EXPLANATION OF MAP UNITS: BEDROCK-GEOLOGIC MAP, ALASKA HIGHWAY CORRIDOR, LITTLE GERSTLE RIVER TO DOT LAKE, ALASKA

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EXPLANATION OF MAP UNITS:
BEDROCK-GEOLOGIC MAP, ALASKA HIGHWAY CORRIDOR, LITTLE GERSTLE RIVER TO DOT LAKE, ALASKA

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DESCRIPTION OF GEOLOGIC MAP UNITS

This map shows the distribution of bedrock units along the Alaska Highway in parts of the Mt. Hayes C-1, C-2, D-1, and D-2 quadrangles. It is the westernmost of three bedrock-geologic maps along the Alaska Highway corridor (Werdon and others, 2019; Solie and others, 2019), and is part of a multi-year project conducted by the Alaska Division of Geological & Geophysical Surveys (DGGS) between 2006 and 2013. The project focused on investigating and reporting the geology and geologic hazards of the corridor. Bedrock units were mapped and structural elements were measured in the field; where bedrock units are covered by surficial units and vegetation, units were interpreted using airborne-magnetic and electromagnetic surveys published by DGGS in 2006 (Burns and others, 2006). Rock names were assigned based on field and petrographic observations, modal-mineral percentages, and interpretations of geochemical data (Werdon and others, 2014). Surficial-geologic map units are shown in Reger and others (2008). Active faults in map area are described in Carver and others (2008). Ages refer to International Commission on Stratigraphy Chart (2018). Where bedrock map units are shown with a pattern and queried label, unit designation is interpreted based on nearby geology and geophysical characteristics.

SEDIMENTARY MAP UNITS

Tn — NENANA GRAVEL (Pliocene)—Forms flat-lying, <3-m-thick veneers, which unconformably overlie metamorphic and plutonic rocks on Independent Ridge (east of the Canteen fault) and Macomb Plateau in the Mt. Hayes C-2 Quadrangle. Typically composed of well rounded, 1- to 11-cm-diameter pebbles and cobbles of white quartz and mixed lithologies, including schist, orthogneiss, granitic rocks, diorite, hypabyssal porphyritic igneous rocks, volcanic breccia, grit-bearing quartzite, and quartzite. Age assignment is estimated to be early to middle Pliocene for the Nenana Gravel, based on Ridgway and others (2007).

Ts — SEDIMENTARY DEPOSITS (Miocene)—A section at least 50 m thick (Holmes and Foster, 1968) of shallowly dipping, unconsolidated to slightly consolidated, immature, planar-bedded sediments deposited southwest of Horn Mountain in the Mt. Hayes C-2 Quadrangle. White- to gray- to light orangish-brown-weathering and fine grained (mostly clay, silt, and sand, with lesser pebble-size material). Sediments primarily consist of angular to subangular grains of quartz, weathered feldspar(s), granite–lithic fragments, and clay, likely derived from adjacent plutonic rocks. Locally contains sparse carbonaceous layers up to 6 cm thick, with spore and pollen flora derived from conifers, broad-leafed tree genera, ferns, and club moss (Holmes and Foster, 1968).

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Sediments unconformably overlie a monzogranite intrusion (unit Km) and fill a basin, which is bound on the northwestern margin by the Sand Lake fault, a northeast-trending, high-angle fault zone with early mylonite fabric likely formed at depth, either contemporaneous with or just after the intrusion of unit Km during the Cretaceous, and brittle fractures suggesting Tertiary reactivation. Shallowly dipping bedding suggests sediments were deposited within a local basin adjacent to this fault. Apatite fission-track ages from nearby monzogranite (unit Km) indicate that locally derived plutonic clasts must have been deposited more recently than Eocene (Solie and others, 2013b). Age is interpreted to be older than the Pliocene Nenana Gravel (Tn), and time-correlative with the Miocene Usibelli Group (Holmes and Foster, 1968). This sedimentary basin may be correlative with other structurally controlled, fault-bounded basins throughout eastern Interior Alaska (for example, unit Ts of Werdon and others, 2001; unit Ts of Szumigala and others, 2002; unit TKc of Werdon and others, 2004). Sedimentary basin spatially coincides with a high-conductivity anomaly in airborne resistivity data (Burns and others, 2006).

