U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC MAP OF GRAND TETON NATIONAL PARK TETON COUNTY, WYOMING

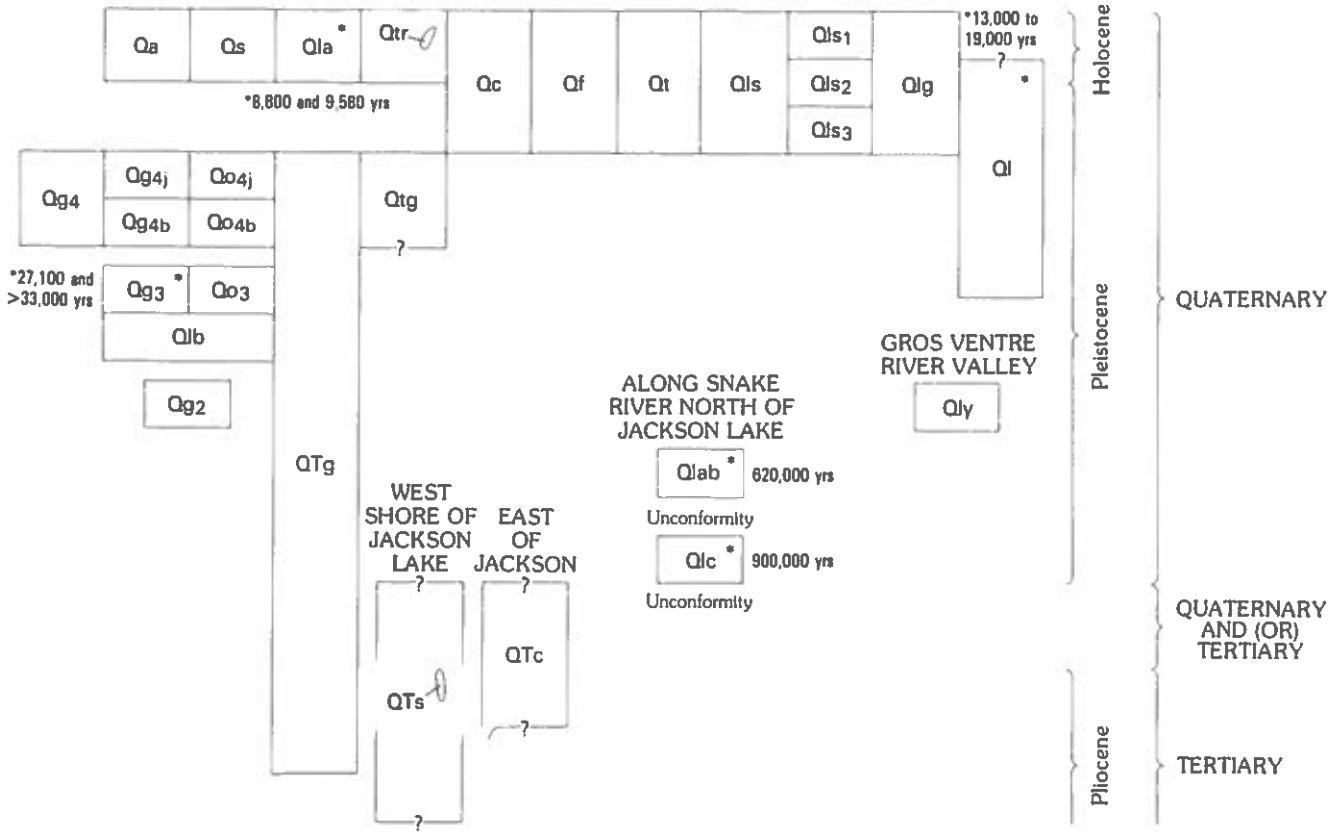
By J. D. Love, John C. Reed, Jr., and Ann Coe Christiansen

Pamphlet to accompany
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–2031

DESCRIPTION OF MAP UNITS

[Asterisk in box shows dated unit; ^{14}C and K-Ar ages shown in table 1]

QUATERNARY AND (OR) TERTIARY DEPOSITS



Holocene sedimentary rocks

Qa **Alluvium, gravel and sand, and flood-plain deposits**

Alluvium—Gravel, sand, silt, and clay along modern streams. In places includes fan, glacial outwash, and stream-laid ice-contact deposits; in some forest-covered areas may include other types of surficial deposits

Gravel and sand—Along and adjacent to active channelways of major streams; composed chiefly of quartzite roundstones

Flood-plain deposits—Sand and gravel overlain by silt and clay in low terraces; in places inundated during modern floods

Qs **Swamp deposits**—Dark-gray and brown clay, silt, and fine sand; rich in debris

Qla **Lacustrine and related deposits**—Thinly laminated white marl, ash, and clay. May have accumulated in kettles

Qtr **Travertine**—Gray limestone deposited by springs

Holocene and Pleistocene sedimentary deposits

Qc **Colluvium**—Silt to boulder-sized rocks derived from underlying and adjacent units. Locally includes glacial drift

Qf **Alluvial-fan deposits**—Crudely stratified deposits of boulders, gravel, sand, silt, and clay, generally coarse at the apex and fine at distal margins. Commonly gradational into talus in mountain areas. Along Spread Creek includes fan deposits composed of white ash, silt, clay, and sand derived largely from Colter (Tc) and Teewinot (Tte) Formations

Qt **Talus and related deposits**—Coarse angular poorly sorted rock debris in talus slopes, talus fans, rock glaciers, and moraines of Holocene glaciers

