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Title: Geologic map of the Cobblestone Creek–May Creek area, east-central foothills,
Brooks Range, Alaska

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UNIT SYMBOL	DESCRIPTION OF MAP UNITS
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- Qa** **ALLUVIUM, UNDIFFERENTIATED** (Quaternary)—Silt, sand, and gravel in active braided river and stream channels.
- Qc** **COLLUVIUM** (Quaternary)—Active talus deposits on steep valley walls.
- Qgm** **GLACIAL MORaine DEPOSITS** (Quaternary)—Poorly sorted, unstratified till; stony silt to sandy, bouldery gravel; large, erratic boulders in some places.
- Qu** **QUATERNARY DEPOSITS, UNDIFFERENTIATED**
(Quaternary)—Fine-grained colluvium, upland silt, and surficial material not otherwise differentiated.
Qu (Ktu)—Undifferentiated colluvium and tundra overlying Tuluvak Formation.
Qu (Ks)—Undifferentiated colluvium and tundra overlying Seabee Formation.
Qu (Kn)—Undifferentiated colluvium and tundra overlying Nanushuk Formation.
Qu (Kt)—Undifferentiated colluvium and tundra overlying Torok Formation.

DEPOSITS OF THE COLVILLE BASIN FOLDBELT

- Ktu** **TULUVAK FORMATION** (revised nomenclature; Turonian to Coniacian)—Clean, well sorted, fine- to medium-grained sandstone and conglomerate, in two intervals each up to 25 m thick, interbedded with shale and siltstone.
- Ks** **SEABEE FORMATION** (revised nomenclature; Cenomanian–Turonian)—Gray to black mudstone and fissile, organic-rich paper shale, with abundant bentonite and some thin, silicified tuff beds.
- Knu** **NANUSHUK FORMATION, UPPER UNIT** (revised nomenclature; Albian–Cenomanian)—Dominantly nonmarine, gray

to light gray sandstone and quartz- and chert-pebble conglomerate interbedded with poorly exposed dark gray carbonaceous shale and coal.

Kn1 **NANUSHUK FORMATION, LOWER UNIT** (revised nomenclature; Albian)—Dominantly gray to greenish gray, very fine- to fine-grained marine sandstone and minor conglomerate.

Ktou **TOROK FORMATION, UPPER PART** (Albian–Aptian or Albian)—Dark gray to black silty shale, mudstone, and clay shale with interbedded thin-bedded siltstone and very fine grained, dark gray sandstone in upper part.

DEPOSITS OF THE DISTURBED BELT

COBBLESTONE PARAUTOCHTHONOUS SEQUENCE

Ktol **TOROK FORMATION, LOWER PART** (Aptian or Aptian–Albian)—Dark gray to black silty shale and mudstone as in Colville basin foldbelt. A locality within the Cobblestone triangle zone on May Creek just north of Cobblestone Ridges consists of ~20 m anomalous gray, hard, lithic, fine to very fine grained, light to medium gray, thin bedded, micaceous sandstone interbedded with soft, gray, clayey, fissile, micaceous shale. Sandstone beds are lighter gray and cleaner than typical Torok beds; one sandstone bed has strong, sweet petroleum odor.

Kfmc **COBBLESTONE MEMBER OF FORTRESS MOUNTAIN FORMATION** (redefined unit) (Barremian?–Aptian)—Sandstone and minor conglomerate, dark greenish gray, medium to thick bedded in amalgamated turbidite units deposited by debris flows. Sandstone commonly contains conspicuous light gray to cream weathering leached chert grains that give a light-colored weathering appearance to the lithic sandstone; carbonaceous plant debris abundant in some beds, also contains flakes of tasmanite, a distinctive, black, organic-rich shale. Conglomerate clasts are dominantly dark gray chert, white to gray leached chert, and minor blue-green chert. Unit probably contains coarser debris flows to south. At one locality on Nanushuk River, consists of ~30 m of beds of poorly sorted greenish gray lithic sandstone, matrix-supported conglomerate, and breccia debris-flow deposits in beds to 2 m thick gradationally overlain by dark gray to black silty mudstone and shale.