BEDROCK MAP UNITS

buk BEDROCK UNKNOWN (Tertiary and older)—Identity of bedrock was not interpreted in areas of thick and widespread unconsolidated Quaternary and Recent fluvial, colluvial and glacial deposits. Although geophysical data were acquired over the entire map area, field observations of exposed bedrock in buk areas were insufficient for reasonable interpretation of bedrock character. The extent of interpreted bedrock underlying the Quaternary is subjectively located and does not indicate a geologic contact. Overlying surficial-geologic units are shown in Reger and others (2008).

IGNEOUS DIKES

GRANITE DIKES (Cretaceous to Tertiary)—Texturally variable, including porphyritic with aphanitic to finely granular groundmass, aplitic, pegmatitic (occasionally with graphic intergrowths of quartz and alkali feldspar), or medium to coarse grained and equigranular. Dikes range from less than 1 cm to 7 m in width and are found throughout the map area. Granite is orange to light pink on weathered surfaces, light green/gray to pink on fresh surfaces. Modal mineralogy includes quartz, alkali feldspar, plagioclase, biotite (<10 percent), and, rarely, garnet. Where present, phenocrysts are less than 60 percent of the rock, and variably include quartz (clear–vitreous to smoky gray, rounded to equant, often embayed, typically <1 cm in diameter), alkali feldspar, plagioclase (euhedral, <1 cm in length), and, less commonly, biotite (<1 cm in diameter, often altered to chlorite). Secondary minerals include hematite, white mica, clay minerals, and pyrite. Southwest of Dot Lake, on the eastern edge of the map area, the matrix of porphyritic granite dikes is altered to pale green white mica, and feldspar phenocrysts are altered to clay minerals or white mica. These dikes also contain 15–20 percent small rectangular-shaped vugs (former feldspar), coated with iron oxide and spatially associated with low-level gold values (<90 parts per billion gold; Solie and others, 2008). Adjacent to the Sand Lake fault, near Horn Mountain in the Mt. Hayes C-2 Quadrangle, aplite dikes are cut by mylonite shears (up to 5 cm wide), which suggests some dikes were intruded at depth prior to mylonitization of the surrounding alkali feldspar–megacrystic monzogranite host (unit Km). Other nearby aplite dikes have been folded and exhibit aligned mineral fabric, developed during the mylonite-forming faulting event. Most granite dikes throughout the map area are likely comagmatic with the Cretaceous plutons they cut, but some granitic dikes could be as young as Tertiary in age. Magnetic susceptibility is low to moderate (average 1.19 x 10^{-3} SI [Système International]).

BASALTIC ANDESITE/ANDESITE/GRANODIORITE DIKES (Cretaceous)—Intermediate dikes are hypabyssal, porphyritic to equigranular, fine to medium grained, and gray to dark brown in color. Modal mineralogy includes hornblende (<35 percent), plagioclase and alkali feldspar (<65 percent), biotite (<2 percent), and quartz. Phenocrysts comprise less than 30 percent of the rock, and include hornblende (2–6 mm long), biotite (1–2 mm in diameter), and feldspar (1–5 mm long). Mafic minerals are locally altered to chlorite and epidote. Major- and minor-oxide and trace-element characteristics suggest an arc-related magmatic affinity (Solie and others, 2008). Magnetic susceptibility is low to moderate (average 1.07 x 10^{-3} SI).

DIORITE DIKES (Cretaceous)—Medium- to coarse-grained, equigranular to porphyritic dikes are found throughout the map area. Light to dark gray on fresh surfaces and dark gray on weathered surfaces. Modal mineralogy includes quartz, plagioclase, hornblende, and biotite. Magnetic susceptibility is low (average 0.34 x 10^{-3} SI).

