```
/* ----------------------- CODESET ------------------------ */
```
Title: Geologic map of the Eagle A-1 Quadrangle, Fortymile mining district
Publication: PIR 2002-1A
URL: http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=citation&ID=2863

Title: Bedrock geologic map of the Eagle A-1 Quadrangle, Fortymile mining district, Alaska
Publication: PIR 2002-1B
URL: http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=citation&ID=2864
```
/* ------------------------------------------------------- */
```

UNIT SYMBOL	DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

The extent of unconsolidated deposits in the Eagle A-1 Quadrangle, Fortymile mining district, was mapped primarily by the interpretation of 1:63,360-scale, false-color, infrared aerial photographs taken from July 1978 through August 1981 and was locally verified by ground observations during field visits.

Terms used to describe the estimated percentages of cobbles and boulders are 'numerous', 'scattered', and 'rare.' 'Numerous' implies that drilling through the layer would encounter two cobbles or boulders in an interval of 0.6 to 3 m; 'scattered' implies that drilling would encounter two cobbles or boulders in an interval of 3 to 4.5 m; and 'rare' implies that drilling would encounter two cobbles or boulders in an interval of more than 4.5 m.

Alluvial Deposits

Qa ALLUVIUM OF MODERN STREAM CHANNELS – Elongate deposits of moderately to well-sorted, well-stratified, fluvial pebble-cobble gravel, sand, and silt, with scattered to numerous boulders, deposited in active stream channels, floodplains, and associated low terraces. Deposit is medium- to thick-bedded, locally crossbedded, shows fining-upward cycles, and is locally auriferous. Cobbles are generally rounded and may reach a maximum diameter of 1 m. Locally overlain by up to 3 m of ice-rich organic silt and muck, particularly along valley margins, containing Pleistocene mammalian remains (including mammoth, horse, caribou, sheep, and bison). Surface disturbances, such as from excavation, commonly result in melting and subsequent slumping and flowage. Surface smooth except for local low scarps.

Qaf ALLUVIAL-FAN DEPOSITS – Fan-shaped, heterogeneous mixtures of poorly to moderately sorted, partially stratified gravel with some sand and silt and scattered to numerous, subangular to rounded boulders, especially in proximal areas. Deposits are locally channelized across fan surface. Clasts generally locally derived from the immediate vicinity along the short, steep streams feeding many of the fans. May include torrential fluvial deposits and debris-flow deposits. Thick- to thin-bedded.

Generally form at intersection between tributary and trunk streams. Surface smooth except for numerous shallow, interconnected channels.

Qat3 YOUNG TERRACE ALLUVIUM – Elongate deposits of well-sorted, well-rounded to subrounded, stratified pebble-cobble gravel and sand with trace to some silt and rare to numerous boulders forming elevated benches bordering floodplains of larger streams. Clearly related to recent drainage. Maximum tread elevation approximately 15 m above the present streams. Deposits may be capped by variable thickness of locally ice-rich primary and reworked eolian silt. Surface smooth to hummocky with local low scarps and bogs.

Qat2 OLD TERRACE ALLUVIUM – Elongate deposits of well-sorted, well-rounded to subrounded, pebble-cobble gravel and sand with trace to some silt and rare to numerous boulders forming elevated benches bordering major streams. Probably related to Pleistocene drainage. Maximum tread elevation approximately 30 to 40 m above the present streams. Thickness highly variable. Deposits locally capped by variable thickness of ice-rich primary and reworked eolian silt. Surface smooth to hummocky with local low scarps and bogs.

Qat1 OLDEST TERRACE ALLUVIUM – Elongate deposits of well-sorted, well-rounded to subangular, generally poorly stratified gravel, sand, and silt, possibly of glaciofluvial origin, forming elevated benches bordering major streams. Especially prominent and continuous on north side of Walker Fork valley and lower Canyon Creek. Maximum tread elevation approximately 200 to 220 m above the present streams. Thickness highly variable, ranging from thin gravel veneers on bedrock to a reported maximum of 40 m at Napoleon Creek in the Eagle A-2 Quadrangle (Yeend, 1996). Drilling by a placer miner on the north side terrace of Walker Fork near Boundary showed maximum gravel thicknesses of approximately 13 m. Maximum cobble size observed was 0.5 m diameter, but most large clasts are in the range of 0.1 to 0.2 m diameter. Mostly clast-supported, with a medium to coarse, subangular sand matrix. Locally stained orange by limonite. While generally massive and structureless, exposures may locally preserve bedding structures, boulder lags, and ice-wedge casts up to 2 m tall. Locally thickly mantled by ice-rich, primary and redeposited eolian silt. Surface generally smooth and heavily vegetated. Bench gravels are auriferous and have been successfully mined at Napoleon Creek and upper Walker Fork.

Qfp FLOODPLAIN ALLUVIUM – Elongate deposits of moderately to well-sorted, well-stratified, fluvial gravel, sand, and silt with scattered to numerous boulders in floodplains and associated low terraces. Locally auriferous. Deposits may reflect former channels and flow regimes. Typically mantled by thin layer of silty overbank deposits. May locally include Wisconsin- to Holocene-age terrace alluvium. Lower surfaces may be flooded during periods of maximum stream discharge. Locally overlain by up to 3 m of ice-rich organic silt and muck, particularly along valley margins, containing Pleistocene mammalian remains (including mammoth, horse, caribou, sheep, and bison). Surface disturbances of the frozen silt cover, such as from excavation, commonly result in melting and subsequent slumping and flowage. Ground ice content highly variable. Surface smooth to hummocky with local low scarps and bogs.

Colluvial Deposits

Qc UNDIFFERENTIATED COLLUVIUM – Irregular, heterogeneous blankets, aprons, and fans of angular to subangular rock fragments, gravel, sand, and silt that are left on slopes, slope bases, or high-level surfaces by residual weathering and complex mass-movement processes including rolling, sliding, flowing, gelifluction, and frost action. Locally washed by meltwater and slope runoff. Deposit is generally unsorted to very poorly sorted, and medium to thick bedded. Thickness is highly variable, with thickest deposits at the bases of slopes. Organic material is commonly incorporated in the deposit, and it is locally overlain by up to 3 m of ice-rich organic silt and muck that may contain Pleistocene mammalian remains, especially at the bases of slopes bordering streams. Surface disturbances, such as from excavation, commonly result in melting and subsequent slumping and flowage. Surface smooth, lobed, or terraced and, if deposit is thin, generally reflects configuration of underlying bedrock surface.

Qcf FINE-GRAINED COLLUVIUM AND SILT – Irregular, heterogeneous blankets, fans, and aprons of fine-grained colluvium and silt. Silt is largely retransported from original hillside sites of eolian deposition to lower slopes by mudflows, slopewash, gelifluction, and frost action. May contain abundant angular clasts of local origin. Thickness is highly variable, with thickest deposits at the bases of slopes. Commonly perennially frozen and ice rich. Surface disturbances, such as from excavation, may result in melting and subsequent slumping and flowage. Surface smooth and steep to gently sloping. Unit mapped only in southern part of study area where preservation is best. These deposits are probably remnants of a much more extensive thick silt blanket that has been largely removed by slope processes and stream erosion.