Qls **Landslide debris**—Chaotically mixed boulders and finer rock debris

Qls_1 **Unit 1 (Holocene)**—Still moving locally

Qls_2 **Unit 2 (Holocene and/or Pleistocene)**—Stabilized, overgrown with vegetation, but having unmodified topography

Qls_3 **Unit 3 (Pleistocene)**—Stabilized, overgrown with vegetation, and having subdued topography

Qlg **Landslide and glacial debris, intermixed or undivided**

Ql **Loess**—Light-gray structureless homogeneous wind-deposited silt

Pleistocene sedimentary deposits

Qlb **Loess and boulders**—Chalky-white formless unstratified deposits consisting of glacial erratics of many sizes and compositions, derived from till of glaciation 2 and embedded in matrix of white calcareous loess. Chiefly on higher hills in National Elk Refuge between Flat Creek and Gros Ventre River

Qly **Leidy Formation**—Intertonguing lacustrine, fluviatile, and glacial deposits. Chiefly very fine grained chocolate-brown, pink, and gray clay, laminated in part, interbedded with unlithified gray sand; lenticular quartzite pebble gravels; basal quartzite boulder conglomerate in some places; intertongues laterally with drift and outwash deposits of glaciation 2 (Qg_2). Normal polarity and lack of volcanic debris indicate age younger than about 0.75 Ma. Thickness 0–450 ft

Deposits related to glaciation 4

Qg_4 **Drift**—On west side of Jackson Hole composed mostly of Precambrian rocks from Teton Range; on southeast side consists of a wide variety of rocks derived from the north and east. Locally may include older glacial deposits on lower eastern slopes of Teton Range. Displays little or no soil development; supports abundant coniferous trees except in eastern part of Jackson Hole where debris contains more quartzite and shale and supports fewer trees. Topography generally characterized by steep-sided morainal ridges and small closed depressions except west of Jackson Lake

Qg_{4j} **Debris of the Jackson Lake moraine**—South and east of Jackson Lake. Source was Teton Range and Yellowstone National Park

Qg_{4b} **Debris of the Burned Ridge moraine**—Slightly older than debris of the Jackson Lake moraine (Qg_{4j}), although recessional deposits may be the same age. Extends across floor of Jackson Hole south of Jackson Lake. Northeastern and eastern source contributed finer debris that resulted in more subdued topography than that of the Jackson Lake moraine

Outwash gravel and sand—In outwash terraces related to, and local depressions within, moraines of glaciation 4. Outwash plains and terraces display numerous braided channel scars left by meltwater streams. Generally unforested

Qo_{4j} **Outwash gravel forming terraces graded to Jackson Lake moraine**—East of Snake River Overlook, also includes gray sand and white, brown, pink, and gray silt as thick as 50 ft in local depressions; these may be ice-margin deposits

Qo_{4b} **Outwash gravel forming terraces graded to Burned Ridge moraine**

Qtg **Terrace gravel**—Outwash gravel composed predominantly of quartzite roundstones; deposited by glacial meltwater

Deposits related to glaciation 3

Qg_3 **Drift**—Till containing moderately weathered granite erratics and capped by loess in many places. Contains some rocks from northeastern part of Jackson Hole. Subdued topography

Qo_3 **Outwash gravel**—Gravel chiefly of quartzite roundstones, crudely stratified; top characteristically planar and commonly capped by loess resting on a buried soil

Deposits related to glaciation 2

Qg_2 **Drift and outwash deposits**—Till containing large and small erratics, in places mixed with outwash gravel, sand, silt, and colluvial debris. Most erratics are not locally derived. Soil development is extensive in some places and erratics of Paleozoic sedimentary and Tertiary volcanic rocks are deeply weathered. Lacks topographic expression and commonly recognized only as lag deposits; generally does not support coniferous trees

Pleistocene volcanic rocks along Snake River north of Jackson Lake

Qlab **Lava Creek Tuff, member B (Yellowstone Group)**—Gray to brown dense hard welded rhyolite ash flows. Thickness at least 100 ft

Qlc **Lewis Canyon Rhyolite**—Crystal-rich flows, locally glassy, containing phenocrysts of quartz, plagioclase, sanidine, and clinopyroxene. Thickness at least 600 ft

Quaternary and (or) Tertiary sedimentary deposits

On west shore of Jackson Lake north of hot-spring area

QTs **Red and gray sequences of clay, silt, sand, conglomerate, till, and (or) loess**

Red sequence—Lacustrine(?) and fluviatile clay, silt, sand, and conglomerate similar to Shooting Iron Formation (Tsi). Conglomerate is chiefly of Tertiary rhyolite and Precambrian rocks. Unconformably overlies gray sequence. Thickness at least 20 ft

Gray sequence—Lacustrine(?), fluviatile, and glacial silt, till, loess, and clay of uncertain correlation. Numerous striated quartzite boulders and andesite clasts. Lack of rhyolite clasts suggests that deposit may be older than Huckleberry Ridge Tuff (Th). Thickness at least 30 ft

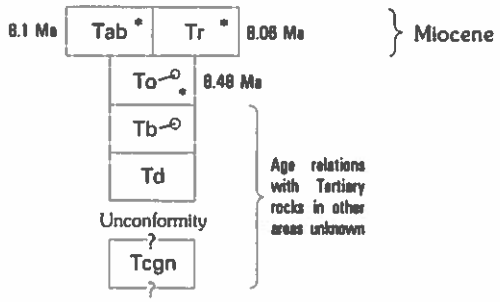
East of Jackson

QTc **Conglomerate**—Partly lithified conglomerate consisting of gray limestone clasts but also containing sparse clasts of Precambrian rocks from unknown source. May be related to later phases of glaciation 1 (Tg_1). Thickness as much as 400 ft