GABBRO, BASALT, and LAMPROPHYRE DIKES (Tertiary to Cretaceous)—Gabbro and basalt dikes are aphanitic to fine grained, equigranular to locally porphyritic, locally diabasic textured, and occasionally amygdaloidal. These dikes range from less than 2.5 cm up to 3 m in width and are sparsely distributed throughout the map area. Gray/green to black on fresh surfaces, and gray to dark brown/orange on weathered (some spheroidal) surfaces. Modal mineralogy includes clinopyroxene, olivine, orthopyroxene, plagioclase, opaque minerals, amphibole, and accessory apatite. Where present, phenocrysts compose less than 20 percent of the rock, and include plagioclase or pyroxene. Amygdules, where present, are calcite filled and represent up to 10 percent of the rock. Amphibole from a gabbro dike yields an $^{40}Ar/^{39}Ar$ plateau age of 111.6 ± 1.5 Ma (map location A15; table 1; Solie and others, 2013a), which is relatively older than other gabbro dikes in Interior Alaska (for example, Newberry and others, 1998). Tectonomagmatic diagrams indicate a mixed tectonic affinity ranging from arc-related to within-plate setting (Solie and others, 2008; Werdon and others, 2014). Magnetic susceptibility is low (average 0.30 x 10^{-3} SI).

Lamprophyre dikes are fine grained, slightly porphyritic, generally exhibit sharp contacts with wall rocks, range from 15 to 50 cm wide, and crop out as a volumetrically minor dike swarm 3.2 km east of Horn Mountain in the Mt. Hayes C-2 Quadrangle. Weathers medium to dark brown and is dark greenish brown on fresh surfaces. The rock is slightly phlogopite–phyric (phenocrysts up to 3 mm, but average 1 mm in diameter). Chilled margin is 2.5 to 4 cm wide, aphanitic, with rare (<2 percent) calcite-filled amygdules (up to 1.5 cm in diameter). The matrix includes calcite (20 percent), magnetite, and phlogopite. Major- and minor-oxide and trace-element analyses (Solie and others, 2008) indicate the lamprophyre dikes are alkalic in composition and formed in a within-plate tectonic setting. Magnetic susceptibility is very high (20.0–

29.7 x 10^{-3}, average 24.9 x 10^{-3} SI). Phlogopite from one lamprophyre dike yields an $^{40}Ar/^{39}Ar$ plateau age of 90.9 ± 0.7 Ma (map location A4; table 1; Solie and others, 2013a).

IGNEOUS MAP UNITS

Knob Ridge Monzogranite

lKgr KNOB RIDGE MONZOGRANITE (Late Cretaceous)—Crops out as a 10 km^2 intrusion, which forms a prominent set of tors along ridgelines on the northern edge of Knob Ridge, approximately 8 km southwest of Dot Lake, in the Mount Hayes C-1 Quadrangle. The tors are up to 20 m high, white to tan colored, and dark gray to tan on weathered surfaces and surrounding grus soils. These rocks are coarse to very-coarse grained, equigranular to alkali feldspar porphyritic, massive with abundant jointing. The main intrusion is monzogranite with lesser syenogranite; both are cut by comagmatic aplite to pegmatite dikes. Modal mineral abundances include quartz (20–35 percent), alkali feldspar (25–35 percent), plagioclase (28–35 percent), biotite (4–20 percent), and hornblende (0–10 percent). Magnetic susceptibility is highly variable (0.06–4.23 x 10^{-3} SI, average 1.68 x 10^{-3} SI). This intrusion spatially corresponds to a low in the airborne magnetic survey data (Burns and others, 2006). The monzogranite intrudes mid-Cretaceous plutonic rocks (units Ktn, Kgd, and Kg), and biotite yields an $^{40}Ar/^{39}Ar$ plateau age of 67.6 ± 0.4 Ma (map location A1; table 1; Solie and others, 2013a). This pluton likely correlates with two similarly aged Late Cretaceous (~69 Ma) plutons 110 km to the north, in the Big Delta C-3 Quadrangle (Werdon and others, 2004). Other rocks with similar ages include (1) compositionally dissimilar, garnet-bearing biotite muscovite granite from the Eielson pluton to the northwest, which yielded a SHRIMP (sensitive high-resolution ion microprobe) U-Pb age on zircon of 73 ± 2 Ma (Dusel-Bacon and Murphy, 2001); (2) two granite intrusions in the western Fortymile mining district that yielded SHRIMP U-Pb age on zircon of 69 ± 1 Ma (Dusel-Bacon and others, 2009); and (3) Late Cretaceous volcanic and plutonic rocks just across the border in the Yukon Territory, which yield conventional U-Pb ages on zircons of approximately 68–69 Ma (Mortensen, 1999).