Qcl LANDSLIDE DEPOSIT – Oval- to tongue-shaped heterogeneous mixture of fractured bedrock and pebble-cobble gravel with trace to some sand and silt believed to be deposited by near-surface to deep creep and sliding due to instability of failed bedrock near Cherry Creek in southern map area. Feature is characterized by arcuate headwall with pronounced depression at base emphasized by snow and brushy vegetation. Deposit ranges from slightly hummocky to extremely irregular with jumbled blocks on the surface.

Qcr RUBBLE DEPOSITS – Irregular blankets of coarse, angular rubble derived largely from frost shattering of local bedrock. Maximum block diameter commonly ranges to 2 m. Occurs on the crests and upper flanks of high ridges as jumbled, openwork rubble fields showing little or no evidence of transport.

Glacial Deposits

Qd UNDIFFERENTIATED DRIFT – Heterogeneous mixtures of poorly to moderately sorted, subangular to rounded boulders, gravel, sand, and silt believed to be deposited by ancient alpine glaciers. Preserved as extremely localized, irregular patches of possible drift characterized by hummocky topography with a surface scattering of angular to subrounded boulders up to 1.5 m diameter, and associated with coarse boulder lags in streams that form small rapids. Identified only in two localities in the southeastern map area. Associated valley headwalls in the highest elevations exhibit subdued cirque-like morphology that is especially apparent on northern faces. Valley cross-profiles are highly modified U-shaped, with streams that are markedly underfit for the relative valley width. Based on characteristics such as subdued morphology, elevation of source areas, and apparent extreme age, the mapped deposits may be correlative with glacial deposits of Charley River age (early Pleistocene) mapped by Weber (1986) in the Yukon-Tanana Upland.

<u>Complex Deposits</u>

Qca COLLUVIAL AND ALLUVIAL VALLEY-FILL DEPOSITS – Elongate, apron- and fan-shaped, heterogeneous mixtures of poorly to moderately sorted angular rock fragments with trace to some gravel, sand, and silt deposited in upper stream courses and on lower slopes along the margins of stream valleys by complex mass-movement processes (including rolling, sliding, flowing, gelifluction, and frost action) and strongly influenced by meltwater and slope runoff. Other important depositional processes may include debris flows, brief, intense (torrential) summer stream flows, and minor snow-avalanching. Commonly forms alternating stratified and unstratified zones and lenses in gullies and steep tributary valleys with intermittent or ephemeral streams. Locally overlain by variable thickness of ice-rich organic silt and muck, especially in areas of little or no slope. Surface disturbances, such as from excavation, commonly result in melting and subsequent slumping and flowage. Surface steep to gently sloping, with local low scarps and shallow channels from ephemeral runoff streams.

Qs SWAMP DEPOSITS – Elongate to blanket deposits of complexly bedded peat, organic silt, and organic sand accumulated as surface deposits in local basins and in former stream channels. Saturated and locally frozen, locally ice rich. Thickness highly variable. Surface smooth, hummocky, or pitted. May have standing water.

<u>Man-made Deposits</u>

Qh PLACER-MINE TAILINGS AND ARTIFICIAL FILLS – Pebble-cobble gravel with trace to some sand and silt forming bases for roads and airports and piled in active or former gravel pits, open-pit mines, and dredged areas. Well to poorly sorted. Surface smooth to irregular. Extent based primarily on distribution between July 1978 and August 1981 when the aerial photographs were taken.

BEDROCK UNITS

SEDIMENTARY ROCKS

Ts SEDIMENTARY ROCKS (Tertiary) — Poorly- to well-indurated, nonmarine sedimentary rocks of Tertiary age, as established by pollen (Foster, 1976; Foster and Igarashi, 1990). The unit typically consists of conglomerate, with lesser sandstone, shale, siltstone, and graywacke. Magnetic susceptibility is very low, <0.1 x 10-3 SI (Système International). Spatial association with placer-gold-bearing gravels in the Baby Creek area suggests that this unit may be gold-bearing as well. The unit is truncated by high-angle faults; unconformable contacts with older units are not observed.

IGNEOUS ROCKS

lTb ALKALI BASALT (late Tertiary) — Dark gray, variably vesicular, alkali basalt containing phenocrysts of olivine + augite, in an aphanitic groundmass of augite + plagioclase + magnetite, with calcite-filled amygdules. Magnetic susceptibility is high, typically ~5 x 10-3 SI. Major and minor oxide analysis indicates alkali basalt composition; minor oxide and trace element analysis is consistent with within-plate basalt geochemistry. The unit occurs as dikes that are finer grained and contain higher incompatible element concentrations than the early Tertiary mafic dikes seen in the Eagle A-2 and A-3 quadrangles. Two alkali basalt samples yielded whole-rock 40Ar/39Ar plateau ages of 13.8 ± 0.4 Ma (sample A1; table 1) and 18.0 ± 0.2 Ma (sample A2; table 1). Alkali olivine basalt about 15 km southeast of the Eagle A-1 Quadrangle gave a K–Ar biotite age of 17.2 ± 0.3 Ma (Hunt and Roddick, 1991). Late Tertiary alkali olivine basalt is mapped at several locations to the east in Yukon Territory, including near the head of Moose Creek, about 5 km east of the Eagle A-1 Quadrangle (Mortensen, 1988a). The occurrence of these extension-related basalt dikes suggest late-Tertiary high-angle normal faulting.

eTd DIABASE (early Tertiary) — Fine- to medium-grained (1–5 mm) tholeiitic diabase. Typically contains 50–70 percent felted plagioclase laths, 30–50 percent altered clinopyroxene + olivine, 3–5 percent magnetite + ilmenite, and 0–1 percent biotite. Age based on 40Ar/39Ar biotite plateau age of 57.5 Ma for a dike of indistinguishable major and minor element content from the Eagle A-2 Quadrangle (Werdon and others, 2001). Probably correlates with Tertiary basalts of similar major- and trace-element compositions (within-plate) throughout Interior Alaska. Relatively unaltered mafic dikes (too small to be shown at map scale) are sporadically present elsewhere in the map area and probably represent the same early Tertiary magmatism. Magnetic susceptibility of the unit is moderate to high, usually 1–11 x 10-3 SI. In the Eagle A-2 and A-1 quadrangles this mafic rock occurs along or is cut by north–northeast-trending high-angle faults, indicating a change in structural regime following Late Cretaceous magmatism and faulting.

