/* ------------------------ CODESET ------------------------ */
Title: Geologic unit code set for the Geologic map of the Upper Chena River area, eastern interior Alaska
Publication: PR 115
URL: http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=citation&ID=2315
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DESCRIPTION OF GEOLOGIC UNITS

SURFICIAL DEPOSITS

Qd GLACIGENIC DEPOSITS, UNDIFFERENTIATED—Includes all varieties of till, outwash, and minor colluviated drift or other diamicton. Consists of poorly sorted, generally non-stratified, gravelly sediment, with a sand and silt matrix. Age unknown

Qd5 GLACIAL DRIFT—Heterogeneous glacial diamicton and minor outwash deposits. Consists of nonstratified, poorly to moderately sorted sandy gravel with varying amounts of silt, clay, and boulders. Deposits are associated with valley-head moraines in cirques. Least extensive of all drift units recognized. Age uncertain, but probably late Pleistocene to Holocene

Qd4 GLACIAL DRIFT—Heterogeneous glacial diamicton associated with unmodified knob-and-kettle moraine. Consists of till and minor outwash. Sediment ranges from poorly sorted bouldery gravel in a silty matrix to well-sorted sandy gravel. Less extensive than Qd3 but more extensive than Qd5. Age uncertain, but probably late Pleistocene

Qd3 GLACIAL DRIFT—Heterogeneous glacial diamicton in moraines and minor glaciofluvial deposits. Drift bodies and moraines are partially subdued and locally exhibit hummocky, ice-stagnation topography. Natural exposures and hand-dug pits reveal poorly sorted silty gravel and moderately well-sorted, sandy gravel with variable amounts of boulders and cobbles. Less extensive than Qd2 but more extensive than Qd4. Age uncertain, but probably middle to late Pleistocene

Qd2 GLACIAL DRIFT—Heterogeneous glacial diamicton associated with subdued moraine and outwash deposits. Usually present as isolated remnants on valley floors inside limits of Qd1. Consists of poorly sorted to moderately well sorted silty gravel with variable amounts of silt, sand, and boulders. Age uncertain, but probably middle Pleistocene. Morainal crests generally wind deflated and littered with highly weathered and pitted erratic boulders

Qd1 GLACIAL DRIFT—Heterogeneous glacial diamicton, present in very subdued drift bodies that partially cap ridges and knolls. Includes varying amounts of till, outwash, colluviated drift, and gelifluction deposits. Consists of poorly sorted, silty gravel. Locally frozen below depths of about 3 feet. Age uncertain but is probably early to middle Pleistocene. Qd1 is the most extensive drift recognized. Generally not associated with recognizable morainal topography. Contains exhumed, highly weathered erratic boulders

Qdo GLACIFLUVIAL OUTWASH, UNDIFFERENTIATED—Clast-supported cobble and small-boulder gravel. Generally exhibits good primary stratification, is well sorted and contains

rounded to subrounded clasts. Associated with high-level fluvial terraces. Locally capped by up to 7 feet of frozen eolian silt. Age uncertain. May have placer potential

Qdo5 GLACIFLUVIAL OUTWASH—Moderately to well-sorted, clast-supported, cobble and small-boulder gravel with minor silt and sand. Deposits form fluvial terraces that are related to glacial drift units by morphologic relations. Estimated age same as associated drift units. Outwash terraces are usually mantled by several feet of frozen eolian silt and sand. May have placer potential

Qrg ROCK-GLACIER DEPOSITS—Lobate or tongue-shaped accumulations of bouldery talus and scree exhibiting evidence of down-slope movement. Often characterized by multiple crescentic ridges that are parallel to but upslope of deposit terminus

Qca ALLUVIUM AND COLLUVIUM, UNDIFFERENTIATED—Interstratified alluvium and colluvium that include mudflows, debris flows, snow and avalanche fans, and colluvial deposits emanating from steep channels and gullies. Consists of poorly stratified, nonsorted, gravelly to silty sediment

Qa UNDIFFERENTIATED ALLUVIUM—Moderately to well-sorted cobble and pebble gravel, sand and silt. Undifferentiated with respect to age. Generally forms low terraces above active flood plains. May have placer potential