Lake George Granitic Suite

The Lake George Granitic Suite comprises a comagmatic suite of compositionally variable mid-Cretaceous plutonic rocks, characterized by high magnetic signature, northwest of Lake George in the Mount Hayes D-2 Quadrangle (units Kls, Klg, and Klq). The northeast and northwest contacts of this suite of intrusions are well delineated by airborne magnetic data (Burns and others, 2006). Adjacent metamorphic units are hornfelsed, but the morphology and geophysical data suggest the contact is either near vertical or dips slightly back under the intrusion. On the southeast and southwest sides, the intrusions extend in the subsurface for about 6 km (not shown), dipping under the surrounding metamorphic rocks. Major- and minor-oxide and trace-element analyses (Solie and others, 2008) indicate that the Lake George Granitic Suite is high-K calc-alkaline in composition and formed in a volcanic arc setting.

Kls SYENITE, QUARTZ SYENITE, ALKALI–FELDSPAR SYENITE, QUARTZ MONZONITE, and MONZONITE (Cretaceous)—Coarse- to very-coarse-grained, equigranular to alkali feldspar porphyritic, alkalic igneous intrusions composed of syenite, quartz syenite, alkali–

feldspar syenite, and quartz monzonite. Light orange to white in color, with euhedral, rectangular alkali feldspar megacrysts (up to 3.5 cm in length). Modal mineralogy includes alkali feldspar, plagioclase, hornblende, clinopyroxene, biotite, quartz, and accessory magnetite and apatite. Magnetic susceptibility is high to very high (average 31.8 x 10^{-3} SI). These rocks are comagmatic with monzogranite (Klg) and quartz monzonite (Klq) and yield an $^{40}Ar/^{39}Ar$ hornblende plateau age of 95.1 ± 0.5 Ma (map location A9; table 1; Solie and others, 2013a).

Klg MONZOGRANITE AND SYENOGRANITE (Cretaceous)—Coarse- to very-coarse-grained, equigranular to alkali feldspar porphyritic, monzogranite and lesser syenogranite. Light colored, with shades of orange and pink. Alkali feldspar is typically megacrystic, rectangular, and up to 3.5 cm in length. Mineralogy includes alkali feldspar, plagioclase, quartz, hornblende, biotite, and accessory magnetite and apatite. Magnetic susceptibility is high (average 8.94 x 10^{-3} SI). Age is inferred to be approximately 94 Ma by correlation with comagmatic units Kls and Klq.

Klq QUARTZ MONZONITE (Cretaceous)—Medium- to coarse-grained, equigranular to alkali feldspar porphyritic, and occurs in smaller zones of low silica in the granitic suite. Typically darker gray on weathered surfaces, with shades of orange, brown, and pink, while fresh surfaces are light gray. Alkali feldspar megacrysts are present, but less abundant than in the monzogranite and syenogranite (unit Klg). Mineralogy includes alkali feldspar, plagioclase, quartz, hornblende, biotite, and accessory magnetite and apatite. An $^{40}Ar/^{39}Ar$ hornblende plateau age indicates a crystallization age of 93.2 ± 0.5 Ma (map location A6; table 1; Solie and others, 2013a). Magnetic susceptibility is high (average 8.53 x 10^{-3} SI).

Other Igneous Rocks

Mid-Cretaceous granitoids are widespread throughout the Yukon–Tanana terrane and Interior Alaska. Compositions range from tonalite to syenogranite, but are predominantly medium- to coarse-grained, often porphyritic, granodiorite and monzogranite. Geochemically, they are high-K calc–alkaline in character, with volcanic-arc-related tectonomagmatic affinity (Solie and others, 2008; Werdon and others 2014). Plutons in the map area range in age from approximately 86 Ma to 102 Ma, and are generally characterized by a moderate magnetic signature.

Kgd GRANODIORITE (Cretaceous)—Fine- to medium-grained, subequigranular, commonly poikilitic with alkali feldspar crystals up to 2 cm in diameter. Granodiorite appears, at least locally, to be comagmatic with monzogranite (Kg). Leucocratic, tan/gray to light pink/orange. Mineralogy includes quartz, alkali feldspar, plagioclase, and biotite with minor hornblende. $^{40}Ar/^{39}Ar$ analyses of hornblende yield a plateau age of 97.4 ± 1.3 Ma (map location A12; table 1; Solie and others, 2013a) and three samples of biotite yield plateau ages of 92.9 ± 0.5 Ma, 99.6 ± 0.5 Ma, and 102.2 ± 0.5 Ma (map locations A5, A12, and A14, respectively; table 1; Solie and others, 2013a). Magnetic susceptibility is moderate to high (average 4.23 x 10^{-3} SI).