lKf FELSIC PORPHYRY (Late Cretaceous) — Brownish-gray porphyritic rock with quartz phenocrysts and altered sanidine phenocrysts in an aphanitic groundmass of sericite + quartz + calcite + iron oxides, occurring as rare dikes in the northeast and southeast parts of the quadrangle. Magnetic susceptibility is low: 0.01–0.1 x 10-3 SI. Major oxide analysis indicates rhyolite to rhyodacite composition. Whole-rock 40Ar/39Ar dating (Flynn and Newberry, 2001) of a rhyolite from 3 km south of the Eagle A-1 Quadrangle yielded a plateau age of 64.7 ± 0.4 Ma, which most likely represents latest Cretaceous igneous crystallization. Late Cretaceous volcanic and plutonic rocks occur just to the east in Yukon Territory, up to within 6 km of the U.S. border (Mortensen, 1988a). A rhyolite porphyry pluton 15 km to the east has a U–Pb (zircon) age of 68.7 ± 0.3 Ma; the Moosehide Hills rhyolite, 45 km to the east, has a U–Pb (zircon) age of 68.1 ± 0.6 Ma (Mortensen, 1999). The small felsic porphyry dikes in the Eagle A-1 Quadrangle most likely represent the distal fringes of latest Cretaceous magmatism abundantly exposed in the western Yukon Territory. Latest Cretaceous mafic and alkalic igneous rocks are temporally and spatially associated with the felsic rocks just south of the Eagle A-1 Quadrangle (Flynn and Newberry, 2001) and especially to the east, in Yukon Territory (Mortensen, 1988b; 1999). The magmatic associations indicate an extensional tectonic environment; these igneous bodies are characteristically within (Flynn and Newberry, 2001) or bounded (Mortensen, 1988a) by high-angle, northeast-trending faults of likely similar age.

Jh HORNBLENDITE (Jurassic) — Black, unfoliated, very coarse-grained rock containing more than 85 percent subequant hornblende (0.5–2 cm), with minor plagioclase ± biotite ± sphene, and minor secondary epidote + calcite + sericite. Magnetic susceptibility is moderate to very high, 0.2–22 x 10-3 SI. Numerous biotite clinopyroxenite dikes with up to 50 percent amphibole are found in the northwest Eagle A-2 Quadrangle (Werdon and others, 2001). Biotite hornblendite is also noted in the Eagle C-3 (Newberry and others, 1998) and B-1 (Foster and Keith, 1968) quadrangles. In the east-central Eagle Quadrangle such dikes contain anomalous concentrations of platinum (Pt) and palladium (Pd); however, none of the dikes sampled in the Eagle A-1 Quadrangle contained detectable gold, palladium, or platinum. 40Ar/39Ar dating of hornblende from hornblendite yielded a plateau age of 191.4 ± 1.6 (sample A3; table 1). Hornblende from a hornblendite dike just south of the Eagle A-1 Quadrangle gave a 40Ar/39Ar age of 175.8 ± 2.2 (Flynn and Newberry, 2001). Hornblende in biotite hornblendite from the Eagle C-3 Quadrangle yielded a plateau age of 184 ± 0.6 Ma (Newberry and others, 1998). While clearly Jurassic in age, the hornblendite dikes apparently represent a protracted magmatic episode.

Jd THE GREAT DIKE (Jurassic) ¾ Sub-equigranular, medium-grained, locally foliated to nonfoliated biotite granodiorite to hornblende–biotite granodiorite, present in a body 7 km long and 50–400 m wide, herein called the Great Dike. Typical modal mineralogy is 15–30 percent quartz, 35–45 percent plagioclase, 7–15 percent K-feldspar, 20 percent mafics, 1 percent each of sphene, myrmekite, and magnetite, and trace apatite and allanite. Relative mafic mineral abundance ranges from nearly all biotite to hornblende slightly greater than biotite. K-feldspars are up to 8 mm in length, other major minerals typically are 1–5 mm. Alteration is usually minor, with some chloritization of mafic minerals and sericitic dusting of plagioclase. Trace and major element characteristics indicate the body is of I-type, arc-related affinity. No obvious hornfels alteration is seen in metamorphic rocks surrounding the body; the dissimilar rock types on opposite sides of the dike suggest it was intruded along a Jurassic west–northwest-trending fault that was subsequently reactivated. Magnetic susceptibility is moderate (0.3–1.4 x 10-3 SI), similar to Jurassic plutons in the Eagle A-2 Quadrangle (Werdon and others, 2001). 40Ar/39Ar hornblende plateau age of 189.6 ± 1.0 Ma (sample A4; table 1) is similar to that of mildly foliated Jurassic plutons in the adjacent Eagle A-2 Quadrangle (Werdon and others, 2001).

Jga GRANITE PEGMATITE AND APLITE (Jurassic) ¾ Unfoliated, leucocratic granite with mixed pegmatite, aplite, and rare seriate textures. Grain size varies between >1 cm and ~1 mm, typically either coarse- or fine-grained. Variations in texture and grain size occur at the outcrop and hand-specimen scale. Typical modal mineralogy is 5 percent mafics (biotite and/or muscovite), 25–35 percent quartz, 25–30 percent K-feldspar, and 30–35 percent plagioclase. Muscovite occurs both as a replacement of biotite and as apparently primary grains. Trace and major element compositions suggest that these are highly fractionated I-type granites of arc affinities, which occur both as kilometer-scale bodies and as dikes. Magnetic susceptibility is low, typically ~0.1 x 10-3 SI. Muscovite from a large aplite-granite body yielded a 40Ar/39Ar plateau age of 181.3 ± 1.5 Ma (sample A5; table 1). Similar-appearing granite pegmatite–aplite bodies about 10 km east of the Eagle A-1 Quadrangle yield U–Pb (zircon) ages of 190–191 Ma (Mortensen, 1999). 40Ar/39Ar muscovite plateau age for similar-appearing granite in the Eagle A-2 Quadrangle is ~186 Ma (Werdon and others, 2001). These bodies may have been intruded over a protracted period in the early Jurassic.

Jg GRANODIORITIC PLUTONS (Jurassic?) ¾ Numerous small to moderate-sized, commonly elongate Jurassic(?) plutons scattered throughout the quadrangle. These bodies texturally resemble the Jurassic Uhler pluton of the Eagle A-2 Quadrangle (Werdon and others, 2001) and the Great Dike. Rocks of these plutons may display a slight foliation; they are commonly porphyritic to sub-equigranular, medium- to fine-grained. Compositions are largely granodiorite, but include lesser granite, tonalite, and quartz diorite. Trace and major element compositions indicate I-type, arc affinity. Typically contain 15–30 percent quartz, 15–35 percent K-feldspar, 35–45 percent plagioclase, 0–15 percent hornblende, 2–10 percent biotite, and minor sphene, magnetite, and allanite. Epidote and chlorite are variably present as alteration products of the mafic minerals. Magnetic susceptibilities vary from 0.1 to 0.6 x 10-3 SI. 40Ar/39Ar plateau ages for granodiorite dikes and plutons in the Eagle A-1 Quadrangle include 183.7 ± 1.2 Ma (sample A6; table 1), 184.8 ± 1.4 Ma (sample A7; table 1), and 204.1 ± 1.5 Ma (sample A8; table 1). A 40Ar/39Ar minimum age of 178.7 ± 1.3 Ma (sample A9; table 1) was determined for a granodiorite dike located near a Miocene basalt dike. The smaller size and absence of magmatic epidote in the Jurassic bodies of the Eagle A-1 Quadrangle suggests these bodies are exposed at a shallower level than those of the Eagle A-2 Quadrangle.