Northern and eastern part of map area

QTg **Glacial drift (Pleistocene and/or Pliocene)**—In northern and northeastern part, drift was deposited by ice that moved south from the area of Yellowstone National Park or east from the Teton Range; in eastern part, drift was deposited by westward-moving ice. Most drift has more subdued topography and is probably older than drift of glaciation 4 (Qg_4); some is possibly as old as drift(?) of glaciation 1 (Tg_1)

TERTIARY ROCKS



Near Teton Pass

Tab **Andesite and basalt (upper Miocene)**—Gray dense porphyritic andesite flows containing hypersthene phenocrysts; several thin gray basalt flows; north of Teton Pass. On the Teton Pass mountains, rhyolite and black obsidian nodules at base of unit. Thickness 0–800 ft

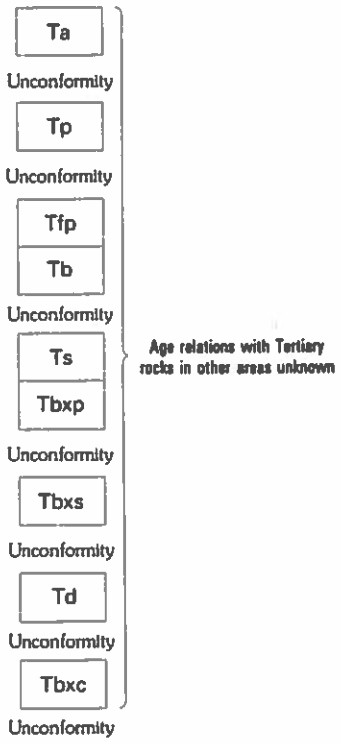
Tr **Rhyolite (upper Miocene)**—Large intrusive body southwest of Wilson; light gray to tan, fine grained, phenocryst rich; includes several intrusions of black, glassy, translucent obsidian

To **Obsidian pipes (upper Miocene)**—Black to gray glassy translucent obsidian; south and southeast of Teton Pass

Tb **Basalt**—Dark-gray fine-grained basalt; southeast of Teton Pass on ridge southeast of Black Canyon

Td **Dacite flows**—Medium- to dark-gray fine-grained dense dacite; trachytic texture

Tcgn **Conglomerate containing no volcanic material (possibly as old as Eocene)**—Boulders of Tensleep Sandstone and Phosphoria Formation and smaller clasts of Chugwater, Madison, and Gallatin Formations. Underlies volcanic rocks north of Teton Pass. Thickness 0–50 ft



East and West Gros Ventre Buttes

Ta **Andesite**—Pink, brown, and black coarsely porphyritic andesite; chiefly flows and intrusive masses. Thickness at least 100 ft

Tp **Perlite**—Dark-gray granular soft perlite; contains abundant obsidian fragments. Thickness 100 ft

Tfp **Felsite porphyry**—Light-gray intrusive felsite porphyry

Tb **Basalt(?)**—Dense fine-grained gray homogeneous basalt(?); slabby structure in flows; greenish-yellow to black scoria locally at base and in other layers. Appears to be similar to gray basalt included in andesite and basalt (Tab) north of Teton Pass (Schroeder, 1972). Maximum thickness about 500 ft

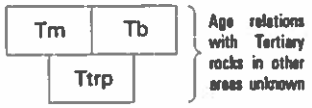
Ts **Scoria**—Lightweight frothy black rock containing masses of dark-green glass and gray pumiceous rock. Thickness about 10 ft

Tbxp **Flow-breccia and pumice**—At top, red dense lava flow as thick as 200 ft, underlain by 50–100 ft of red flow-breccia and pumice; locally, at base, 100 ft of ribbon-laminated red and gray hard densely welded tuff containing angular fragments of black obsidian

Tbxs **Pumice breccia and sandstone**—Pale-pink and white pumice breccia, composed of frothy pumice chunks and black obsidian in a soft massive shard matrix; some perlite; underlain by gray tuff and sandstone, in part very calcareous. Thickness about 120 ft

Td **Intrusive dacite(?)**—Dark-gray coarse-grained porphyritic dacite(?); contains abundant hornblende and fragments of Late Archean amphibolite

Tbxc **Flow breccia and conglomerate (Miocene?)**—Upper half is dense red flow breccia and welded tuff containing abundant gray and black obsidian fragments as much as 2 in. in diameter. Lower half is pink well-bedded conglomerate containing clasts of Nugget and Tensleep Sandstones, Late Archean gneiss, and chunks of white pumice as much as 6 in. across. Near base, coarse-grained gray sandstone. Thickness at least 100 ft