Qal FLOOD-PLAIN ALLUVIUM—Moderately to well-sorted cobble and pebble gravel, sand, and overbank silt on flood plains or in active stream channels. May contain organic detritus as discrete beds or layers. May be mantled by colluvial deposits along flood plain margins. Coarse-grained alluvium may contain placer deposits

Qaf ALLUVIAL FAN DEPOSITS, UNDIFFERENTIATED—Moderately sorted, crudely stratified, cobble and pebble gravel with minor sand and silt. Forms cone- or fan-shaped alluvial deposits along the base of mountain fronts and valley slopes. Usually clast-supported and may contain lenses or wedges of angular colluvial gravel

Qc COLLUVIAL DEPOSITS, UNDIFFERENTIATED—Angular, poorly sorted, nonstratified gravel with varying amounts of sand, silt, and clay. Common on slopes less than 45°, where these deposits form blanketing mantles. May include gelifluction deposits and minor alluvium. Deposits usually include permafrost

Qcd COLLUVIAL DRIFT—Reworked surfaces of moraines and other glacial deposits. Consists mainly of retransported glacial diamicton and outwash. Contains varying amounts of sand, silt, and boulders

Qcg GELIFLUCTION DEPOSITS—Poorly sorted to angular gravel with varying amounts of sand, silt, and clay. Forms lobate sheets or individual tongues of reworked sediments on underlying deposits that are prone to seasonal freezing and thawing. Well developed in older, subdued glacial drift

Qct TALUS FANS AND APRONS, UNDIFFERENTIATED—Coarse, blocky, rock rubble along the base of steep mountain slopes. Associated with cone- or fan-shaped talus landforms that often coalesce, forming talus aprons. Includes avalanche boulder tongues, boulder trains, and may include debris flow deposits

Qcc SLOPE TALUS—Coarse, blocky, rock rubble that forms a blanketing layer of talus and scree on mountain slopes. Includes stone stripes, gelifluction deposits, and rock-glacier talus

Qcf FINE-GRAINED COLLUVIUM—Retransported silt, locally interbedded with sand and gravel. Mainly on lower hill slopes and valley bottoms

Qcl LANDSLIDE DEPOSITS—Unconsolidated sediments disturbed by slope failure in the form of slumps or slides. Deposits usually exhibit hummocky surface morphology and tipped, uprooted, and leaning trees and vegetation

Qlp PEAT, PEATY SILT, AND FEN DEPOSITS—Accumulations of peat in bogs and swamps. May be interstratified with loess or alluvium. Usually found in low-lying areas; deposits are up to several meters thick

Qht PLACER TAILINGS—Irregular piles and mounds of mining waste and overburden. Consists mainly of gravel, sand, and minor silt

BEDROCK UNITS

IGNEOUS ROCK UNITS

Tgr GRANITE—Medium light-gray to gray, fine- to coarse-grained, nonporphyritic, hypidiomorphic granular, hornblende-biotite granite. Estimated modal composition: 40 percent microcline, 25 percent plagioclase, 15 percent quartz, 10 percent biotite, 5–10 percent hornblende, minor chlorite replacing biotite, and calcite. Granite yields a K–Ar age of 64.4 ± 0.48 Ma on biotite (map loc. 2; table 1)

TKgd GRANODIORITE—Light- to dark-gray, fine- to medium-grained, equigranular to porphyritic, biotite-hornblende granodiorite. Estimated mode: 45 percent plagioclase (An40–45), 30 percent quartz, 20 percent K-feldspar, 2 percent hornblende, 2 percent biotite, and <1 percent zircon and calcite as accessories

Kgr1 GRANITE AND GRANODIORITE—Medium gray, medium- to coarse-grained, porphyritic, muscovite-biotite granite with potassium feldspar phenocrysts to one-half inch long and quartz phenocrysts to one-half inch in diameter; and medium to dark-gray, fine- to medium-grained, biotite granodiorite. Locally unit contains abundant quartz veining. Quartz veinlets contain quartz crystals, muscovite, limonite, and specular hematite. Estimated modal composition of the granite phase: 45 percent microcline, 20 percent plagioclase (An20–25), 20 percent quartz, 12 percent biotite, 2 percent white mica (muscovite ?), <1 percent apatite, chlorite, zircon, and calcite as accessories. Biotite from granitic phase yields a K–Ar age of 72.8 ± 1.6 Ma (map loc. 1; table 1)