METAMORPHIC ROCKS

MAFIC AND ULTRAMAFIC ROCKS METAMORPHOSED TO LOWER GREENSCHIST FACIES: SEVENTYMILE TERRANE

Dunite and gabbro metamorphosed to lower greenschist facies occur together in the southeastern Eagle A-1 Quadrangle; their similar character, metamorphism, and spatial proximity suggests a genetic relationship. There are numerous serpentinized ultramafic bodies in interior Alaska, especially in the Eagle Quadrangle (Foster and Keith, 1974), currently described as the ‘Seventymile Terrane’ and interpreted to represent dismembered ophiolites. Gabbro is associated with dunite and harzburgite at Mount Sorenson (Keith and others, 1981) but not reported with the other large ultramafic bodies. The serpentinite of the Eagle A-1 Quadrangle is universally considered part of the Seventymile Terrane; the gabbro has been included within a quartz mica schist and greenschist unit (Foster, 1976; Foster and others, 1985) that, in turn, has been either assigned to the Seventymile Terrane (Foster and others, 1994) or to the Klondike Schist (Dusel-Bacon and others, 1998). We group together the altered gabbro and dunite as Seventymile Terrane and distinguish them from nearby upper greenschist and amphibolite facies rocks. The serpentinite and metagabbro occur as discontinuous wedges along the thrust contact between the amphibolite and greenschist facies rock units.

Permian chert is spatially associated with the two largest ultramafic bodies (Foster and others, 1978; Keith and others, 1981) in Interior Alaska; Late Triassic limestones are spatially associated with ultramafic rocks western Yukon Territory (Abbott, 1983). These ages most likely set an upper limit to the ages for the mafic and ultramafic rocks; the lower limit is undefined, but presumably Paleozoic.

MzPzs SERPENTINITE (Mesozoic to Paleozoic) — Green to dark gray, orange-brown weathering, slightly foliated, fine-grained rock dominated by serpentine with accessory chromite, local relict olivine, and secondary magnetite + magnesite. In samples not totally serpentinized, olivine relicts are optically continuous for up to 5 mm, occupying a volume representing greater than 90 percent of the primary modal mineralogy. Magnetic susceptibility of the serpentinite is very high, typically 10–60 x 10-3 SI. Consequently, serpentinite has also been mapped in areas lacking rock exposures but displaying strong magnetic anomalies. Aeromagnetic data also indicate that serpentinite locally underlies amphibolite-facies metamorphic rocks, i.e., that serpentinite occurs imbricated in thrust faults, and not as the structurally highest block. Waxy massive serpentinite with relatively low magnetic susceptibility (0.1–1 x 10-3 SI) is present near some fault contacts. Chrysotile typically is scarce, and is most common near fault contacts.

MzPzmg METAGABBRO (Mesozoic to Paleozoic) — Green and white, medium- to coarse-grained, slightly- to un-foliated rock consisting of sub-equal clinopyroxene and plagioclase entirely pseudomorphically replaced by fine-grained actinolite + chlorite + epidote–clinozoisite + albite + sphene. Primary silicates were 3–15 mm, but locally several centimeters, in size. Includes sparse coarse-grained actinolite ± chlorite schist and rare very coarse-grained chlorite rock. Magnetic susceptibility is variable, between 0.1 and 6, but averaging 0.3 x 10-3 SI. Like the serpentinite, interpreted to occur as imbricate wedges in thrust faults.

ROCKS METAMORPHOSED TO UPPER GREENSCHIST FACIES: NASINA AND KLONDIKE SERIES

Greenschist-facies assemblages of predominantly metasedimentary and metavolcanic rocks in the eastern Eagle A-1 Quadrangle are mapped as the Nasina and Klondike series, respectively, after McConnell (1905). The Nasina and Klondike series in this area are greenschist facies; the local presence of biotite (and more commonly, its compositional equivalent, muscovite + chlorite) and the rare occurrence of kyanite (and pyrophyllite) suggest that these rocks were metamorphosed to borderline upper greenschist facies. A biotite-in isograd could not be mapped; either there has been too much deformation subsequent to metamorphism or the rocks of the area essentially straddle the isograd. The Nasina series primarily contains carbonaceous metasedimentary rocks, and the Klondike schist predominantly metavolcanic and lesser non-carbonaceous metasedimentary rocks (Mortensen, 1988b). These rocks were previously mapped as “quartz mica schist and greenschist” (Foster, 1976; Foster and others, 1985) that, in turn, have been assigned either to the Y3 subterrane of the Yukon–Tanana terrane (Churkin and others, 1982), the Seventymile Terrane (Foster and others, 1994), or to the Klondike and Nasina units of the Yukon-Tanana terrane (Dusel-Bacon and others, 1998).

U–Pb (zircon) dates for felsic interlayers in Nasina quartzite of 361 ± 2 and 358.5 ± 1.5 Ma (Mortensen, 1999) indicate a latest Devonian age; galena from several stratiform Pb–Zn–Ba occurrences in Nasina series rocks give Devonian lead isotope model ages (Mortensen, 1996). Most likely the age range of the Nasina series extends into the Mississippian. We follow Dusel-Bacon and others (1988) in correlating the Nasina series with the Devono–Mississippian Keevy Peak formation of the central Alaska Range and rocks of similar age and appearance in the Fairbanks and Big Delta quadrangles. Numerous UPb (zircon) age determinations from Klondike schist metafelsites, including one from 3 km east of the Eagle A-1 Quadrangle, give ages of 253 to 263 Ma, that is, mid to late Permian (Mortensen, 1990; Dusel-Bacon and others, 1998; Mortensen, 1999). Metavolcanic rocks of Permian age have not been identified in Interior Alaska outside of easternmost Eagle Quadrangle, but are common in western Yukon Territory, extending as far east as the Klondike district (Mortensen, 1999). The Chicken metamorphic complex, a greenschist-metamorphosed package of metavolcanic and metasedimentary rocks with a Permian U–Pb (zircon) age (Mortensen, written commun., 2001) in the Eagle A-2 Quadrangle may be correlated. However, a significant thickness of Devono–Mississippian bimodal metavolcanic and metasedimentary rocks overlies the Keevy Peak formation in Interior Alaska. These rocks are only confidently distinguished from lithologically similar Klondike schist through U–Pb zircon dating; hence, unrecognized Klondike series rocks may occur elsewhere in Alaska.