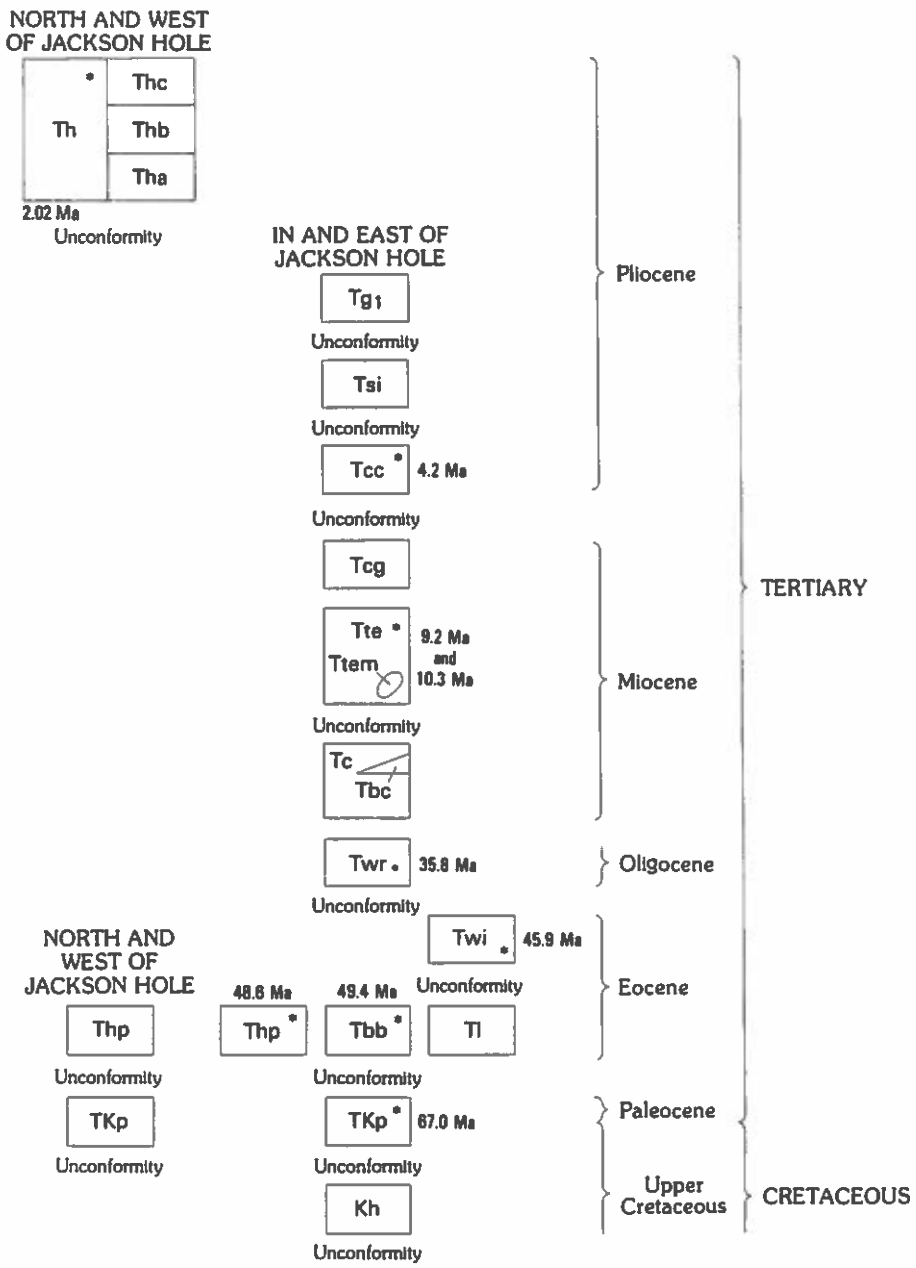


East and northeast of Jackson Hole

Tm **Mafic dike**—Dull-green dense hard brittle igneous rock. Intrudes Cody Shale (Kc) on west flank of Mount Reid

Tb **Basalt**—Sills and flows of red and black basalt. Vuggy scoriaceous basalt intrudes Teewinot Formation (Tte) along Flat Creek

Ttrp **Trachyte porphyry (Miocene?)**—Gray, vesicular; contains abundant plagioclase phenocrysts as long as 10 mm, pyroxene phenocrysts 1–2 mm in diameter, and phenocrysts of olivine altered to iddingsite 1–2 mm in diameter. In plug cutting Hominy Peak Formation (Thp) north of Two Ocean Lake



North and west of Jackson Hole

Th **Huckleberry Ridge Tuff (Pliocene) (Yellowstone Group)**—Compound cooling unit of gray to brown rhyolitic ash-flow tuff, generally densely welded and devitrified but locally glassy or partly welded. Most parts contain abundant phenocrysts of quartz, sanidine, and sodic plagioclase, sparse opaque oxides, clinopyroxene, and fayalitic olivine

Thc **Member C**—Strongly foliated and lineated, entirely devitrified, containing glassy quartz phenocrysts smaller than those in members B and A; layering conspicuous; abundant lithic inclusions. Thickness 0–300 ft

Thb **Member B**—Coarsely porphyritic, entirely devitrified, light brown to gray, welded; phenocrysts abundant and as large as 5 mm in upper part. Two types of welded pumice in upper part, one very dark and scoriaceous, the other light colored and compact. Thickness 0–500 ft

Tha **Member A**—Mainly devitrified, but having black vitrophyre at base. Phenocrysts abundant in lower part, but progressively less abundant upward. Thickness 0–700 ft

Thp **Hominy Peak Formation (Eocene) (Absaroka Volcanic Supergroup)**—Brown to dull-green andesitic mudflow breccia, vent breccia, conglomerate, and sandstone; light-gray tuff and thin claystone zones near top and at base; lenses of gold-bearing quartzite boulder conglomerate in lower part; fossil trees common. In northwestern part of map area, contains slide blocks of Proterozoic, Paleozoic, and Mesozoic rocks 10–150 ft in diameter. Thickness as much as 2,000 ft

TKp **Pinyon Conglomerate (Paleocene and Upper Cretaceous)**—Rusty-brown conglomerate composed of quartzite roundstones in matrix of rusty coarse-grained sandstone that contains tiny flakes of gold; sporadic boulders of older conglomerate and quartzite 5–8 ft in diameter. Thickness 0–3,800 ft