- Kpm** **UNNAMED PHOSPHATIC–MANGANIFEROUS SHALE**
(Barremian)—Hard, bioturbated shale with conspicuous reddish brown, manganiferous weathering sheen.
- KJu** **UNDIVIDED CRETACEOUS, JURASSIC, AND TRIASSIC ROCKS**—Dominantly gray to black shale and mudstone, structurally contorted, exposed at two localities on south side of Cobblestone Ridges (east bank of Cobblestone Creek and in tributary of May Creek). Includes units too thin to differentiate at scale of map:
UNNAMED PHOSPHATIC-MANGANIFEROUS SHALE
(Lower Cretaceous, Barremian)—Hard, reddish brown weathering bioturbated shale with conspicuous manganiferous weathering sheen;
BUCHIA LIMESTONE COQUINA (Valanginian)—See description below;
KINGAK FORMATION (Lower Cretaceous, Valanginian)—Gray silty shale with large ovoid ironstone concretions;
BLANKENSHIP MEMBER OF OTUK FORMATION (Lower to lower Upper Jurassic, Pliensbachian–Oxfordian)—Organic-rich, black, fissile shale and paper shale with a few thin bentonite seams; excellent oil and gas source-rock potential; unit represents condensed deposition coeval with lower part of Kingak Shale of northern Colville Basin.
- Kc** **BUCHIA LIMESTONE COQUINA** (Valanginian)—Distinctive reddish brown weathering, thin-bedded limestone <2 m thick; in beds 2 to 10 cm thick, with thin interbeds and partings of dark gray to black fissile shale; composed entirely of the pelecypod *Buchia sublaevis* (Valanginian); unit too thin to be delineated on geologic map and cross section; outcrop locations indicated by small fossil icon and symbol.
- J o** **OTUK FORMATION** (Upper Triassic–lower Upper Jurassic, Oxfordian)—Thinly interbedded, organic-rich, fossiliferous limestone, shale, and marlstone; poorly exposed in small stream-bank exposures north of Cobblestone Ridges on west bank of May Creek, in small gully on east side of May Creek, and in tributary of May Creek on south side of Cobblestone Ridges. Limestone member in lower part of formation is black fossiliferous limestone and calcareous shale containing abundant Upper Triassic *Monotis* and *Halobia* sp. overlain by 1-m-thick shale and 20-cm-thick glauconitic siltstone of Karen Creek Member. Upper part of formation is Blankenship Member—organic-rich black marl and fissile paper shale with scattered small (<1 cm diameter) Jurassic pelecypods *Otapiria tailleuri*.

ALLOCHTHONOUS ROCKS

Syntectonic Turbidites, Mélange, and Olistostromal Deposits

Kmo **UNNAMED MÉLANGE/OLISTOSTROME** (Lower Cretaceous, post- Valanginian, Aptian?)—Dark gray to black mudstone locally sheared to a scaly argillite, and thin-bedded dark gray to black turbidites; contains large sheared exotic blocks and elongate masses of white-weathering, partly leached chert, greenish gray chert, and silicified mudstone of the Imnaitchiak Chert (**J**₁**i**). South of Peregrine Ridge anticline, contains masses of Okpikruak graywacke (**Kog**) with *Buchia sublaevis* (Valanginian), and blocks of *Buchia* limestone coquina (**Kc**) (Valanginian) derived from top of underlying Endicott Mountains allochthon, (see below). Interpreted to be a tectonically disrupted large-scale, mass-transport deposit gravitationally transported a long distance basinward from an area of active tectonics. Unit appears to disconformably overlie Okpikruak Formation (**Kog**) on south flank of Peregrine Ridge anticline and to be folded around the faulted southwestern plunge of the anticline. On north side of Peregrine Ridge, anticline unit disconformably overlies lower Fortress Mountain Formation (**Kfml**). Contains five exotic blocks of graywacke with apatite-fission track ages of 135–144 Ma (see Table 2), which suggests that this mélange/olistostrome unit may not have been deeply buried since its deposition. Age unknown, probably Aptian; may be coeval with part of lower Fortress Mountain Formation.

Kfml **FORTRESS MOUNTAIN FORMATION, LOWER PART** (Lower Cretaceous, Aptian?)—Poorly sorted polymict cobble to boulder conglomerate and breccia probably deposited as debris flows, ~15 m thick; contains clasts of chert, mafic igneous rocks, gabbro, granitic rocks, limestone, and quartzitic sandstone. Vertical beds well exposed on Peregrine Creek form resistant ridge on north flank of Peregrine Ridge anticline. Resistant conglomeratic beds apparently thin and fine upward into lithic sandstone, silty mudstone, and shale that underlie lowland area north of Peregrine Ridge; mudstone and shale contain conspicuous ovoid yellowish brown weathering concretions similar to lower part of Fortress Mountain Formation in Atigun Gorge east of map area. Base of unit on Peregrine Ridge is a thrust fault (probable backthrust) overlying elongate masses of Imnaitchiak Chert (**J** **i**) and *Buchia* limestone coquina (**Kc**) in a thin section of the unnamed mélange/olistostrome disconformably overlying the Okpikruak Formation (**Kog**) on the north flank of Peregrine Ridge anticline. In lowland areas east of Cobblestone Creek, unit is mostly rubble consisting of thinly bedded,

fine-grained, dark greenish gray graywacke interbedded with dark gray to black mudstone; resembles lower part of Fortress Mountain Formation in Atigun Gorge east of map area. Unit appears to be structurally contorted. Unless bounded by an unrecognized fault, upper part of unit appears to be a lateral equivalent of mélangé/olistostrome (Kmo) west of Cobblestone Creek. Age uncertain, probably Aptian.