Kg GRANITE (Cretaceous)—Fine- to medium-grained, subequigranular, commonly poikilitic with alkali feldspar crystals up to 2 cm in diameter. Locally appears to form a marginal comagmatic phase to granodiorite (Kgd). Tan to light orange. Modal mineralogy includes quartz, alkali feldspar, plagioclase, biotite, and minor hornblende. Two samples of hornblende yield $^{40}Ar/^{39}Ar$ plateau ages of 89.7 ± 1.1 Ma and 96.7 ± 0.5 Ma (map locations A3 and A8; table

1; Solie and others, 2013a) and three samples of biotite yield plateau ages of 94.3 ± 0.5 Ma, 94.5 ± 0.5 Ma, and 98.6 ± 0.5 Ma (map locations A7, A8, and A13, respectively; table 1; Solie and others, 2013a). Magnetic susceptibility is moderate to high (average 3.87 x 10^{-3} SI).

Km MONZOGRANITE AND SYENOGRANITE (Cretaceous)—Coarse- to very-coarse-grained, equigranular to alkali feldspar porphyritic monzogranite and less abundant syenogranite. Leucocratic, light orange/pink, with large rectangular alkali feldspar megacrysts up to 3.5 cm in length. Mineralogy includes alkali feldspar, plagioclase, quartz, hornblende, biotite, and accessory magnetite and apatite. Magnetic susceptibility is moderate to high (average 2.88 x 10^{-3} SI). $^{40}Ar/^{39}Ar$ analyses of biotite yield plateau ages of 95.2 ± 0.5 Ma and 96.6 ± 0.5 Ma (map locations A10 and A11; table 1; Solie and others, 2013a).

Ktn TONALITE (Cretaceous)—Fine- to medium-grained, equigranular, tan to light-colored tonalite is comagmatic with monzogranite (Kg) and granodiorite (Kgd). Modal mineralogy includes quartz, alkali feldspar, plagioclase, hornblende, and biotite. Hornblende yields an $^{40}Ar/^{39}Ar$ plateau age of 85.9 ± 6.9 Ma (map location A2; table 1; Solie and others, 2013a). In the Mt. Hayes C-1 Quadrangle, this unit is intruded by and hornfelsed adjacent to a later monzogranite intrusion (lKgr), and is cut by hundreds of chlorite-filled, linear to anastomosing fractures.

METAMORPHIC MAP UNITS

Amphibolite Facies Metaigneous and Metasedimentary Rocks — Lake George assemblage of parautochthonous North America

Amphibolite-facies rocks are correlated to the Lake George assemblage of the parautochthonous North American assemblage as defined by Dusel-Bacon and others (2006).

MDlo UNDIFFERENTIATED ORTHOGNEISS (Mississippian to Devonian)—Unit includes granite, granodiorite, and lesser tonalite orthogneiss, all with a trace-element-indicated, arc-related tectonic setting (Solie and others, 2008; Werdon and others 2014). Is present as isolated pluton-shaped bodies several square kilometers in area, sill-shaped bodies up to several hundred meters thick, and as small, thin, isolated sills, some of which might be metamorphosed volcanic rocks or dikes that have been rotated parallel to regional foliation. Generally light colored, medium grained, equigranular, and moderately to strongly foliated. Granodiorite and tonalite orthogneiss range from light to dark, as they often have a higher mafic mineral content (up to 20–30 percent). Local textural variations include: (1) porphyritic (granitic varieties often contain alkali feldspar augen up to 5 cm in length in a coarse-grained groundmass); (2) faint to distinct gneissic banding; (3) prograde metamorphic recrystallization (mafic domains best preserve earlier foliation, where hornblende is still aligned along the foliation planes and biotite has recrystallized without a preferred orientation); and (4) in granodiorite phases, biotite and hornblende occurring together, defining an earlier relict gneissic foliation. Modal mineralogy varies depending on the bulk composition, but usually includes quartz, alkali feldspar (microcline and orthoclase), plagioclase, biotite, hornblende, and white mica. Accessory minerals include chlorite (after biotite and hornblende), muscovite, apatite, allanite, titanite, opaque minerals (magnetite), and zircon. A few brittle shears of cataclasite, epidotized shear zones, and microfaults have been observed throughout the map area. Some areas have undergone progressive deformation under more brittle–ductile conditions, where feldspars are fractured and rotated; in these areas, the interstitial matrix comprises finer-grained, often elongate, quartz and biotite. Magnetic susceptibility is generally low (average 0.02–0.71 x 10^{-3} SI). Samples with higher magnetic susceptibilities of 1–18 x 10^{-3} SI are often hornfelsed, which is likely a result of contact metamorphism from nearby Cretaceous plutons.

