

DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

- Q6 **Reworked stream gravel (tailings).**--Placer-mine tailings derived from buried stream gravels that were worked for gold by pick and shovel, mechanized drifting, or dredging methods. Shown when map scale permits, and some small areas are included in unit Qc. Thickness commonly less than 30 feet.
- Q9 **Swamp deposits.**--Humus, peat, and silt in poorly-drained areas with abundant stagnant water. Generally frozen below a depth of several feet. Some small areas are included in units Qa, Qab, and Qac. Thickness at least several feet, maximum unknown.
- Qa **Alluvium.**--Silt, sand, and granule- to boulder-size gravel, with minor amounts of organic debris. Forms active stream beds, flood plains, and adjacent low terraces along most streams; is largely unfrozen. Commonly covered by the soil layer except in stream beds, and may be mantled by units Qau or Qlc. Includes minor glacial deposits near Cache Mountain. Thicknesses may range from one foot to about 30 feet.
- Qd **Dune sand.**--Eolian sand, moderate yellowish-brown, consisting mainly of well-sorted, angular to round, yellowish-white, clear to opaque quartz grains (65 to 85 percent) and some dark gray to black rock fragments, chert, mica, traces of feldspar and light-colored rock fragments. Isolated dunes up to 30 feet high; mostly covered by eolian silt and stabilized by vegetation.
- Qab **Abandoned flood-plain alluvium.**--Silt, sand, and granule- to pebble-size gravel, with minor amounts of organic material; commonly frozen. Thicknesses not known, but may be as much as 100 feet.
- Qau **Silt undifferentiated and organic material (muck).**--Silt, largely of eolian origin and, in part, locally transported from original site of deposition to lower slopes and valley bottoms by alluvial and solifluctional processes. Locally rich in organic layers, masses, and disseminated debris. Commonly frozen and contains abundant ground ice as horizontal and vertical sheets, wedges, and irregular masses. Thicknesses may range from several feet to about 200 feet.
- Qlc **Loess and colluvium.**--Loess is massive, homogeneous eolian silt, buff to tannish gray when dry and brown when wet; chiefly on upper slopes and hillslopes. Hopped or interpreted where thickness is at least 3 feet; maximum thickness not known but locally is at least 40 to 50 feet. Colluvium is a mixture of silt and fragments of the local bedrock; generally several feet thick on upper slopes to several tens of feet in thickness lower on the slopes. Probably frozen if thicker than 10 to 15 feet, or on northerly-facing slopes.
- QTg **Gravel, sand, and silt.**--Alluvial gravel, sand, and silt that vary greatly in composition and size-grade distribution; locally developed and of limited extent. The Idaho Bar deposit near Hunter Creek includes some placer gold. Probably mostly frozen, and as much as 100 feet in thickness.

CONSOLIDATED SEDIMENTARY AND METAMORPHIC ROCKS

- Ta **Sandstone, siltstone, conglomerate, and coal.**--Non-marine clastic rocks, dominantly arenaceous and calcareous, light to medium greenish gray to gray, weather light and medium yellowish brown and brown, poorly to well consolidated, friable. Commonly have calcareous cement, some ironstone nodules, lenses, and thin layers, and plant fossils and fragments. Conglomerates are locally derived and the pebbles, cobbles, and less-common boulders range greatly in composition, angularity, and size. Siltstone and shale less common. Lignitic shale, bituminous coal, and associated thin clay layers are present in minor amounts. Coal beds probably do not exceed 7 feet, and generally are 2 feet or less, in thickness. Plant fossils from the Drew mine locality are Eocene; some Tertiary and(?) Oligocene rocks may also be present here and elsewhere. Thickness is about 5,000 feet at Drew mine locality, and unknown elsewhere.
- Tbs **Shale, graywacke, and quartzite.**--Shale and siltstone are generally medium gray, silty and clayey, and silty and clay. Graywacke is commonly medium gray, fine to very coarse grained, thin to medium bedded, graded bedding and some flow-cast and hill-marked surfaces, calcareous cement in part; some feldspathic (volcanic) graywacke. Quartzite is light to dark gray, weathers to light yellow and tan, very fine to medium grained, rarely conglomeratic with small pebbles and angular shale fragments, generally massive but shaly bedded in minor part; some interbedded thin layers of shale and siltstone, some flow-cast and hill-marked surfaces; white quartz in veins, pods, and irregular masses is common. Rarely fossiliferous; poorly preserved invertebrate (mostly pelecypods, probably *Buchia*) and plant fossils in the Holverine Mountain-Hunter Creek area are identified as Cretaceous, and *Buchia* is suggestive of Early Cretaceous. The thickness and sequence are not known, but the quartzite beds are probably in the lower part.
- Kfc **Conglomerate, graywacke, and shale.**--Polymictic conglomerate and conglomeratic graywacke, dark olive-gray to medium-dark gray, commonly friable, often stained on weathered surfaces, granules to cobbles and less-abundant boulders include greenstone, quartzite, dark gray limestone, sandstone, chert, siltstone, phyllite, siliceous slate, medium dark gray slate (some with pencil cleavage), diorite, and other intrusive rocks; thick to massive beds, locally is greatly sheared and pebbles are flattened and stretched. Graywacke is medium to medium dark gray and greenish gray, iron stained on weathered surfaces, mostly very fine to medium grained, gradational to and interbedded with both conglomerate and siltstone; some rill or turbidity-current markings on graywacke-shale bedding planes. Shale is common, grades to siltstone, generally medium dark gray, micaceous, fissile to chunky, locally pencil fracture and poorly developed and irregularly bedded. Locally fossiliferous; poorly fossil found (on the north side of the Dugan Hills) is a poorly preserved *Inoceramus* (?) probably of Cretaceous or possibly Jurassic age. The thickness of this unit is unknown.