Kc **BUCHIA LIMESTONE COQUINA** (Valanginian)—Reddish brown weathering, thin-bedded limestone <2 m thick, in coquina beds 2–10 cm thick composed of pelecypod *Buchia sublaevis* (Valanginian); occurs as sheared masses in southern part of mélangé/olistostrome, derived from top of Endicott Mountains allochthon. Unit too thin to be delineated on geologic map and cross section; outcrop location indicated by small fossil icon and symbol.

J i **IMNAITCHIAK CHERT** (Pennsylvanian to Jurassic)—Light gray to white to yellowish orange weathering, thin to thick bedded, gray to greenish gray chert or silicified mudstone with interbedded siliceous shale; white chert is commonly leached. In map area present only as structurally contorted elongate exotic blocks up to 100 m long, abundant in mélangé/olistostrome between Cobblestone Creek and Cascade Creek on both north and south limbs of Peregrine Ridge anticline.

Picnic Creek or Ipnavik River Allochthon

Kog **OKPIKRUAK FORMATION, GRAYWACKE FACIES** (Lower Cretaceous, Valanginian)—Fine grained, dark greenish gray graywacke turbidites rhythmically interbedded with dark gray to black mudstone, exposed in tightly folded and faulted Peregrine Ridge anticline between Cascade Creek and May Creek. Contains interbedded *Buchia* limestone coquina (Kc) and black shale.

Koqg **OKPIKRUAK FORMATION, QUARTZOSE GRAYWACKE FACIES** (Lower Cretaceous, Berriasian or Valanginian)—Fine to medium grained, light gray to greenish gray, medium to thick bedded, quartzose graywacke, possibly tuffaceous, with minor amounts of interbedded sheared black shale. Some beds contain abundant black shale or carbonaceous flakes and light gray chert granules, some beds finely micaceous, some load and groove casts and burrowing. Beds have abundant dark healed microfractures resulting in a characteristic spiderweb-like appearance on fresh surfaces. Weathers light gray in contrast to dark gray weathering Okpikruak graywacke facies. Present only on Nanushuk River at

west edge of map area but widespread in Kanayut River map area to west.

DEPOSITS OF THE BROOKS RANGE MOUNTAIN FRONT

ENDICOTT MOUNTAINS ALLOCHTHON

- Kc** **BUCHIA LIMESTONE COQUINA** (Lower Cretaceous, Valanginian)—Reddish brown weathering limestone coquina composed entirely of pelecypod *Buchia sublaevis* sp., in beds 2–10 cm thick, interval <2 m thick, structurally contorted and thickened; in Cobblestone map area, found associated with Blankenship Member of Otuk Formation on Cobblestone Creek and May Creek (see below) and as exotic blocks within southern part of mélange/olistostrome belt. Unit commonly infolded with upper part of underlying Otuk Formation and is too thin to be delineated on geologic map and cross section; outcrop locations indicated by small fossil icon and formation symbol.
- OTUK FORMATION** (Middle Triassic–lower Upper Jurassic, Oxfordian)—Limestone member—black fossiliferous, organic-rich limestone, siliceous limestone, and organic-rich black sooty shale, with abundant *Monotis* and *Halobia* sp. Pelecypods. Karen Creek Member—2 m black, very fine-grained quartzose sandstone. Top of unit: Blankenship Member (Early and Middle Jurassic)—organic-rich black shale and marl. Unit is intensely deformed and generally not well exposed, but is well exposed on west bank of Cobblestone Creek downstream from mountain front.
- Ps** **SIKSIKPUK FORMATION** (Permian)—Greenish gray claystone and siltstone, with scattered barite and siderite nodules; unit is incompetent and intensely deformed and generally not well exposed.
- MI** **LISBURNE GROUP** (Upper Mississippian, Meramecian–Lower Pennsylvanian, Atokan)—Not mapped in detail south of mountain front. Dominantly massive, light gray weathering, cliff-forming crinoidal limestone and dolomite; in places contains abundant black chert nodules, lenses, and beds. Dolomite commonly has pinpoint to small vugular porosity containing solid black hydrocarbon. Unit forms high mountains in southern part of map area, is repeated by multiple thrust faults along detachment horizon in underlying Kayak Shale.
- Mk** **KAYAK SHALE** (Lower Mississippian)—Dark-gray to black fissile clay shale with yellowish brown-weathering, thin,

fossiliferous limestone beds near top, reddish brown weathering nodules common, base of unit contains quartzitic sandstone beds transitional with underlying Kanayut Conglomerate, which is extensively exposed south of map area.