In and east of Jackson Hole

Tg_1 **Drift(?) probably related to glaciation 1 (Pliocene)**—Unstratified gray till-like deposits of rounded to angular fragments of Mesozoic, Paleozoic, and sparse Precambrian rocks in matrix of gray clay, silt, and sand; in places tightly cemented with gray calcium carbonate and in places uncemented. Some quartzite clasts are striated. Many quartzite clasts were derived from considerable distances at a time when present drainage systems either were nonexistent or were buried by ice. At least 80 ft thick in exposures below Huckleberry Ridge Tuff (Th) at north end of Signal Mountain

Tsi **Shooting Iron Formation (Pliocene)**—Pink, red, green, yellow, dark-gray, and brown bentonitic mollusk-bearing lacustrine and fluvial claystone, gray and yellow tuffaceous sandstone and siltstone, and pebble conglomerate of volcanic rock fragments in bentonitic matrix. Some mollusks indicate deep-water environment. Exposed north of Flat Creek along east edge of map area and locally on south ends of East and West Gros Ventre Buttes. Maximum thickness greater than 100 ft

Tcc **Conant Creek Tuff (lower Pliocene)**—Gray to buff and pale-lavender phenocryst-poor slabby hard welded rhyolite tuff; black welded-tuff obsidian near base, underlain in places by white to gray friable tuff. Thickness 0–300 ft

Tcg **Conglomerate (upper Miocene)**—Gray poorly cemented conglomerate underlying Conant Creek Tuff (Tcc) on northeast and east sides of Signal Mountain; consists chiefly of quartzite roundstones, some Paleozoic and Mesozoic sedimentary rock fragments, and some Tertiary andesite clasts. Thickness 0–1,200 ft

Tte **Teewinot Formation (upper Miocene)**—Chalky-white to light-gray soft porous limestone, claystone, and pumicite. Upper part is very fossiliferous thin-bedded claystone, marlstone, and tuff; lower two-thirds, chiefly nodular porous limestone in beds 100–200 ft thick interbedded with pumicite in beds 20–75 ft thick. In middle part of formation is a 110-ft-thick conglomerate of limestone, quartzite, and obsidian clasts. Thickness more than 6,000 ft

Ttem **Detachment mass of Madison Limestone within Teewinot Formation**—About 3 mi northeast of Jackson Peak

Tc **Colter Formation (middle and lower Miocene)**— Light-gray, green, and brown waterlaid tuff, sandstone, claystone, and mafic volcanic conglomerate; light-gray tuffaceous soft massive to irregularly bedded poorly cemented sandstone beds in lower part. Locally, an upper conglomerate, 0–60 ft thick, consists of 50-percent roundstones of mafic volcanic rocks and the remainder of quartzite. Some rhyolitic welded tuff is in upper part. A middle tuffaceous sandstone and claystone sequence contains many layers of grit and pebble conglomerate of mafic andesite and basalt clasts; some thick beds of pale-green, pink, and white bentonitic claystone. In some places basal beds are of clasts of quartzite, andesite, and basalt in a drab tuff and sandstone matrix. Thickness 0–4,900 ft

Tbc **Basalt (Miocene) intruded into Colter Formation**—Gray sugary breccia and dense black and red basalt on Ditch Creek. Relation to Colter Formation uncertain but could be contemporaneous with it

Twr **White River Formation (Oligocene)**—White nodular calcareous siltstone and pale-green bentonitic claystone; contains vertebrate fossils. Exposed locally along East Fork Pilgrim Creek north of west end of Two Ocean Lake. Thickness 0–30 ft

Twi **Wiggins Formation (upper Eocene) (Thorofare Creek Group, Absaroka Volcanic Supergroup)**—Yellow, chalky-white, and bright-red claystone, underlain by green and pink waxy claystone; bentonitic, weathering with puffy surface. Exposed along East Fork Pilgrim Creek north of west end of Two Ocean Lake. Thickness 0–70 ft

Thp **Hominy Peak Formation (Eocene) (Absaroka Volcanic Supergroup)**—Brown to dull-green andesitic mudflow breccia, vent breccia, conglomerate, and sandstone; light-gray tuff and thin claystone zones near top and at base; lenses of gold-bearing quartzite boulder conglomerate in lower part; fossil trees common. Thickness as much as 2,000 ft