SEDIMENTARY AND VOLCANIC ROCKS

- Tvs **Volcanic and sedimentary rocks.**--Volcanic rocks are basaltic, light to medium green, bluish green, and grayish green, very finely crystalline to aphanitic, in part amygdaloidal, probably chiefly extrusive but some may be sills. The interbedded sedimentary rocks include siltstone, shale, graywacke sandstone, and polymictic granule-pebble sandy conglomerate, and all in part have graded bedding and cross bedding, and are non-calcareous, and in part calcareous. Carbonaceous plant fossils and fragments are abundant in a few silty shale layers, and are tentatively identified as Eocene or Oligocene. Thickness is approximately 1,500 feet near Isom Creek.
- Sova **Volcanic and sedimentary rocks.**--Volcanic rocks are chiefly mafic lava, tuff, breccia, and agglomerate, with a minor amount of mafic intrusive rock. Lava is basalt and diabase commonly altered to greenstone, medium to dark greenish gray, fine grained to aphanitic, amygdaloidal and vesicular in parts, layered, locally pencil fracture and poorly developed and irregularly bedded. The only clearly visible blocks and small fragments, crushed and slickensided zones common, foliation, slaty cleavage, and green schist locally developed. Fragmental rocks are dense tufts similar in appearance to basalt, light olive gray to medium yellow-green and grayish green, laminated to thin layered with some silty cleavage. *Campylopus* tuffaceous breccia with angular fragments, and agglomerate and/or volcanic conglomerate with rounded pebbles, cobbles, and boulders are less common than lava and tuff. Some gabbroic-diabase breccias, basaltic and diabolic, and possibly andesitic in part, are dark green and grayish green to almost black and weather yellowish and red-brown, generally aphanitic to very fine grained, and calcareous. The volcanic, volcanoclastic, and clastic rocks, are included. Contact with the overlying Tolovana Limestone is disconformable and the uppermost 30 to 200 feet of section, present in many, but not all, places includes: volcanic, calcareous, or micaceous gray to red, medium to medium dark gray, sandy in part, and irregularly bedded to lenticular, gritty to conglomeratic in part, and may contain invertebrate fossils and fragments. Some interbedded or intruded mafic extrusive and intrusive rocks, unit Tvs, which are too small to show separately, are included. Fossils from the Drew mine north of Hunter Creek were originally identified as Mississippian, but recent reexaminations indicate a possible Early Permian age; bryozoans and pelecypod prisms from classic limestone in this unit on the Yukon River 0.25 mile west of 150°00' W. long., in the Tanana quadrangle, have been identified as probably of Permian age. The thickness of this unit is unknown.