The contact between the Nasina and the Klondike series is most recently mapped as a younger-over-older thrust fault in west-central Yukon Territory (e.g., Mortensen, 1988a). However, there is no obvious increase in deformational fabrics near the contact between the Nasina units and Klondike schist units in the Eagle A-1 Quadrangle, there are no exotic lithologies at this contact, there is no obvious difference in structural grain, nor is there an abrupt change in rock type. If Nasina series rocks are equivalent to Keevy Peak formation, however, then a considerable amount of metavolcanic-dominant section is missing between the Nasina and the Klondike series present in the Eagle A-1 Quadrangle. We follow Green (1972) and map this as an unconformable contact.

Pks KLONDIKE SCHIST (Permian) — Predominantly rusty-weathering, fine- to medium-grained, albite–chlorite–phengite–quartz schist and lesser albite–phengite–quartz schist, with an apparent thickness of ~500 m. Pks is distinguished from Pkf based on abundance of metafelsites—rare in Pks and abundant in Pkf. Magnetic susceptibility is low, 0.03–0.25 x 10-3 SI, with sporadic higher values. In the southeast Eagle A-1 Quadrangle this unit was explored in the 1970s for volcanogenic massive sulfide deposits, and a polymetallic (Pb–Zn–Cu–Ag) soil anomaly was defined (Resource Associates of Alaska, 1977; Smit, 2000). Several short core holes drilled in upper Brophy Creek drainage did not encounter massive sulfide, although highly pyritic zones were intersected, with rare galena and sphalerite (Resource Associates of Alaska, 1977). Galena from this core displayed lead isotope ratios indistinguishable from those of syngenetic Klondike schist-hosted prospects in Yukon Territory (J.K. Mortensen, written commun., 2002). Rocks in upper Arkansas Creek and, to a lesser extent, Brophy Creek, are heavily iron-stained. Phengite yielded a 40Ar/39Ar plateau age of 157.5 ± 1.2 Ma (sample A10; table 1), which represents cooling from peak metamorphism.

Pkf KLONDIKE METAFELSITE (Permian) — Fine-grained, greenschist-facies, feldspar-rich felsic to intermediate-composition metavolcanic rocks, commonly with relict igneous texture, up to 300 m thick. Most commonly present as chlorite–clinozoisite–phengite–albite–quartz metafelsite and schist (locally with minor biotite); clinozoisite–phengite–quartz schist; and phengite–albite–quartz–K-feldspar metarhyolite. Mineral proportions vary considerably; those of apparently meta-intermediate composition contain abundant chlorite, clinozoisite, albite, and phengite. X-ray diffraction analysis indicates the unit locally contains pyrophyllite in addition to phengite. Disseminated pyrite and quartz lenses are locally common. Albite and K-feldspar are present in variable proportions, and are fine-grained to porphyroclastic (up to 2 mm in size); some rocks appear to be metaporphyritic.

Magnetic susceptibility is low, 0.02–0.2 x 10-3 SI.

MDq NASINA QUARTZITE (Mississippian–Devonian) — Fine-grained, predominantly dark gray, commonly pyritic, carbonaceous quartzite and phengite–quartz schist, with lesser graphite–quartz schist and light gray quartzite. Locally grades into thin layers of biotite–albite-bearing quartz schist and quartzite, and are locally calcite-rich and include some marble. Apparent thickness is greater than 1,000 m, as this unit underlies a large adjacent area in Yukon Territory (Mortensen, 1988a). Foliation is locally crenulated; quartz lenses are common and commonly isoclinally folded. Magnetic susceptibility unit is very low, 0.01–0.15 x 10-3 SI, with sporadic higher values. The carbonaceous rocks are strongly conductive, although low-conductivity quartzite with little to no carbon is interlayered throughout the unit. Consequently, high conductivity, covered zones near outcrops of Nasina quartzite were also mapped as Nasina. Phengite from a phengite–quartz schist layer yielded 40Ar/39Ar plateau ages of 106.3 ± 0.6 Ma and 116 ± 0.9 Ma (sample A11; table 1), presumably reflecting age of cooling from peak metamorphism.

MDkq NASINA KYANITE QUARTZITE (Mississippian–Devonian) — Fine- to medium-grained, bluish-gray quartzite containing ~two-thirds quartz and one-third 1–2 mm euhedral kyanite, with several percent each of 0.5 mm euhedral chlorite and white mica, and <1 percent each of apatite, rutile, opaque, and graphite. The absence of garnet, biotite, and tourmaline—invariably seen with kyanite-bearing rocks of the amphibolite facies rocks—and the presence of primary chlorite indicates that kyanite quartzite is most similar to lithologies in the Nasina quartzite unit (MDq). Lacking any evidence of fault contacts with surrounding MDq, it is included within the Nasina Series. Most likely the protolith was a highly weathered or altered rock, for example, a paleosol or pyrophyllite-altered metarhyolite. Mortensen (1990) describes rare metarhyolitic intervals in the Nasina series, which may be less-metamorphosed equivalents to the kyanite quartzite. Magnetic susceptibility is low to moderate, 0.05–0.7 x 10-3 SI.

MDa NASINA ACTINOLITE SCHIST (Mississippian–Devonian) — Fine- to coarse-grained, green actinolite schist consisting of 70 to more than 90 percent actinolite + minor quartz ± clinozoisite ± biotite. Major and minor oxide analyses indicate the actinolite schist has mafic to ultramafic composition. Magnetic susceptibility is moderate: 0.1–0.5 x 10-3 SI. Actinolite schist grades into Nasina quartzite in several places in the Eagle A-1 Quadrangle and vicinity (Flynn and Newberry, 2001) and mafic interlayers within Nasina quartzite are described in the Yukon Territory (Mortensen, 1990). The presence of biotite distinguishes this unit from the lower-grade, but actinolite-rich metagabbro of the Seventymile Terrane.