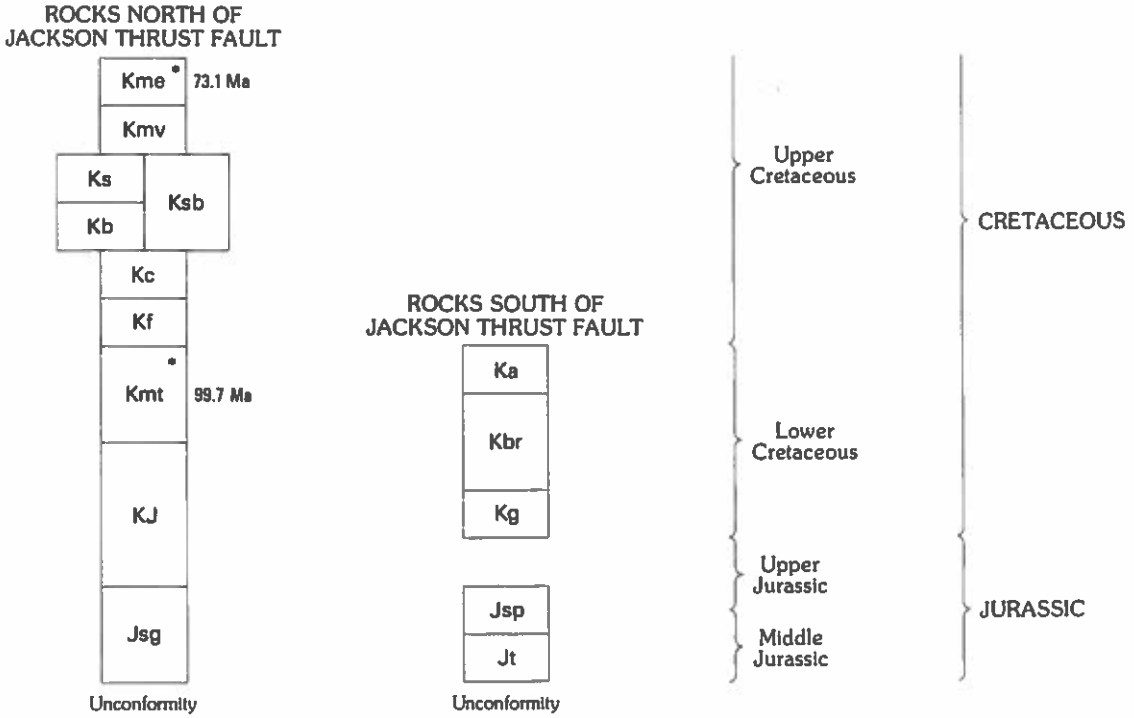
Tbb **Basalt breccia (Eocene)**—Red, brown, and purple basalt breccia of large and small angular fragments in matrix of same type of material; some dikes and flows. May be an upper igneous facies of Langford Formation (Tl). Exposed on summit of Pinyon Peak and along Coulter Creek 3.5 mi to the west. Thickness 400 ft or more

Tl **Langford Formation (Eocene) (Thorofare Creek Group, Absaroka Volcanic Supergroup)**—Volcanic conglomerate and tuff. Conglomerate is light gray, composed of boulders of andesite and basalt with lesser amounts of quartzite, granite, and, locally, huge masses of limestone and dolomite; many fossil tree stumps. Tuff is dull green to chalky white, soft, sandy, blocky in part, rich in magnetite. Exposed on Pinyon Peak and in local areas to south and southwest. Thickness 500 ft or more

TKp **Pinyon Conglomerate (Paleocene and Upper Cretaceous)**—Rusty-brown conglomerate composed of quartzite roundstones in matrix of rusty coarse-grained sandstone that contains tiny flakes of gold; sporadic boulders of older conglomerate and quartzite 5–8 ft in diameter. Thickness 0–3,800 ft

Kh **Harebell Formation (Upper Cretaceous)**—Conglomerate, sandstone, claystone, and tuff. Conglomerate consists of quartzite roundstones in matrix of brown gold-bearing sandstone; sandstone is brown, gray, and dull green, silty, hard, tuffaceous, rich in magnetite; claystone is gray, dark green, black, and mustard yellow, silty, tuffaceous. Marine or brackish-water fossils at some horizons. Thickness as much as 10,000 ft

UPPER CRETACEOUS THROUGH JURASSIC SEDIMENTARY ROCKS



North of Jackson thrust fault

Kme **Meeteetse Formation (Upper Cretaceous)**—Chalky-white to gray salt-and-pepper soft sandstone, interbedded with yellow, pale-green, and dark-gray carbonaceous shale, thin coal beds, white slabby tuff, and yellow to gray bentonite beds. Conglomerate composed of quartzite cobbles in gold-bearing sandstone matrix at several horizons. K-Ar age 73.1±0.7 Ma. Thickness about 1,000 ft

Kmv **Mesaverde Formation (Upper Cretaceous)**—White massive to thick-bedded soft porous medium- to coarse-grained sandstone containing abundant pink and green grains; interbedded with thin gray shale and sparse impure coal and bentonite beds. Sections near Elk Ranch Reservoir southwest of Moran Junction contain conglomerate beds of quartzite cobbles in gold-bearing matrix, one conglomerate as thick as 50 ft. Thickness 0–1,000 ft

Ks **Sohare Formation (Upper Cretaceous)**—Lenticular gray and brown fine-grained sandstone interbedded with light- and dark-gray shale and siltstone; largely nonmarine; contains thin coal beds. Thickness as much as 2,400 ft

Kb **Bacon Ridge Sandstone (Upper Cretaceous)**—Tan to gray thick-bedded fine-grained sandstone containing abundant marine fossils; interbedded with gray marine and brackish-water shale and siltstone; thin bentonite beds near top and in lower part. Coal beds in several parts of the section have been mined. A gold-bearing quartzite boulder conglomerate 30 ft thick in lower part intertongues with marine strata. Ferruginous concretions in an upper sandstone contain as much as 14 percent zircon. Thickness 1,000–1,500 ft

Ksb **Sohare Formation and Bacon Ridge Sandstone**

Kc **Cody Shale (Upper Cretaceous)**—Dull-gray shale, interbedded with lesser amounts of gray siltstone and gray fine-grained slabby glauconitic sandstone; marine. Thickness 1,400–2,200 ft

Kf **Frontier Formation (Upper Cretaceous)**—Gray fine- to coarse-grained sandstone, pebbly and highly glauconitic near top, interbedded with gray and black shale and thin coal beds; bentonite and white to pink porcellanite beds in lower part. Thickness about 1,000 ft