VOLCANIC ROCKS

- Dcl **Conglomerate, graywacke, and shale.**--Conglomerate, light to medium-dark gray, has predominantly dark chert and white quartz granules and pebbles, locally polymictic, sandy graywacke matrix, locally sheared and pebbles are flattened or stretched. Graywacke is medium gray, weathers medium yellow to reddish brown, mostly fine to very fine grained, and partly calcareous. Siltstone is light to medium dark gray, sandy in part, grades in part to argillite. Silt shale and clay shale are medium to medium dark gray and olive gray, silty and pencil fractured in part, and partly micaceous. Some quartzite, very light and medium gray, is in thin beds. Limestone and classic limestone are very rare. Light gray and dark gray, sandy in part, grades to light brown and dark yellowish orange, finely crystalline, locally very fossiliferous with *Coprolites*, *stromatopora* that weather to white patches, massive bryozoans, and pelmatosion debris. Fossils, including *Actinoptera* (McAlester, 1964), corals, echinoderms, and *Amplexipora*, and plant fragments, are locally abundant near Livengood in shale-siltstone units, and in thin dark reddish-brown weathered *Copina* associated with a conglomerate-graywacke-shale unit. A late Middle to early Late Devonian age is indicated. Thickness is unknown.
- Dcl (South of Beaver Creek fault) **Conglomerate, graywacke, and shale.**--Conglomerate, light and medium gray, hard, granules and small pebbles are quartzite, chert, and mafic other rock types, many angular pebbles, matrix is medium to fine-grained. Graywacke is similar and fine to very coarse grained. Conglomerate and graywacke are quartzitic in part. Siltstone and shale are medium gray and weather gray to olive. Thickness is unknown.
- DSt **Tolovana Limestone.**--Limestone is light to medium gray, rarely dark gray, and weathers white, very light gray, and yellow to buff, predominantly finely crystalline, thick bedded and massive, less commonly thin bedded, blocky jointed, locally greatly fractured and recombed and veined by calcite and quartz; locally some dense dolomitic limestone. Fossils are rare, and include corals, crinoids, brachiopods, and *Amplexipora*; some have been identified as Silurian and others as young as Middle Devonian. Rocks are the same north and south of Beaver Creek fault. Thickness is unknown, but may be several thousand feet.
- Dol **Dolomite, limestone, silicified carbonate rocks, and chert.**--Dolomite and limestone are light to very light gray and nearly white and weather light to medium gray, light grayish yellow to light yellow, buff, and, in part, to a faint light pink or lavender, fine to very finely crystalline, siliceous to micaceous, and locally massive, medium bedded, and rarely thin to shaly bedded; brecciated in part and commonly veined with quartz and some calcite. Only fossils are from a site near Lost Creek, 9 miles west of Livengood, and this poorly preserved assemblage has been identified as most probably Silurian, or possibly Devonian. Limestone that is medium gray, weathers to medium dark gray or light gray, dense to very finely crystalline, generally thin bedded, and includes some chert lenses and nodules in less common; the interbedded chert is generally medium dark gray to black, greatly fractured and associated in part with associated silty shale and siliceous argillite or siltstone that are dark gray with some medium red to brownish red, thin bedded, tuffaceous in part, and gradational to chert. Includes some mafic rocks, basaltic and diabasic, that are medium to dark greenish gray to grayish green and medium to medium-dark red and reddish brown, generally very fine grained; probably some are flows and others are sills and dikes, all too small to differentiate on this scale. Thickness is unknown.