ROCKS METAMORPHOSED TO AMPHIBOLITE FACIES: FORTYMILE RIVER ASSEMBLAGE

Foster (1969) grouped all the amphibolite-facies rocks in the Eagle A-1 Quadrangle as a single gneiss and schist unit. Although individual lithologic unit boundaries were not delineated, marble-rich, garnet-rich, quartzite-rich areas, and augen gneiss localities encountered on ridgeline traverses are indicated by various symbols on her map. Based on mineral assemblages in metabasalts and metapelites, rocks of the Eagle A-1 Quadrangle have experienced epidote–amphibolite facies metamorphism (Dusel-Bacon and others, 1995; this study). Local presence of staurolite and kyanite, invariably with tourmaline, in schist is apparently related to local aluminum–boron-rich protoliths and not to significant variations in metamorphic conditions. Pre-, syn-, and post-tectonic mineral fabrics are observed in the rocks, indicating a complex thermal and structural history, probably involving multiple deformational episodes. Hornblendes from these amphibolite-facies metamorphic rocks have yielded highest-temperature 40Ar/39Ar fraction ages of 190–214 Ma and stepped pseudo-plateau, plateau, and saddle ages of 188–204 Ma (Cushing, 1984; Hansen and others, 1991). Metaplutonic rocks, which intrude the amphibolite-facies package, have ages as old as mid-Devonian (Aleinikoff and others, 1986; Mortensen, 1990; Mortensen, 1999) although metaplutonic rocks in the Eagle A-1 Quadrangle and immediate vicinity yield Mississippian U–Pb (magmatic) ages (Mortensen, 1999; Mortensen, written commun., 2001; Day and others, in press). Thus, most of the amphibolite-facies metamorphic rocks are of Devonian or older age. Notably, the metaharzburgite (Pzum) and amphibolite, paragneiss, and schist (Pza) units are not intruded by orthogneiss and their ages are poorly constrained. Churkin and others (1982) referred to the amphibolite facies rocks of the Eagle Quadrangle as subterrane Y4; Hansen and Dusel-Bacon (1998) call it the Taylor Mountain Terrane. The amphibolite-grade metamorphic rocks of the Eagle Quadrangle were distinguished from other amphibolite-facies rocks of interior Alaska based on the alleged scarcity of Devono–Mississippian meta-plutonic rocks and abundance of metapelitic rocks in the former (Churkin and others, 1982; Foster and others, 1994). However, Day and others (2000) and Werdon and others (2001) have shown that metaplutonic rocks are abundant, at least in the Eagle A-1 and A-2 quadrangles. Similarities in protolith age, major- and trace-element composition, and metamorphic facies to metamorphic rocks of the Tanacross Quadrangle (Dusel-Bacon and Cooper, 1999) and to the Fairbanks area (Newberry and others, 1996) suggest that this unit of amphibolite-facies metamorphic rocks is widespread in eastern Interior Alaska. Although previously referred to as the Taylor Mountain Terrane (Hansen and Dusel-Bacon, 1998), these units are not in contact with the Taylor Mountain Batholith (Werdon and others, 2001) and the name is consequently inappropriate. The amphibolite-facies units of the Eagle Quadrangle are currently referred to as the Fortymile River Assemblage (C. Dusel-Bacon, written commun., 2000). We infer that this unit was structurally juxtaposed with the lower-grade Permian and Devono–Mississippian metamorphic rocks during the early Mesozoic, as the youngest foliated rocks are of latest Permian age and the oldest little-deformed rocks of the region are the early Jurassic plutons. Most contacts between the amphibolite facies rocks and the lower-grade rocks are obscured by extensive high-angle faulting and generally poor exposures characteristic of the region; however, locally, the high-grade rocks are seen in thrust contact with the low-grade rocks; a thin zone of serpentinite is invariably present within such thrusts.

Motr TRONDHJEMITIC ORTHOGNEISS (Mississippian) ¾ Bodies consisting primarily of leucocratic, medium- to coarse-grained, (K-feldspar)–biotite–quartz–sodic plagioclase gneiss with trondhjemitic composition and remnant plutonic textures. Typical grain size is 2–5 mm, and texture is sub-equigranular; K-feldspar porphyroclasts are consistently absent. Major mineral abundances: 45–80 percent plagioclase (average 63), 0–10 percent K-feldspar (average 4), 15–40 percent quartz (average 26), 0–10 percent biotite (average 6), 0–10 percent muscovite (average 2), and 0–3 percent garnet. Plagioclase is typically An5-15 with little obvious zoning; albite replacement textures are seen in some samples. Myrmekite is commonly present. Total mafic mineral abundances of 10 percent or less give this rock a very white appearance; foliation may be difficult to discern in very low mafic samples. Magnetic susceptibility is low, rarely more than 0.2 x 10-3 SI. A sample from the Eagle A-2 Quadrangle gave a U–Pb (zircon) age of approximately 335–340 Ma (J. Mortensen, written commun., 2001).

Motn TONALITIC ORTHOGNEISS (Mississippian) — Bodies consisting primarily of medium-grained, (hornblende)–biotite–quartz–feldspar gneiss with tonalitic composition and remnant plutonic textures. Includes some granodiorite and quartz diorite. Typical grain size is 1–3 mm, with evidence for granulated quartz phenocrysts of originally 3–6 mm size. Major mineral abundances: 40–75 percent plagioclase (average 50), 0–20 percent K-feldspar (average 3), 15–40 percent quartz (average 27), 10–30 percent biotite (average 15), 0–10 percent hornblende (average 3), 0–5 percent garnet, 0–7 percent epidote, and 0–2 percent oxides. Plagioclase is typically oligoclase-andesine; zoning is sometimes present and myrmekite is rare. Magnetic susceptibility is moderate, typically 0.2–0.5 x 10-3 SI. A tonalitic orthogneiss sample from the Eagle A-1 Quadrangle (sample A12; table 1) gave a U–Pb (zircon) age of 343 ± 4 Ma (Day and others, in press).

Mog FELSIC ORTHOGNEISS (Mississippian) — Bodies consisting primarily of fine- to coarse-grained, biotite–quartz–feldspar gneiss with granite or granodiorite mineralogy and bulk composition and some remnant igneous texture. Typical grain size is 1–4 mm, but quartz grains especially are granulated remnants of larger (commonly 3–8 mm) phenocrysts. Feldspar augen are occasionally present, but most feldspar is finer-grained than quartz. Major mineral abundances: 20–55 percent plagioclase (average 39), 7–40 percent K-feldspar (average 23), 15–42 percent quartz (average 28), 1–25 percent biotite (average 9), 0–7 percent hornblende, 0–10 percent muscovite, and 0-15 percent epidote. Apatite, zircon, sphene, and opaques are present in trace amounts. Myrmekite is commonly present. Magnetic susceptibility is usually low (average 0.2 x 10-3 SI), but ranges up to 1.5 x 10-3 SI. A sample from the Moose Creek granodiorite orthogneiss, 3 km to the east of the Eagle A-1 Quadrangle, gave a U–Pb (zircon) age of 348.2 ± 0.7 Ma (Mortensen, 1988b).

Mo UNDIFFERENTIATED ORTHOGNEISS (Mississippian) — Composite orthogneiss bodies or bodies with considerable compositional variability, as indicated by chemical analyses and feldspar staining. Individual bodies can range through the spectrum of granite–granodiorite–trondhjemite–tonalite–quartz diorite, but more commonly exhibit a smaller range in composition. Also locally includes schist, gneiss, and other metamorphic rock types present in minor abundance. Nearly always contain 15–40 percent quartz and more than 50 percent total feldspar; the remainder is mostly biotite ± muscovite or hornblende. Fine-grained orthogneiss, of potentially metavolcanic origin, constitutes up to one-third of a given body. Many bodies appear sill-like, either because they were intruded as sills or because they were deformed into sub-parallelism with the surrounding layered rocks. Magnetic susceptibility varies with rock type; 0–0.5 x 10-3 is typical but values up to 3 x 10-3 SI. These composite bodies presumably possess the same Mississippian ages as displayed by less compositionally diverse ones.