Kmt **Mowry and Thermopolis Shales**

Mowry Shale (Lower Cretaceous)—Dark-gray to black, weathering silvery gray, very hard brittle silicified thin-bedded shale; several cream-colored bentonite beds; secondarily silicified fine-grained sandstone common. K-Ar age 99.7±1.0 Ma. Thickness 500–700 ft

Thermopolis Shale (Lower Cretaceous)—Black fine-grained flaky soft shale. Muddy Sandstone Member, at top of formation, is 20- to 100-ft-thick rusty-brown to gray sandstone interbedded with black and gray siltstone and shale. Thickness generally 150–200 ft, except north of Jackson Lake where it is only 55 ft thick

KJ **Cloverly Formation (Lower Cretaceous) and Morrison(?) Formation (Upper Jurassic)**

Upper unit—Olive-green, gray, and buff thin-bedded sandstone that weathers with a conspicuous rusty color. Commonly known as the "rusty beds member" of the Cloverly. Thickness 100–200 ft

Middle unit—Variegated red, gray, lilac-colored, and pink bentonitic claystone weathering with a puffy surface; contains thin beds of hard nodular dense cream-colored limestone. Thickness 290–545 ft

Lower unit—Buff and gray chloritic, in part sparkly, sandstone interbedded with red, green, and gray siltstone and claystone. Possibly correlative with Morrison Formation. Thickness 185–250 ft

Jsg **Sundance and Gypsum Spring Formations**

Sundance Formation

Upper part (Upper Jurassic)—Glauconitic gray, buff, and green very calcareous sandstone; a few thin shale and very fossiliferous limestone beds. Forms marker ridges. Thickness 75–140 ft

Lower part (Upper and Middle Jurassic)—Gray calcareous plastic to splintery shale, clayey limestone, hard oolitic limestone, and one or more zones of red soft plastic shale; marine; highly fossiliferous. Thickness 400–550 ft

Gypsum Spring Formation (Middle Jurassic)—Dark-red soft shale, underlain by, and interbedded with, slabby gray dolomite and white gypsum. In most outcrops the gypsum has been leached, leaving lithified carbonate breccia that forms rounded cliffs. Thickness 50–150 ft, depending on amount of leaching of gypsum

South of Jackson thrust fault

Ka **Aspen Shale (Lower Cretaceous)**—Dull-green to black siliceous shale and claystone, interbedded with gray and greenish-gray hard brittle siliceous salt-and-pepper sandstone and dull-green claystone. Thickness about 1,500 ft

Kbr **Bear River Formation (Lower Cretaceous)**—Greenish-gray calcareous sandstone, interbedded with dark-gray shale; near base are cliff-forming gray sandstone beds, black shale beds, and, at base, slabby rusty sandstone. Thickness about 1,000 ft

Kg **Gannett Group (Lower Cretaceous)**—White to dark-gray limestone, variegated claystone, and

reddish-brown siltstone in upper part; maroon to red siltstone and sandstone, thin limestone, and ledge-forming conglomeratic sandstone beds in lower part. Lower part of sequence may be of Jurassic age (Eyer, 1969, p. 1377; Furer, 1970, p. 2295; Love and Christiansen, 1985). Thickness about 700 ft

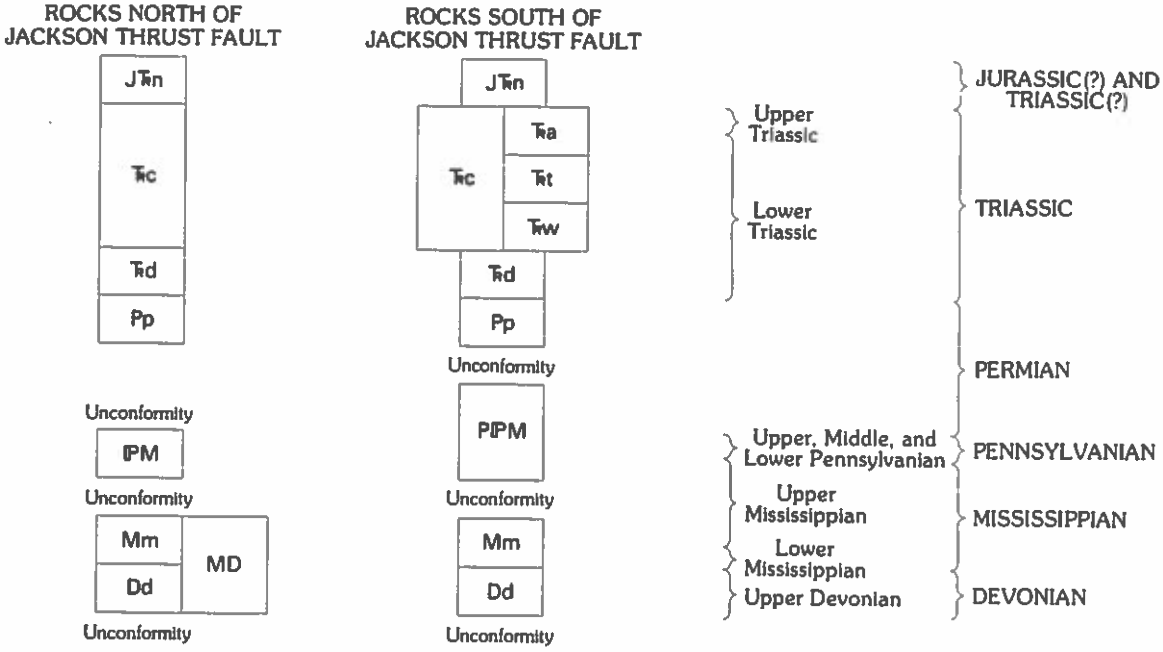
Jsp **Stump Formation and Preuss Redbeds**