VOLCANIC AND PLUTONIC ROCKS

- Tvs **Extrusive and intrusive mafic rocks with some undifferentiated sedimentary rocks.**--Lava flows, tufts, and breccias, basaltic and diabolic and possibly andesitic in part, are dark green and grayish green to almost black and weather yellowish and red-brown, generally aphanitic to very fine grained, and calcareous. The gradational into sedimentary tufts and chert. The origins (volcanic or sedimentary, and intrusive or extrusive) of many of these rocks are difficult to determine; no pillow structure or other clearly extrusive features are obvious, and if such did exist they have probably been obliterated by structural deformation. Some undifferentiated sedimentary rocks of units Tvs and Tvc, and possibly some unrecognized rocks of unit Tvs may be included. Thickness is unknown. The intrusive rocks include diorite, diabase, and gabbro that are medium to dark green, grayish green, and reddish brown, and weather to yellowish and reddish brown, light green, and reddish brown, fine to very coarse grained, hard, blocky jointed; commonly form prominent ridges, knobs, and bluffs. A hornblende K^{40}/Ar^{39} age date of 205 ± 6 m.y. (Tranasi) has been obtained from a gabbro on the north bank of the Yukon River about 4.2 miles west of 150°00' W. long., in the Tanana quadrangle (Brogsg, Lanphere, Seiser, Chapman, 1969).
- Tvm **Mafic and ultramafic rocks.**--Mafic and ultramafic rocks, intrusive and possibly some extrusive, commonly more or less altered, include diorite, metadiorite, diabase, gabbro, basalt, metabasalt, and greenstone (altered mafic rocks that cannot be readily identified more precisely) that are generally medium to dark green, yellowish green, grayish green, and greenish gray and weather to darker shades of yellow, yellowish brown, reddish brown, olive gray, or greenish gray, fine to coarse grained and in part aphanitic, massive with blocky jointing and irregular fracturing, or in parts with poorly developed layering and rarely foliation.
- Rsp **Serpentine with some rodingite and tectonic inclusions.**--Serpentine is light to dark yellowish green, grayish green, greenish black, and black and weathers to various shades of medium to dark brown, reddish brown, and grayish brown. It ranges from a sheared, foliated type (silenite) with shiny smooth, commonly slickensided surfaces to an unfoliated type (blackenite); small segregations rich in chromium and nickel, and very thin veins of chrysotile asbestos are rare and sporadically developed. Minor dike equivalents of unit Tvm may be included. Rodingite and tectonic inclusions are tabular to irregular blocks, ranging from 2 to 50 feet in maximum dimension, and include olive-green, light green, dark gray, and very light gray rocks derived from intrusive and volcanic, sedimentary, and metamorphic rocks, and show various degrees of alteration. This unit commonly is overlain by barren to thinly-vegetated brownish and grayish soil and rubble patches on upper slopes and hillslopes.
- Tkg **Granitic rocks.**--Monzonite, quartz monzonite, quartz diorite-granodiorite, and granite are generally very light to medium gray and weathers to various shades of yellow and reddish brown with abundant iron staining, commonly well jointed and irregularly fractured, largely medium to very coarse grained, both equigranular and porphyritic with feldspar megacrysts as much as 5 to 7 centimeters in length, and some fine-grained phases; both angular and blocky. Some mafic and argillite and minor very fine-grained high peaks and knobs, and have surrounding hornfelsed zones of resistant rocks. Elephant Mountain is chiefly monzonite and quartz monzonite, which are generally porphyritic. Holverine Mountain and the adjacent small stocks are mostly porphyritic. Sawtooth Mountain is monzonite and quartz monzonite, partly porphyritic; the biotite K^{40}/Ar^{39} age date is 88.8 ± 3 m.y. The small muscovite granite stock on Troublesome Creek just below Union Creek has a muscovite K^{40}/Ar^{39} age date of 66.4 ± 2 m.y. Tolovana Hot Springs Dome is largely porphyritic with minor blocks and streaks of biotite K^{40}/Ar^{39} age date of 63.3 ± 2.5 m.y. Similar small stocks in the Livengood-Cascaden Ridge area are mostly medium to fine grained and sparsely porphyritic. Cache Mountain is a quartz monzonite, medium- to coarse-grained, with some porphyritic and fine- to fine to very fine grained, rarely conglomeratic with small quartz fragments. Some silty shale and silty monzonite that range from fine- to coarse-grained with some porphyritic phases; a mica K^{40}/Ar^{39} age date of 90.7 ± 5.1 m.y., has been obtained from the quartz diorite-granodiorite, and a hornblende K^{40}/Ar^{39} age date of 93 ± 5 m.y., was determined for the quartz monzonite (Britton, 1969; Forbes and others, 1968).
- Tkd **Dikes, sills, and small intrusive bodies.**--These are closely associated with unit Tkg, and include a variety of granite, apatite, pegmatite, pyroxene, monzonite-lignite, muscovite, and some mafic differentiates. They are generally very light to dark gray, have various grain sizes, and some are porphyritic.
- Tks **Syenite.**--The only known syenite body, on Bear Creek near Cache Mountain, is medium-light gray, mostly weathered to yellow, orange, and brown, coarse to very coarse grained, porphyritic, deeply weathered. Age is uncertain, but probably is closely related to unit Tkg rocks.