Age assignment is based on correlation with orthogneiss bodies to the north in the Big Delta Quadrangle (Weber and others, 1978; Werdon and others, 2004) and to the southeast in the Tanacross Quadrangle (Werdon and others, 2019), with zircon U-Pb (magmatic) ages ranging from Late Devonian to Early Mississippian (Day and others, 2003; Dusel-Bacon and others, 2006; Solie and others, 2014). Similar orthogneisses and augen orthogneisses are present throughout the Lake George assemblage of Interior Alaska and Yukon Territory, Canada. Zircon U-Pb crystallization ages of orthogneisses in the broader region fall within three age groups: (1) Late Devonian, 360–375 Ma, (2) Early Mississippian, 341–357 Ma, and (3) Middle and Late Permian (Mortensen, 1986; 1990; 1992; Dusel-Bacon and Aleinikoff, 1996; Dusel-Bacon and others, 2004; 2006; Dusel-Bacon and Williams, 2009; Ruks and others, 2006; Murphy and others, 2006).

Associated with this granitic orthogneiss in Mt. Hayes C-2 Quadrangle are amphibolite bodies that have apparent dike-like relationships with the enclosing orthogneiss. These amphibolite bodies do not occur in large enough bodies to be mapped separately. They have relict or weakly preserved foliation overprinted by strong hornfels recrystallization so that most of the hornblende and plagioclase do not have a preferred orientation. These may be equivalent to amphibolite bodies in the older metasedimentary sequence rocks.

pMlp PARAGNEISS and SCHIST (pre-Mississippian)—Paragneiss is the dominant metasedimentary rock in the map area, interlayered with equal to lesser amounts of schist. Paragneiss is distinguished from schist by having lower modal mica content; from quartzite by having less modal quartz; and from gneiss or orthogneiss by having less modal feldspar. The map unit is heterogeneous; paragneiss and schist are interlayered with small bodies or layers of quartzite, amphibolite, and marble. Only where quartzite and amphibolite were observed in exposures extensive enough to map are they shown as separate units. Contacts between the lithologies can be sharp or gradational; individual lithologic layers range in thickness from centimeters to many meters. No significant difference was noted in the unit north and south of the Tanana River.

Paragneiss and schist are mineralogically similar, varying only in relative proportions of quartz, feldspar, and mica. Biotite is nearly ubiquitous; white mica is common. Quartz and feldspar typically form lenses and bands; feldspar porphyroblasts up to 2 mm are present locally. Plagioclase is the predominant feldspar; alkali feldspar absent or <3%. Garnet is not uncommon, particularly on Independent Ridge (between Gerstle and Johnson rivers). Less common are tourmaline, graphite, calcite, amphibole, titanite, opaque minerals (mostly magnetite), rutile, and andalusite. Alteration minerals include chlorite and epidote.

The metasedimentary rocks and amphibolite have undergone amphibolite-facies dynamic metamorphism and many localities preserve a retrograde thermal event. Crenulated foliations, lineated foliation planes, and isoclinal folding at outcrop to hand sample scale are common. The metamorphic rocks north of the Tanana River are part of the Lake George assemblage. Those south of the Tanana River are part of the Macomb subterrane, as defined by Nokleberg and others (1992a, b); others include it as part of the Lake George assemblage (for example, Dusel-Bacon and others, 2006). Nokleberg and others (1992b) interpret the metasedimentary rocks of both subterranes as Devonian or older, based on intrusive ages of associated orthogneiss. Magnetic susceptibilities of the paragneiss average about 0.35 x 10^{-3} SI; at least one area of paragneiss has a higher range of susceptibilities, up to 13 x 10^{-3} SI.