Kgr2 GRANITE—Light-gray, coarse-grained, equigranular to porphyritic, biotite granite with potassium feldspar phenocrysts to one-inch long. Estimated mode: 40 percent microcline, 25 percent quartz, 20 percent plagioclase (An25–30), 10 percent biotite, 3 percent chlorite, 1 percent white mica (muscovite ?), and <1 percent zircon, calcite, apatite and opaques as accessories

Kgr3 GRANITE—Light- to medium-gray, fine- to medium-grained, equigranular and porphyritic, muscovite-biotite granite with potassium feldspar phenocrysts to one-half inch long. Estimated mode: 45 percent microcline, 25 percent quartz, 25 percent plagioclase (An15–20), 2 percent biotite, 2 percent white mica (muscovite ?), and <1 percent zircon and apatite as accessories. Border phase is medium dark-gray, fine-grained, non-porphyritic biotite granite. Unit contains numerous pegmatite dikes and thin quartz-tourmaline veins. Granite yields a K–Ar age of 68.7 ± 2.1 Ma for biotite and 77.55 ± 2.3 Ma for muscovite (map loc. B; table 1)

Kgr4 GRANITE AND QUARTZ MONZONITE—Light- to medium-gray, fine- to medium-grained, equigranular to porphyritic, biotite granite and gray, medium-grained, porphyritic quartz monzonite with potassium feldspar phenocrysts to one-eighth inch long. Estimated mode for the granite: 45 percent microcline, 35 percent quartz, 17 percent plagioclase, 2 percent biotite, and <1 percent muscovite and zircon as accessories. Unit contains abundant pegmatite dikes. Pegmatite dikes are medium to dark gray, medium- to coarse-grained, equigranular rocks containing quartz, plagioclase, white mica, biotite and garnet locally. Unit also contains zones of quartz-tourmaline veining. Kgr4 yields K–Ar age of 73.5 ± 2.5 Ma for biotite and 77.6 ± 2.0 Ma for muscovite (map loc. 4; table 1)

Kgr5 QUARTZ MONZONITE AND GRANITE—Medium light-gray to gray, fine- to medium-grained, slightly porphyritic muscovite-biotite quartz monzonite and gray, fine- to medium-grained, equigranular muscovite-biotite granite. Estimated mode for the granitic phase: 35–40 percent microcline, 30–35 percent quartz, 22 percent plagioclase (An25–30), 3 percent biotite, and <1 percent muscovite and zircon as accessories. Locally unit has an incipient foliation

Kgd1 GRANODIORITE—Light- to medium-gray, fine-to coarse-grained, equigranular to porphyritic biotite-hornblende granodiorite, and biotite granite. Estimated mode for the granodiorite: 45 percent plagioclase (An40–45), 30 percent quartz, 20 percent K-feldspar, 2 percent hornblende, 2 percent biotite, and <1 percent zircon and calcite as accessories. Porphyritic phases contain abundant potassium feldspar phenocrysts and are biotite rich.

Kgd2 GRANODIORITE—Medium- to dark-gray, medium- to fine-grained, equigranular hornblende-biotite granodiorite. Estimated mode: 35 percent plagioclase (An30–35), 35 percent K-feldspar, 25 percent quartz, 2 percent hornblende, 2 percent biotite, and <1 percent chlorite, zircon, calcite, white mica, and apatite as accessories. Contains small (generally less than one-inch wide) dikelets of similar composition. Zones of dark-gray, fine-grained biotite granodiorite are present locally. Center of Kgd2 body is medium grained, grading to fine-grained border phase