- 2a1 **Argillite, slate, quartzite, siltstone, and limestone.**--Argillite and slate are medium to very dark red or maroon, and light to medium green and grayish green, and the colors alternate in interbedded units or in bands or irregular veining within one unit; fissile to chunky; the colors alternate in interbedded units or in bands and distinctive unit. Also slate and argillite that are medium-light to dark gray and greenish gray, and grade to a similar phyllite which ranges to light gray. Quartzite is light to medium gray and greenish gray, medium to thin bedded, generally fine grained and, in part, grit. Limestone that forms a unit near base of brown, yellow, and red, thin bedded and platy, dense to very finely crystalline. Another limestone unit is medium to dark gray and weathers medium gray or various shades of upper part of the section and interbedded, or closely associated, with the red and green slate. Minor amounts of mafic rock, basaltic, probably intrusive, thin and too small to differentiate, are included. Entire unit is extensively folded, sheared, and fractured; quartz and calcite veins are common. Rocks are the same north and south of Beaver Creek fault. Thickness is unknown.
- 2a2 **Grit, quartzite, slate, argillite, and chert.**--Grit and quartzite, gradational to hard sandstone and graywacke, are light to medium gray, greenish gray and olive and weather light gray with iron stain and flecks of oxidized pyrite, thin to medium bedded (3 inches to 2 feet), very hard, blocky fracture, generally very fine prominent ridges, hills, and ledges. Slate, grading to alsty argillite and phyllite, is light to medium gray, greenish gray, and olive, commonly thin bedded (3 to 8 inches) and interbedded with grit and quartzite, micaceous in part. Some gray and black chert near top of section; may grade upward into unit Gg. *Oldhamia* fossils in greenish gray to olive slate and argillite, 8.5 miles northeast of Hoodoo Dome, tentatively indicate a Cambrian age, but previously were identified as Mississippian (Churkin and Brabb, 1965; Mertie, 1937). Thickness is unknown, but probably is relatively thick.
- 2a3 **(South of Beaver Creek fault) Grit, quartzite, slate, and argillite.**--Unit is similar to that described above, but does not include chert or fossils. Thickness is unknown, but probably is relatively thick.

METAMORPHIC ROCKS

- 2b **Greenschist facies.**--Dominantly micaceous quartzites, garnet-mica schists, quartz-mica schists and phyllitic schists with subordinate greenschists and rare impure marbles are various shades of gray and weather reddish or yellowish brown. Degree of crystallization increases across a northerly structural trend, toward the northwest. This transition is marked by the disappearance of garnet in the phyllitic schists and by gradation from mica and quartz-mica schists to phyllites. Grades upward into unit Gg. Thickness is unknown.
- 2c1 **Epidote-amphibolite facies.**--Unit includes lime silicate marbles, eclogitic rocks, garnet amphibolites, epidote amphibolites, garnet-mica schists, and graphitic and calcareous quartzites. These rocks are mostly various shades of gray and weather reddish or yellowish brown, except the amphibolites, eclogites, and some of the marbles which are grayish green to greenish black.
- 2c2 **Geochronology.**--Greenschist facies metamorphic rocks in the southeastern part of the quadrangle generally give Cretaceous K^{40}/Ar^{39} mica ages. Phyllitic schists in the McSheridan Dome area, which show decreasing recrystallization to the northwest, have given K^{40}/Ar^{39} whole rock ages as old as 256 ± 8 m.y. (Forbes and Engels, verbal commun., 1970).
- 2c3 **Epidote-amphibolite facies rocks near the Chatanika River have provided amphibole K^{40}/Ar^{39} ages up to 470 ± 35 m.y. (Forbes and others, 1968) and a Rb^{87}/Sr^{86} muscovite age of 509 m.y. (Wasserburg and others, 1965). These rocks were apparently first recrystallized during an Ordovician metamorphic event, followed by partial recrystallization during a later Neoproterozoic orogenic episode. It is probable that the parent sedimentary rocks were, at least in part, of Precambrian age.**