pMq QUARTZITE (Pre-Mississippian) ¾ Fine- to medium-grained quartz-rich (>70–90 percent quartz) metamorphic rock. Greenish-gray to pure white, locally color banded, foliated, relatively pure quartzite with minor white mica and (or) feldspar; variable garnet and magnetite; and occasional pyrite and limonite disseminations and fracture fillings. Contains occasional slightly carbonaceous or magnetite-rich layers; locally interlayered with marble, lesser feldspar–quartz paragneiss (± garnet, ± biotite), and schist. Forms bold, massive outcrops where not strongly jointed. Highly fractured quartzite is quarried near Jack Wade Junction for road aggregate and used throughout the Eagle A-1 Quadrangle. Magnetic susceptibility for quartzite is generally very low (0.01–0.11 x 10-3 SI) except in magnetite-rich areas (up to 9 x 10-3 SI).

pMqgs QUARTZITE, PARAGNEISS, AND SCHIST (Pre-Mississippian) ¾ Mixed unit consisting of, in decreasing order of abundance, interlayered quartzite, paragneiss, and schist. Quartzite is fine grained, contains ± garnet, ± feldspar, muscovite (1–20 percent), biotite (± chloritized), and is locally calcareous and (or) marble bearing. Magnetic susceptibility for quartzite is bimodal, 0.01–0.5 x 10-3 SI and 5–30 x 10-3 SI. Gneiss varies from a fine- to medium-grained, locally banded, equigranular biotite–muscovite-feldspar–quartz paragneiss grading into a locally schistose, garnet–biotite ± muscovite feldspar quartz paragneiss. Magnetic susceptibility for gneiss is generally 0–0.6 x 10-3 SI, but occasionally as high as 16 x 10-3 SI. Schist is fine- to coarse-grained, and varies from a ± garnet–biotite–muscovite schist to a ± muscovite, biotite (± chloritized)–feldspar–quartz–schist. Locally asymmetrically folded. Magnetic susceptibility for schist is generally 0.1–0.4 x 10-3 SI.

pMsg SCHIST AND PARAGNEISS (Pre-Mississippian) ¾ Mixed unit characterized by abundant aluminous metasedimentary rocks. Small-scale isoclinal folds are locally visible, suggesting that the entire unit is isoclinally folded. Primarily interlayered, medium- to coarse-grained, schist (commonly crenulated and folded) and paragneiss, with minor local biotite quartzite, marble, and fine-grained plagioclase-rich (metavolcanic?) gneiss. The schist contains a minimum of 30 percent mica and typically contains 1–10 percent rotated, poikiloblastic garnet, 10–15 percent biotite, 15–75 percent muscovite, 2–20 percent plagioclase, 20–50 percent quartz, and 0–5 percent K-feldspar. Garnets are commonly 1–5 mm, other minerals typically 1–2 mm in size. Kyanite (0.2–0.5 mm, to 5 percent), staurolite (0.3–1 mm, to 5 percent), and tourmaline (0.1 mm, to 1 percent) are variably present, especially in the northwestern part of the Eagle A-1 Quadrangle. Staurolite, kyanite, and tourmaline are more abundant than shown on the geologic map, as they are virtually never identifiable in hand specimen. The common occurrence of staurolite with kyanite and tourmaline suggests that their occurrence is caused by aluminum–boron-rich bulk composition and not variations in metamorphic grade within the Fortymile River Assemblage. The paragneiss contains less than 30 percent micas and typically 40–60 percent quartz, 5–20 percent biotite, 1–20 percent muscovite, 10–25 percent plagioclase and 0–2 percent garnet, all with average grain sizes of 0.5–1 mm. The plagioclase-rich gneiss contains mineral abundances similar to that of the tonalite gneiss (Motn), but grain sizes of 0.20.5 mm suggest it may represent local (andesitic?) metavolcanic layers within a largely metasedimentary sequence. Magnetic susceptibilities for rocks of this unit are highly variable, with values between 0 and 20 x 10-3 SI, although low values (< 0.3 x 10-3 SI) are more common.

pMag AMPHIBOLITE AND GNEISS (Pre-Mississippian) — Amphibolite with a MORB-like trace element signature (Dusel-Bacon and Cooper, 1999) grading into fine-grained hornblende–epidote–plagioclase gneiss. The amphibolite characteristically contains significant amounts of magnetite with trace biotite and garnet and has a high magnetic susceptibility (average 3.5 x 10-3 with values to 20 x 10-3 SI). The gneiss commonly contains magnetite and sphene and also has a high magnetic susceptibility (average 2 x 10-3, with values to 10 x 10-3 SI). Mineralogical and major oxide composition of the gneiss indicates a basaltic andesite or graywacke protolith. This unit appears to underlie the schist and gneiss unit (pMsg).

pMg GNEISS (Pre-Mississippian) ¾ Predominantly fine-grained, typically plagioclase-rich gneiss, including rocks with apparently sedimentary and volcanic/volcaniclastic protoliths, and includes local orthogneiss and minor amphibolite. Primary mineralogy consists of garnet, biotite, plagioclase, and quartz ± muscovite ± hornblende, and all minerals with grain sizes of 0.5–1 mm. Rock types present suggest a protolith package of mixed arenites, possibly graywackes, with some volcanic rocks. Magnetic susceptibilities are generally moderate to low (0.1–1 x 10-3 SI), with some high values.

pMm MARBLE AND CALCAREOUS ROCKS (Pre-Mississippian) ¾ Massive outcrops of non-fossiliferous, fine- to coarse-grained, light gray, usually calcite, marble. Coarse-grained (5 mm), graphitic, dolomite marble occurs locally in the southeastern part of the Eagle A-1 Quadrangle. Mapped as a separate unit where semi-continuous, massive marble outcrops or float are abundant within other amphibolite-facies units. Also includes minor calcareous quartzite and calcareous or calc–silicate gneiss and schist. Magnetic susceptibility <0.01 x 10-3 SI. Mostly light gray with lesser green, reddish brown, and pink color variations, folded and discontinuous, with granoblastic polygonal texture. Locally contains veins, bands, and (or) disseminated crystals of quartz, clinopyroxene, epidote, tremolite, garnet, apatite, plagioclase, white mica, and (or) iron sulfides/oxides. Most calc–silicates were produced by regional metamorphism of impure carbonates; hydrothermal skarn is locally developed in pMm adjacent to Jurassic intrusions. The common presence of diopside and absence of wollastonite is compatible with regional metamorphism at epidote–amphibolite facies.