Mzwg GRANITE, GRANODIORITE, AND QUARTZ MONZONITE—Medium-grained equigranular to porphyritic biotite-muscovite granite; medium-grained, porphyritic, biotite granite, and quartz monzonite; and dark-gray, fine- to medium-grained, biotite-hornblende granodiorite. Estimated mode of the granite: 45 percent K-feldspar, 25 percent quartz, 25 percent plagioclase

(An25–30), 3 percent biotite, and <1 percent chlorite and muscovite as accessories. All phases are massive without a planer or linear fabric. Unit intrudes rocks of the West Point complex. Pluton yields a K–Ar age of 85.0 ± 2.5 Ma on biotite (map loc. C; table 1)

MzPzum SERPENTINITE—Medium-dark-green to dark green, fine- to medium-grained, highly altered serpentinite. Present as small isolated bodies or tabular masses along fault zones. Contains altered gabbroic rocks locally

METAMORPHIC ROCK UNITS

Totatlanika Schist

Pztm MARBLE—Massive- to thin-bedded, gray to creamy white marble interbedded with Pztg and Pstp. Garnet and epidote locally present. Siliceous webs and veinlets common in massive beds. Compositionally gradational to Pztc

Pztc CALCSCHIST—Thinly layered, schistose calcareous rocks. Composition varies from impure micaceous marbles to biotite-sericite-calcite-quartz schist with accessory tourmaline, ilmenite(?), and apatite. Interlayered with and gradational to Pztm. Most abundant near contact with Blackshell unit

Pztg GREEN PHYLLITE AND SEMISCHIST—Pale- to dark-green phyllite, semischist, and phyllitic quartz arenite (grits) with foliated chlorite-sericite-plagioclase-quartz groundmass. Subrounded to angular quartz clasts typically compose 35–50 percent of the rock and are poorly sorted to bimodal with clast sizes to one-eighth inch in diameter. Plagioclase composition is An33–35. Unit includes some banded green chert with thin white carbonate laminations. Crenulations and kink folds are common. Abundant quartz veins and limonitic clots on foliation surfaces. Intricately folded near the contact with Pzbp

Pztp GRAY PHYLLITE AND SEMISCHIST—Light- to dark-gray rocks, identical in texture and mineral content to Pztg but without green coloration. Mainly sericite-quartz with minor feldspar and trace chlorite. Small-scale folds and crenulations prevalent

Pztt TAN PHYLLITE AND SEMISCHIST—Tan-weathering phyllite, semischist, and meta-arenite. Identical to Pztg and Pztp except for more abundant feldspar and minor biotite, and disseminated limonite throughout the rock imparts a tan coloration

Pztu UNDIFFERENTIATED TOTATLANIKA SCHIST—Includes several Pzt lithologies described above. Confined to east trending ridge in the southeastern part of the map area

Blackshell and Dan Creek Units

Pzbr BLACKSHELL RHYOLITE—Light- to dark-brown weathering, quartz-K-feldspar porphyry dome and associated aphanitic vitreous muscovite- feldspar-quartz beds (metatuff, metaexhalite) near top of Pzbp unit. Rhyolite is porphyritic with white, Carlsbad- twinned, subhedral K-feldspar and rounded or embayed, gray beta-quartz phenocrysts in an aphanitic groundmass of sericite, feldspar, and quartz with disseminated pyrite blebs. Associated aphanitic,

vitreous quartzite beds (metaexhalites ?) in same stratigraphic horizon are finely laminated, muscovite-feldspar-quartz rock with altered feldspar and pyrite clots. U–Pb model ages of between 355.2 ± 1.2 Ma and 355.9 ± 0.8 Ma were obtained on zircons from rhyolite of this unit (J.K. Mortenson, Geological Survey of Canada, written commun., 1989; map loc. J; fig. 4)

Pzbp BLACKSHELL QUARTZITE AND PHYLLITE—A 4,000-foot-thick sequence of black carbonaceous phyllite and fine-grained, dark, laminated quartzite with minor interbeds of calcschist and marble (Pzbc), rhyolite (Pzbr), and pebble to granule conglomerate. Unit is gradational with increase of carbonate to the Dan Creek calcphyllite below, and in this map area, is in thrust-fault contact with various lithologies of Totatlanika Schist above.