SEDIMENTARY AND VOLCANIC ROCKS

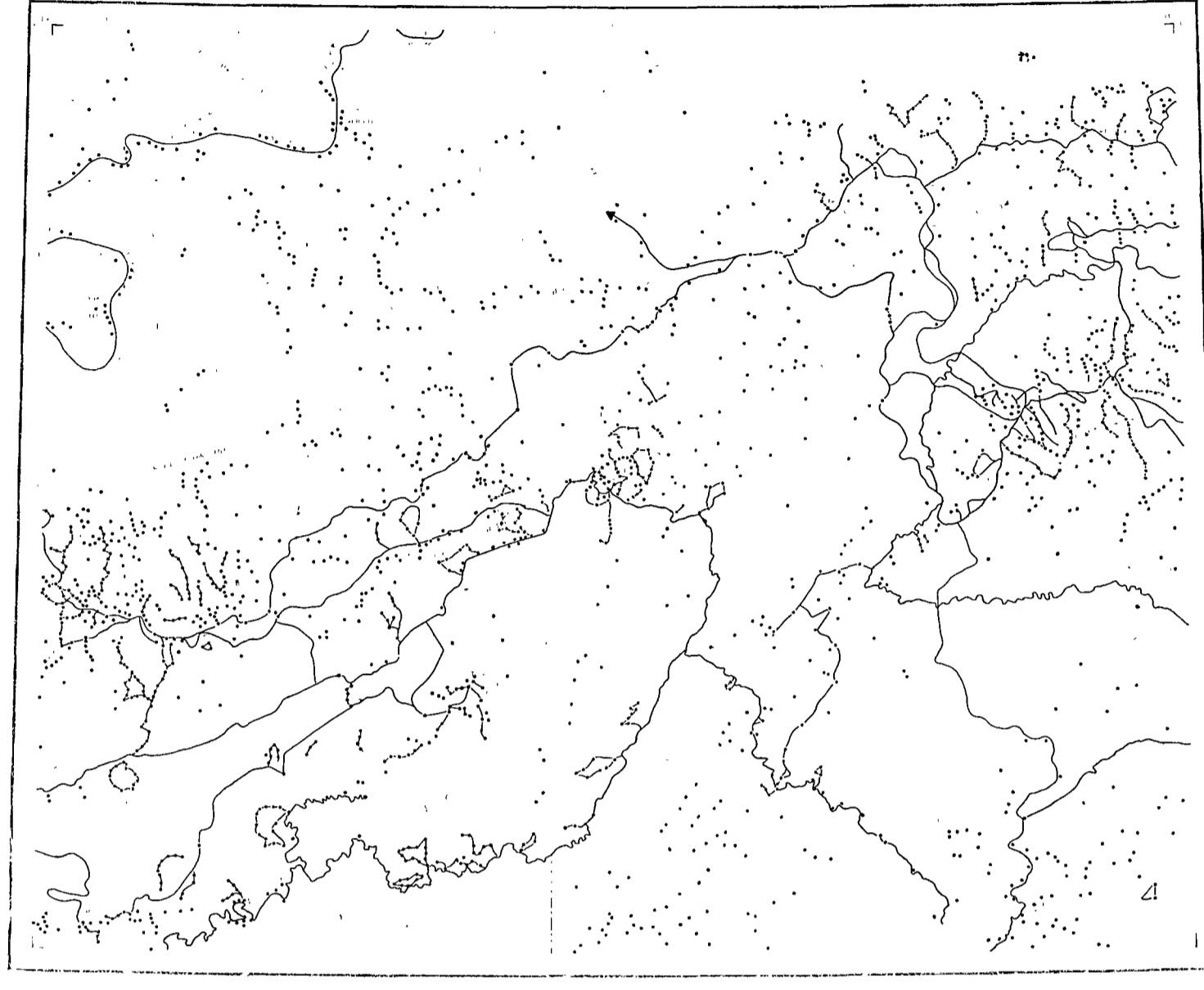
- Tvs **Volcanic and sedimentary rocks.**--Volcanic rocks are basaltic, light to medium green, bluish green, and grayish green, very finely crystalline to aphanitic, in part amygdaloidal, probably chiefly extrusive but some may be sills. The interbedded sedimentary rocks include siltstone, shale, graywacke sandstone, and polymictic granule-pebble sandy conglomerate, and all in part have graded bedding and cross bedding, and are non-calcareous, and in part calcareous. Carbonaceous plant fossils and fragments are abundant in a few silty shale layers, and are tentatively identified as Eocene or Oligocene. Thickness is approximately 1,500 feet near Isom Creek.
- Sova **Volcanic and sedimentary rocks.**--Volcanic rocks are chiefly mafic lava, tuff, breccia, and agglomerate, with a minor amount of mafic intrusive rock. Lava is basalt and diabase commonly altered to greenstone, medium to dark greenish gray, fine grained to aphanitic, amygdaloidal and vesicular in parts, layered, locally pencil fracture and poorly developed and irregularly bedded. The only clearly visible blocks and small fragments, crushed and slickensided zones common, foliation, slaty cleavage, and green schist locally developed. Fragmental rocks are dense tufts similar in appearance to basalt, light olive gray to medium yellow-green and grayish green, laminated to thin layered with some silty cleavage. *Campylopus* tuffaceous breccia with angular fragments, and agglomerate and/or volcanic conglomerate with rounded pebbles, cobbles, and boulders are less common than lava and tuff. Some gabbroic-diabase breccias, basaltic and diabolic, and possibly andesitic in part, are dark green and grayish green to almost black and weather yellowish and red-brown, generally aphanitic to very fine grained, and calcareous. The volcanic, volcanoclastic, and clastic rocks, are included. Contact with the overlying Tolovana Limestone is disconformable and the uppermost 30 to 200 feet of section, present in many, but not all, places includes: volcanic, calcareous, or micaceous gray to red, medium to medium dark gray, sandy in part, and irregularly bedded to lenticular, gritty to conglomeratic in part, and may contain invertebrate fossils and fragments. Some interbedded or intruded mafic extrusive and intrusive rocks, unit Tvs, which are too small to show separately, are included. Fossils from the Drew mine north of Hunter Creek were originally identified as Mississippian, but recent reexaminations indicate a possible Early Permian age; bryozoans and pelecypod prisms from classic limestone in this unit on the Yukon River 0.25 mile west of 150°00' W. long., in the Tanana quadrangle, have been identified as probably of Permian age. The thickness of this unit is unknown.