pMa AMPHIBOLITE, GNEISS, AND SCHIST (Pre-Mississippian) ¾ Mixed unit defined by amphibolite, with arc chemistry (Dusel-Bacon and Cooper, 1999), plagioclase-rich gneiss, and minor schist. Amphibolite is dark green, foliated, fine- to medium-grained, with typical mineralogy of ± epidote, ± garnet, ± quartz, ± biotite, and plagioclase (± sericite altered). Magnetite is locally abundant and titanium-rich minerals (sphene, rutile, ilmenite) are notably absent or nearly so. Locally quartz-veined and bearing disseminated iron sulfides. Amphibolite grades into and (or) is banded with fine-grained, hornblende—epidote–biotite–quartz–feldspar (± garnet, magnetite) gneiss on various scales. Typical modal mineralogy for the unit as a whole is 10–70 percent hornblende, 30–50 percent plagioclase, 0–10 percent biotite, 0–20 percent quartz, 0–5 percent garnet, and 0–5 percent epidote. Typical grain sizes are 0.5–1 mm, with locally coarser hornblende (1–2 mm). Commonly altered to epidote, locally cut by quartz veins with 1–3 percent pyrite, and occasionally contains pyrrhotite, limonite, and carbonate. Locally contains kyanite-bearing garnet–quartz–muscovite schist and muscovite–quartz schist. Compositions, mineralogy and mineral abundances suggest this unit consists primarily of arc basalt, basaltic andesite, and andesite protoliths, with some graywacke and minor aluminous sediment. Magnetic susceptibilities are quite variable, generally 0.1–2.5 x 10-3 SI, with locally high values (5–50 x 10-3 SI).

pMam AMPHIBOLITE (Pre-Mississippian) ¾ Mixed unit defined by epidote amphibolite with within-plate chemistry (Dusel-Bacon and Cooper, 1999), with lesser quartzite, paragneiss, schist, and minor marble. Amphibolite is green to dark green, fine- to coarse-grained, locally plagioclase–porphyroblastic, and consists of hornblende, epidote, plagioclase, sphene (to 3 percent), and minor biotite. Magnetic susceptibilities are generally low, 0.1–0.4 x 10-3 SI, with locally high values (1–2 x 10-3 SI). Interlayered with biotite–feldspar–quartzite ± carbonate, ± white mica, ± garnet, fine- to coarse-grained muscovite–biotite (1–10 percent)–feldspar–quartz paragneiss, muscovite–biotite–quartz schist ± garnet, and rarely, with siliceous and (or) calc–silicate-bearing marble. Spatially associated with a thick quartzite unit (Pmq) and apparently restricted to the central part of the Eagle A-1 Quadrangle and occasional fault slivers. Stratigraphic setting is unclear, but the restricted occurrence suggests it either underlies or overlies the other, more abundant, pre-Mississippian units.

Pza AMPHIBOLITE, PARAGNEISS, AND SCHIST (Paleozoic) — Mixed unit: approximately half epidote amphibolite, and half muscovite-quartz-rich paragneiss grading into garnet–biotite–muscovite–quartz schist. Layers of amphibolite 1–50 m thick alternate with schist–gneiss layers of similar thickness. The amphibolite lacks biotite, commonly contains several percent sphene, and displays a MORB-like (Dusel-Bacon and Cooper, 1999) trace element signature. This particular combination is present exclusively in a fault-bounded wedge in the southwestern part of the Eagle A-1 Quadrangle, spatially associated with the meta-harzburgite unit (Pzum). Asymmetric folds in the unit indicate top-to-the-north movement and suggest this unit is in thrust fault contact with pre-Mississippian metamorphic rocks to the north. This setting suggests unit Pza and associated unit Pzum are older than the pre-Mississippian units, but the lack of orthogneiss in these two units is also compatible with an age younger than Devono–Mississippian. Consequently, their absolute and relative age is unknown, but most likely Paleozoic. Magnetic susceptibility of the amphibolite is moderate, typically 0.3–0.5 x 10-3 SI; that of the schist and paragneiss is low, typically 0.05–0.2 x 10-3 SI.

Pzum META-HARZBURGITE (Paleozoic?) — Medium-grained, moderately foliated ultramafic rock, with an original mineralogy of olivine > orthopyroxene >> clinopyroxene, partly converted to an assemblage of talc ± chlorite ± anthophyllite, and overprinted by a variable degree of serpentinization. Serpentinization is inferred to be a late-stage alteration as the grain size of serpentine in the rocks is much smaller (<0.1 mm) than that of the anthophyllite, chlorite, or talc (1–5 mm). Spatially associated with an amphibolite-bearing unit (Pza) with MORB-type trace element signature. The origin of this body is unknown, but it differs from the serpentinized ultramafic rocks of the southeastern Eagle A-1 Quadrangle by (1) significantly higher pyroxene abundance, (2) abundance of metamorphic talc, chlorite, and anthophyllite, and (3) less abundant serpentine. The presence of anthophyllite suggests it was metamorphosed with the adjacent amphibolite-facies rocks. Magnetic susceptibility is high, 5–30 x 10-3 S.I.

BEDROCK

b UNDIFFERENTIATED BEDROCK - Exposed undifferentiated bedrock.

b’ SHALLOWLY BURIED BEDROCK - Undifferentiated bedrock that is covered by a thin (generally 1 m thick or less) veneer of colluvium. Cover is generally sufficiently thin that planar bedrock structures like joints, foliation, and bedding are reflected at the ground surface by linear and curvilinear shallow troughs and bands of moist ground or hydrophyllic vegetation.

UNIT SYMBOLS	DESCRIPTION OF MATERIALS UNITS

UNCONSOLIDATED MATERIALS

GS Fluvial and glaciofluvial gravel, sand, and silt. 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 may include boulders. Includes primarily GP and GW of the Unified Soil Classification (Wagner, 1957).

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

SM Silt deposited primarily by wind and reworked by fluvial and colluvial processes. May be organic rich. Commonly frozen and ice-rich, especially on north-facing slopes. Chiefly fine materials. Estimated >80 percent silt, sand, and clay. Includes primarily ML, MH, and SM of the Unified Soil Classification (Wagner, 1957).

OR Organic-rich silt and peat in bogs, former stream channels, and lake basins. Commonly frozen and ice-rich due to the excellent insulating properties of peat. Generally water-saturated. Chiefly organic materials. Estimated >50 percent peat, organic sand, or organic silt. Includes Pt of the Unified Soil Classification (Wagner, 1957).

BEDROCK MATERIALS

BC Medium-jointed, fine- to coarse-grained sedimentary carbonate rocks and their metamorphic equivalents. Includes limestone and marble.

BG Coarse-jointed, coarse-grained igneous lithologies and their metamorphic equivalents. Chiefly granitic rocks. Includes coarse-grained gneiss.

BM Medium-jointed, fine- to medium-grained quartzose sedimentary rocks and their metamorphic equivalents. Chiefly quartzite in this map area.

BS Fine- to coarse-grained mafic plutonic rocks and their metamorphic equivalents. Includes metagabbro and serpentinite.

BV Medium-jointed, fine-grained igneous rocks and their metamorphic equivalents.

Chiefly metavolcanics and dikes.

BO Rocks of lithologies that are (a) not listed in other materials classes, but which may be suited for use as construction materials or for other specialized purposes, and (b) mixed units composed of combinations of the above bedrock materials classes. Includes fine-grained gneiss and phyllite.

BU Rocks of mixed lithology and/or very fine-grained sedimentary lithologies that are generally poorly suited for use as construction materials. Includes coal-bearing Tertiary sediments.