Pzbc BLACKSHELL CALCSCHIST AND MARBLE—Tan to medium gray, calcite-rich beds inter-bedded with Pzdp unit; most common near gradational contact with the Dan Creek calcphyllite unit (Pzdp). Calcareous beds are typically 1–2 feet thick, interlayered and interfolded with black quartzite. Texture varies from paper-thin laminations of alternating carbonate and phyllite to banded, faintly schistose white mica-calcite quartzite. Carbonaceous concentrations along bedding traces and disseminated pyrite are present in most Pzbc units

Pzdc DAN CREEK CALCSCHIST—Basal part of the Dan Creek unit, present mainly in the western part of the map area along the Middle Fork of the Chena River. Consists primarily of medium- to dark-gray muscovite-biotite-calcite-quartz schist with interbeds of white and gray marble (Pzdm), gray or black quartzite, and garnet-muscovite-quartz schist. Quartz boudins and veins common. Gradational to Chena River sequence below. Differentiated from Pzdp by the presence of coarse-grained white mica in schists

Pzdp DAN CREEK CALCPHYLLITE—Interbedded silvery gray, calcareous phyllite; brown, gray, or black laminated quartzite, noncalcareous gray phyllite, and minor green phyllite and marble (unit Pzdm). Typical mineralogy is 80–85 percent quartz, 5 percent white mica, and 5–10 percent chlorite and graphite.

Pzdm DAN CREEK MARBLE—Gray to white or greenish gray marble in Pzdc-Pzdp section. Coarsely crystalline with varying amounts of chlorite, muscovite, and quartz. Thinly laminated and fine-grained to massive and granoblastic

Chena River sequence

Pzra AUGEN GNEISS—Mottled gray or brown and white, mainly concordant, granitic augen gneiss bodies in Chena River sequence, upper Clinky quartzite, and West Point Complex. Typically weathers as flaggy plates or blocks, a few inches to several feet in diameter. Thickness of augen gneiss layers varies from a few inches to tens of feet; multiple thin layers are common.

Pzrn GREENSCHIST—Greenish-gray actinolite green-schists with variable mineralogy. Varieties include garnet-chlorite-muscovite-actinolite schist, biotite-muscovite-actinolite quartz schist, plagioclase-quartz-biotite-actinolite schist, and porphyroblastic garnet-chlorite-calcite-actinolite schist. Unit grades compositionally to micaceous amphibolite (Pzrp) and amphibolite (Pzrf). Contains zones of abundant white quartz veins and lenses

Pzrcs CALCSILICATE ROCKS—Thin- to thick-bedded, light green to white units of diopside-bearing quartzite, diopside-calcite quartzite, and diopside-quartz marble. Most beds are somewhat calcareous with pod-like or lenticular calcite concentrations. Typically laminated or banded. Boudinage of quartz-rich layers common.

Pzrs PELITIC SCHIST AND QUARTZITE—Medium- to coarse-grained, silvery to bronze weathering pelitic schist and gray or brown micaceous quartzite. Schist-quartzite ratios in the Chena River sequence are about 4:1. Most commonly, garnet-feldspar-biotite-muscovite-quartz schist with varying amounts of minor minerals—staurolite, kyanite, sillmanite, hornblende, graphite, and secondary chlorite, biotite, or sericite.

Pzrf BANDED AMPHIBOLITE AND FELSITE—Dark-green, coarse-grained, schistose, hornblende-diopside -plagioclase-quartz amphibolite interlayered or interlaminated with muscovite-feldspar-quartz felsite. Garnet, biotite, and vesuvianite are minor minerals; sphene and ilmenite(?) are common accessories. Banded amphibolite sections locally include beds 2–6 inches thick of white laminated micaceous quartzite or beds of silvery-brown pelitic schist. Pzrf rocks were probably recrystallized from mafic, intermediate, and felsic tuffs

Pzrc CALCSCHIST—White to gray, thin-layered quartz-muscovite-biotite-calcite schist. Typically very schistose fabric with "streaked out" muscovite or biotite. Clinozoisite and plagioclase are minor minerals; tourmaline and sphene are accessories. Interbedded with pelitic schist (Pzrs), marble (Pzrm), or forms lenticular interbeds in green calcsilicate units (Pzrcs)