VOLCANIC ROCKS

- Dcl **Basalt.**--Olivine basalt, brownish-black, vesicular in part, shows some columnar jointing and possibly pillow structure. Thickness unknown, but probably relatively thin.
- Tvs **Extrusive and intrusive mafic rocks with some undifferentiated sedimentary rocks.**--Lava flows, tufts, and breccias, basaltic and diabolic and possibly andesitic in part, are dark green and grayish green to almost black and weather yellowish and red-brown, generally aphanitic to very fine grained, and calcareous. The gradational into sedimentary tufts and chert. The origins (volcanic or sedimentary, and intrusive or extrusive) of many of these rocks are difficult to determine; no pillow structure or other clearly extrusive features are obvious, and if such did exist they have probably been obliterated by structural deformation. Some undifferentiated sedimentary rocks of units Tvs and Tvc, and possibly some unrecognized rocks of unit Tvs may be included. Thickness is unknown. The intrusive rocks include diorite, diabase, and gabbro that are medium to dark green, grayish green, and reddish brown, and weather to yellowish and reddish brown, light green, and reddish brown, fine to very coarse grained, hard, blocky jointed; commonly form prominent ridges, knobs, and bluffs. A hornblende K^{40}/Ar^{39} age date of 205 ± 6 m.y. (Tranasi) has been obtained from a gabbro on the north bank of the Yukon River about 4.2 miles west of 150°00' W. long., in the Tanana quadrangle (Brogsg, Lanphere, Seiser, Chapman, 1969).
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PLUTONIC ROCKS

- Tkg **Granitic rocks.**--Monzonite, quartz monzonite, quartz diorite-granodiorite, and granite are generally very light to medium gray and weathers to various shades of yellow and reddish brown with abundant iron staining, commonly well jointed and irregularly fractured, largely medium to very coarse grained, both equigranular and porphyritic with feldspar megacrysts as much as 5 to 7 centimeters in length, and some fine-grained phases; both angular and blocky. Some mafic and argillite and minor very fine-grained high peaks and knobs, and have surrounding hornfelsed zones of resistant rocks. Elephant Mountain is chiefly monzonite and quartz monzonite, which are generally porphyritic. Holverine Mountain and the adjacent small stocks are mostly porphyritic. Sawtooth Mountain is monzonite and quartz monzonite, partly porphyritic; the biotite K^{40}/Ar^{39} age date is 88.8 ± 3 m.y. The small muscovite granite stock on Troublesome Creek just below Union Creek has a muscovite K^{40}/Ar^{39} age date of 66.4 ± 2 m.y. Tolovana Hot Springs Dome is largely porphyritic with minor blocks and streaks of biotite K^{40}/Ar^{39} age date of 63.3 ± 2.5 m.y. Similar small stocks in the Livengood-Cascaden Ridge area are mostly medium to fine grained and sparsely porphyritic. Cache Mountain is a quartz monzonite, medium- to coarse-grained, with some porphyritic and fine- to fine to very fine grained, rarely conglomeratic with small quartz fragments. Some silty shale and silty monzonite that range from fine- to coarse-grained with some porphyritic phases; a mica K^{40}/Ar^{39} age date of 90.7 ± 5.1 m.y., has been obtained from the quartz diorite-granodiorite, and a hornblende K^{40}/Ar^{39} age date of 93 ± 5 m.y., was determined for the quartz monzonite (Britton, 1969; Forbes and others, 1968).
- Tkd **Dikes, sills, and small intrusive bodies.**--These are closely associated with unit Tkg, and include a variety of granite, apatite, pegmatite, pyroxene, monzonite-lignite, muscovite, and some mafic differentiates. They are generally very light to dark gray, have various grain sizes, and some are porphyritic.
- Tks **Syenite.**--The only known syenite body, on Bear Creek near Cache Mountain, is medium-light gray, mostly weathered to yellow, orange, and brown, coarse to very coarse grained, porphyritic, deeply weathered. Age is uncertain, but probably is closely related to unit Tkg rocks.



