorite, and uncommonly alkali syenite. Quartz rare or absent.

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DESCRIPTION OF MATERIALS UNITS

I. Unconsolidated Deposits

SGS Fluvial and glaciofluvial silt, sand, and gravel. Chiefly (estimated >80 percent) clean sand and gravel. Grain size, sorting and degree of stratification are variable. Permafrost may be present, especially in older deposits. Older deposits may contain highly weathered clasts and thus may not be suitable as construction materials. Rare oversized materials. Includes primarily GP and GW of the Unified Soil Classification (Wagner, 1957).

SGM Poorly- to moderately well-sorted clay, silt, sand, gravel, and diamicton of colluvial and alluvial origins. Includes angular, unsorted talus debris, chaotically deformed colluvium derived from landslides, and unsorted, angular, frost-shattered cobbles and boulders of rock glaciers. Engineering applications vary widely due to large range of grain size and sorting properties. Commonly frozen. Estimated 20-80 percent coarse, granular deposits with considerable oversized material. Includes primarily GC and GM of the Unified Soil Classification (Wagner, 1957).

SSM Well-sorted sand and silt deposited by wind. Sand deposits mostly thawed and dry. Silt mostly frozen and ice-rich. Chiefly fine materials. Estimated >80 percent sand and silt. Includes primarily ML, MH, SM, SP, and SW of the Unified Soil Classification (Wagner, 1957).

SOR Poorly stratified organic-rich silt and peat. Mostly frozen. Might be suitable for horticultural or energy applications. Chiefly organic materials. Estimated >50 percent peat, organic sand, or organic silt. Includes Pt of the Unified Soil Classification (Wagner, 1957).

II. Bedrock Deposits

Clastic Sedimentary Rocks

BSC Pebble to boulder conglomerate. Pebbles are subangular to rounded. Total thickness is highly variable up to 350 m thick, with some individual massive conglomerate layers measuring 25 m thick. Resistant and forms large, 1-m-long, blocky rubble.

BSM Medium- to coarse-grained, massive to locally thin-bedded, calcareous lithic sandstone with lesser amounts of interbedded siltstone, shale, pebble conglomerate, and minor limestone. Up to 400 m thick. Generally resistant, especially the thick sandstone layers that form blocky rubble.

BSU Poorly to moderately indurated, thin- to thick-bedded, granule to pebble and cobble conglomerate, minor sandstone, and interbedded carbonaceous shale and coal. Conglomerate clasts are poorly- to moderately well-sorted, subangular to rounded pebbles and cobbles. Matrix ranges in size from silt and clay to granules. Unit includes weakly to well-cemented diamicton interbedded with crudely stratified sand, silt, and gravel. Up to 300 m thick. Some unconsolidated conglomerate beds might be excellent sources of sand and gravel.

Carbonate Sedimentary Rocks

BCC Massive- to thick-bedded limestone and dolomitized limestone with minor silty sandstone

intervals and thin black chert partings. Ranges from 10 m to 50 m thick. Very resistant and cliff-forming, and may form large blocks.

BCQ Thin-bedded quartzitic limestone, silty limestone, and shale. Up to 100 m thick. Moderately resistant where quartz-rich lime beds exceed 50 percent of unit.

Plutonic Igneous Rocks

BPF Fine- to coarse-grained felsic plutonic rocks, including granite, granodiorite, monzonite, quartz monzonite, monzodiorite, quartz porphyry, and syenite. Very resistant and forms jointed cliffs, tors, high uplands, and rugged terrain. Typically weathers in large blocks.

BPG Fine- to coarse-grained plutonic rocks of varied composition, including gabbro, granite, and quartz syenite. Typically weathers to grus and forms rounded outcrops.

BPM Medium- to coarse-grained plutonic rocks of varied composition, including granite, diorite, and gabbro. Moderately resistant. Forms subdued rubble.

Volcanic Igneous Rocks

BVF Flows and tuffs of andesitic and rhyolitic composition. Andesite flows may exhibit columnar jointing. Up to 150 m thick. Moderately resistant and forms large, locally elongated blocks to 1 m in diameter.

BVI Massive dacite and lesser andesite flows with zones of pyroclastic breccia. May contain abundant angular clasts of sedimentary rocks. Up to 400 m thick. Resistant and forms large, angular blocks up to 3 m in diameter.

BVM Basalt and basaltic andesite flows and minor andesite flow breccia. Groundmass typically altered. May be columnar jointed. Moderately resistant where not brecciated.

BVP Massive, fine- to medium-grained pillow basalt, diabase and gabbro sills, and mafic agglomerate. Rocks are extensively chloritized. Ranges from 150 m to 200 m thick. Very resistant where fresh, but nonresistant where altered.

BVT Lapilli tuff, dacite, and rhyodacite flows with lapilli tuff beds 1 m to 4m thick. Moderately resistant and may form flaggy rubble.

Dike/Sill Rocks

BDA Fine- to coarse-grained ultramafic (picrite) sills, gabbro, and diorite up to 20 m thick. Magnetite is locally extremely abundant (up to 40 percent). Relatively resistant where fresh, but nonresistant where hydrothermally altered.

BDM Sills and dikes of variable composition. Up to 10 m thick. Generally resistant.

BDR Very fine- to medium-grained gabbro, diorite, alkali syenite, and andesite dikes up to 20 m thick. Groundmass commonly altered. Resistant and forms ribs and blocky rubble.

BDS Heterogeneous dike swarms and hornfels of variable composition. Generally resistant.

Metamorphic Rocks

BMH Massive fine- to coarse-grained hornfels and local highly altered carbonate rocks (skarns). Generally resistant and forms equant blocks.

BMQ Fine- to coarse-grained metaquartzite, quartz-feldspar grit, calcareous phyllite, and minor metachert. Quartz-rich grits locally resistant and produce blocky rubble up to 50 cm in diameter.

Other Rocks

BOU Rocks of variable lithology and character that are generally unsuited for use as construction materials.

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