pMlq QUARTZITE (pre-Mississippian)—Fine to medium grained, massive, tan to light gray, commonly with weak foliation; locally interlayered with lenses of paragneiss, schist, and amphibolite. Most quartzite layers are thin or have indistinct gradations into amphibolitic and micaceous layers. Only a few quartzite layers are of mappable scale. Graphite and magnetite are present in darker gray quartzite. Quartzite commonly contains muscovite and biotite (up to 20 percent), with mica-rich layers showing strong isoclinal folding. Calc-silicate and metacarbonate layers are commonly interlayered with, or in close proximity to, quartzite throughout the map area. These calcic rocks are present as thin, alternating bands between 0.5 and 3 mm thick. One quartzite associated with calcium-rich units contains 4-cm-diameter garnets with distinctive sigmoidal inclusion trails. Magnetic susceptibility is generally low (average 0.15 x 10^{-3} SI), with locally higher average magnetic susceptibilities (up to 3.55 x 10^{-3} SI). Quartzite from related Jarvis Creek Glacier subterrane (Nokleberg and others, 1992a, b) just southeast of the map area has yielded SHRIMP U-Pb ages of detrital zircons that fall into two well defined composite groups of approximately 2.8–2.5 and 2.0–1.7 Ga (Dusel-Bacon and Williams, 2009). Dusel-Bacon and Williams (2009) suggest that the metasedimentary quartzite zircons and zircon cores from orthogneisses of the Lake George assemblage (which would include MDlo, this study) share a common general source area, based on their similar zircon core age distributions.

MDla AMPHIBOLITE AND AMPHIBOLE–PLAGIOCLASE GNEISS (Mississippian to Devonian)—Amphibolite is fine to medium grained and dark green; amphibole–plagioclase gneiss is less common. Both occur in thin lenses, layers, and localized outcrop. Amphibolite modal mineralogy consists of hornblende (~90 percent) and plagioclase (~10 percent). Amphibole–plagioclase gneiss is finely banded, with modal mineralogy consisting of hornblende (60–90 percent), plagioclase (10–40 percent), and quartz (<10 percent). Trace-element analyses of Lake George assemblage amphibolites from north and east of the map area suggest alkalic within-plate basalt compositions and tholeiitic MORB-like compositions interpreted as having formed in a rifted continental margin environment (Dusel-Bacon and Cooper, 1999). Trace-element analyses of amphibolites from the map area (Solie and others, 2008) indicate a range in tectonic settings permissive of this interpretation. Magnetic susceptibility is generally low to moderate (average 1.74 x 10^{-3} SI). Dusel-Bacon and others (2004) suggest a bimodal magmatic association of amphibolite with orthogneiss (MDlo) in the Yukon–Tanana Upland. An ortho-amphibolite from the Lake George assemblage (Goodpaster River, north of the map area) yielded a Late Devonian SHRIMP U-Pb zircon crystallization age of 369 ± 3 Ma (Dusel-Bacon and others, 2004). No older amphibolites are currently known; we therefore assign a Devonian to Mississippian age.

pMlx METACLINOPYROXENITE (pre-Mississippian)—Medium- to coarse-grained, equigranular, locally moderately foliated, medium to dark green, poorly exposed body north of the Sand Lake fault in the Mt. Hayes C-1 Quadrangle. Contains about 90 percent clinopyroxene (light green, up to 1 cm in diameter) and 10 percent plagioclase, with secondary, orange-weathering clay(?) after plagioclase, and calcite-coated microfractures. XRF analyses indicate the clinopyroxenite contains >2,000 parts per million chromium (R.J. Newberry, written comm., 2007). Magnetic susceptibility is low (0.23–0.43 x 10^{-3} SI, average 0.25 x 10^{-3} SI). Interpreted as intrusive metaigneous rock. Age unknown, assumed to be broadly time correlative with metasedimentary units.

pMlu SERPENTINITE (pre-Mississippian)—Very fine- to fine-grained, foliated, and poorly exposed. Color ranges from black/dark green to bright and pale green. Mineralogy includes serpentine, epidote, secondary quartz, and opaque minerals. The map area's sole mappable body of serpentinite is south of Dot Lake in Mt. Hayes C-1 Quadrangle. Age unknown; assumed to be time correlative with hosting metasedimentary units, or possibly younger.

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