INDEX MAP OF LIVENGOOD QUADRANGLE SHOWING LOCATIONS OF FIELD OBSERVATION POINTS AND CONTINUOUS TRAVELERS

Identifiable field stations and traverse routes of geologists who worked between 1902 and 1932 are included. There are more field stations in the vicinities of Livengood and Pedro Dome than can be plotted on this scale. Many field stations along the continuous traverse routes are not shown individually.

Bedrock units, contacts, structures, and surficial deposits have been extended and interpreted between field stations with the aid of aerial reconnaissance and aerial photographs.

FOSSIL LOCALITIES NOT PREVIOUSLY REPORTED

Lat. & Long. W	Geographic description	Rock unit	Type of fauna or flora	Age
65°47'09" N 149°25'15" W	Three sites in roadcuts about 1 mile south of Isom Creek	Tvs	Plant leaves, needles, stems, and fragments	Falcoecene or Eocene
65°03'13" N 149°59'24" W	South side of Niggerhead Creek	KJc	Poorly preserved pelecypod	Cretaceous or Jurassic
65°29'30" N 148°27'40" W	On ridge east side of Eator Creek at altitude of 1,200 + feet	Dcl	Mollusks, chiefly pelecypods	Late Middle to early Late Devonian
65°30'40" N 148°32'24" W	On and near highway at Lillian Creek	Dcl	Corals, stromatopora, bryozoans, and pelmatosion debris	-do-
65°17'15" N 148°09" W	North side of highway at mile 38.4	DSt	Corals, stromatopora, <i>Amplexipora</i> ; very rare <i>Amplexipora</i>	Middle Devonian
65°55'55" N 147°13'20" W	Several sites 3.4-4.0 miles north-northeast of Mt. Schwatka	DBt		Probably Middle Devonian

AGE DETERMINATIONS FOR BIOTITE (B) AND MUSCOVITE (M)

(Argon analyses and age calculations by M. A. Lanphere and J. C. Von Esen; potassium analyses by L. B. Schlocker and H. C. Whitehead. Decay constants for K^{40} : $\lambda_1 = 0.585 \times 10^{-10} \text{ year}^{-1}$; $\lambda_2 = 4.72 \times 10^{-10} \text{ year}^{-1}$. Abundance ratio $K^{40}/K = 1.19 \times 10^{-4}$ atom percent.)

Location and field number	Coordinates	Geologic unit and mineral	K_{20} (percent)	Ar^{40} rad (moles/gm)	Ar^{40}/Ar^{39} total	Calculated age (millions of years)
Tolovana Hot Springs Dome 62AC-65	65°15'45" N 148°55" W	TKI B	8.53 8.40 avg. 8.46	8.05 × 10 ⁻¹⁰	0.90	63.3 ± 2.5
Sawtooth Mountain 69AC-96	65°21'40" N 149°35" W	TKI B	9.07	1.239 × 10 ⁻⁹	0.78	88.8 ± 3
Troublesome Creek 69AC-151	65°30'25" N 149°35'30" W	TKI M	10.90 10.77 avg. 10.835	1.082 × 10 ⁻⁹	0.66	66.4 ± 2

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