Pzrm MARBLE—Cream-colored, gray, or pale-green marble layers to 180 feet thick. Massive to thinly bedded. Contains zones with quartz-rich horizons. Marbles grade compositionally to calcschists (Pzrc) with paper-thin bedding and layers of garnet-muscovite-biotite quartz schist. Gray and greenish marbles contain varying amounts of garnet, diopside, and clinozoisite. Limonitic pits and stains along bedding are locally present. Commonly associated with calcsilicate beds (Pzrcs) and amphibolite (Pzrp)

Pzrp MASSIVE AMPHIBOLITE—Dense, fine- to medium-grained, dark-green, schistose amphibolite with varying amounts of biotite, garnet, plagioclase, calcite, and quartz. Associated with thin foliated marble layers and pelitic schist. Accessory sphene and ilmenite. Calcite veinlets common. Unit probably recrystallized from mafic volcanic flows and calcareous mafic tuffs

Pzrg GRAPHITIC SCHIST—Gray to black, micaceous quartz schist with abundant graphite. Grades compositionally to slightly graphitic pelitic schist (Pzrs)

Quartzite-dominant basement units

pCcq CLINKY QUARTZITE—Thickness 3,000–10,000 feet. Dominantly thin- to medium-bedded, gray quartzite with lesser bronze- or silvery- weathering pelitic schist and minor marble (pCcm). The proportion of schist in the unit varies both laterally across the area and vertically within the section; uppermost part of the unit has quartzite/schist ratio of about 1:1, lower part about 6 or 8:1. Quartzites are typically thin-bedded, banded, gray rocks; a few contain "streaky" chalky-weathering feldspar and sparse gray quartz "eyes."

pCcm MARBLE—Interbedded with PzpCcq. Forms beds of gray, white, or pale-green marble to 20 feet thick. Variations include gray-weathering, banded, coarse-grained marble; brown and white, laminated, sugary-textured nonschistose marble; and fine-grained, greenish-gray, impure marble containing feldspar, quartz, and diopside to 20 percent. Limonitic clots are common in marble. Presence of diopside indicates metamorphism in amphibolite facies

pCu UNDIFFERENTIATED QUARTZITE AND SCHIST—Exposed in northern part of the map area. Thickness at least 4,000 feet. Consists dominantly of platy- or blocky-weathering, gray or tan, slightly feldspathic quartzite and medium- to coarse-grained pelitic schist. Quartzite is typically micaceous with muscovite and biotite to 25 percent; some horizons, which may represent channel fills in a submarine fan, contain several percent feldspar as grid-twinned K-feldspar and untwinned plagioclase.

pCm MARBLE—Massive, cream to white, coarse grained, diopside-tremolite- or actinolite-bearing marble. Weathers medium gray to chalky white; locally laminated with biotite and pink or brown garnet. Marbles grade compositionally to calcite-bearing pelitic schist

West Point Igneous/Metamorphic Complex

pCwo ORTHOGNEISS—Foliated, muscovite-biotite granitic orthogneiss bodies within metamorphic complex. Contacts with paragneiss (pCwp) usually gradational. Most bodies contain muscovite and garnet; some contain blastophenocrysts of K-feldspar. Microtextures are cataclastic with deformed or granulated feldspar and quartz, numerous micaceous slip surfaces and secondary white mica replacing biotite.

pCwp PARAGNEISS—Light- to dark-gray, gray- or tan-weathering paragenesis, includes thin- to thick-bedded quartzite and interbedded pelitic gneiss, granitic augen gneiss, marble (pCwm), and abundant igneous and metaigneous rocks. Layering of paragneiss is planar to highly contorted; individual layers are usually dismembered, boudinaged, or lenticular.

pCwm MARBLE—White to light gray, buff weathering, coarse-grained, diopside- and quartz-bearing marble. Typically present in contorted layers with boudinaged and stretched quartzite or diopside-bearing quartzite interbeds. Marble is generally associated with pelitic paragneiss