Stump Formation (Upper and Middle Jurassic)—Greenish- to brownish-gray crossbedded fine- to medium-grained calcareous glauconitic sandstone; limestone bed at top. Thickness about 130 ft

Preuss Redbeds (Middle Jurassic)—Red shaly sandstone and siltstone. Thickness about 50 ft

Jt **Twin Creek Limestone (Middle Jurassic)**—Upper half is light-gray shaly limestone that fractures into pencil-shaped fragments; lower half, red siltstone, shaly limestone, and oolitic limestone; near base is Gypsum Spring Member, consisting of red and gray shale, dolomitic breccia, and gypsum. Thickness 800–900 ft

JURASSIC(?) THROUGH DEVONIAN SEDIMENTARY ROCKS



North of Jackson thrust fault

JTRn **Nugget Sandstone (Jurassic? and Triassic?)**—Light-tan to salmon-pink fine-grained crossbedded hard brittle cliff-forming sandstone characterized by large frosted rounded quartz grains in a finer matrix; softer and more porous than unit south of Jackson thrust fault. Sequence wedges out 5 mi north of Gros Ventre River. Thickness 0–200 ft

TRc **Chugwater Formation (Upper and Lower Triassic)**

Popo Agie Member—Ocher and purple claystone, red shale, lenticular purple limestone-pellet conglomerate, and red siltstone. Thickness 75–300 ft

Crow Mountain Sandstone Member—Red to salmon-pink soft porous sandstone containing large rounded quartz grains in a finer matrix. Thickness 50–100 ft

Alcova Limestone Member—Gray and purple thin-bedded hard limestone and dolomite with interbeds of white gypsum. Thickness 10–60 ft

Red Peak Member—Red gypsiferous siltstone and very fine grained sandstone containing some red shale partings. Thickness 800–1,275 ft

TRd **Dinwoody Formation (Lower Triassic)**—Brownish-gray to olive-drab hard slabby thin-bedded dolomitic siltstone; contains thin partings of fine-grained dolomitic sandstone and silty limestone. Thickness 200–250 ft

Pp **Phosphoria Formation and related rocks (Permian)**—Black phosphatic shale at top; mudstone, carbonate rock, and sandstone; gray cherty dolomite, mudstone, and sandstone; black phosphorite, mudstone, and shale at base. Thickness 180–200 ft

PPM **Tensleep Sandstone and Amsden Formation**

Tensleep Sandstone (Upper and Middle Pennsylvanian)—Light-gray, weathering yellowish brown, fine-grained hard brittle sandstone; some zones of quartzite. Middle and lower parts contain many beds of gray hard fine-grained limestone and dolomite. Transitional with underlying Amsden Formation. Thickness 400–450 ft

Amsden Formation (Middle and Lower Pennsylvanian and Upper Mississippian)

Upper part—Brick-red, red-brown, and green shale and siltstone, interbedded with white to pink dolomite and limestone. Several zones contain ocher and red chert nodules and lenses. Thickness 230–450 ft

Darwin Sandstone Member (Upper Mississippian)—Gray to brownish-pink fine- to medium-grained crossbedded moderately soft and porous sandstone; some large rounded frosted quartz grains; red shale partings near top. Thickness 75–100 ft

Mm **Madison Limestone (Upper and Lower Mississippian)**—Light- to dark-gray limestone, thick-bedded to massive in upper part, thin-bedded and dolomitic in lower part, especially near base; vuggy brown cherty dolomite near base; abundant horn corals in massive beds; many layers and lenses of black chert. At base, discontinuous thin marine black shale containing fish fragments. Thickness 1,100–1,500 ft

Bull Ridge Member (Upper Mississippian)—Red shale and siltstone interbedded with orange-red to tan sandstone, tan to pink dolomite breccia, and blue-gray ledge-forming limestone that contains highly distinctive red and "zebra-striped" gray-and-black chert nodules. Member occurs locally at top of formation. Thickness 50–100 ft

Dd **Darby Formation (Upper Devonian)**—Upper part is dull-yellow, gray, pink, and black thin-bedded dolomitic siltstone and shale; lower part is brown fetid vuggy siliceous brittle dolomite containing sparse thin limestone beds and thin sandstone beds. Thickness 285–350 ft

MD **Madison Limestone and Darby Formation**—East of Signal Mountain

South of Jackson thrust fault

JTRn **Nugget Sandstone (Jurassic? and Triassic?)**—Lithology similar to Nugget north of Jackson thrust fault. Thickness 375–560 ft

TRc **Chugwater Formation (Upper and Lower Triassic)**—Lithology similar to Chugwater north of Jackson thrust fault. Red Peak Member contains some beds of gray silty limestone and gray quartzitic sandstone. Thickness 1,460–1,760 ft

TRa **Ankareh Shale (Upper and Lower Triassic)**—Red to purple calcareous siltstone and shale; has greenish-white polka-dot mottling in several layers. Thickness 450–550 ft

TRt **Thaynes Formation (Lower Triassic)**—Upper half is gray bioclastic limestone underlain by yellowish-gray limy siltstone and sandstone; lower half is red siltstone underlain by slabby dark-brown fossiliferous silty limestone. Thickness 250–300 ft

TRw **Woodside Formation (Lower Triassic)**—Red-brown siltstone, shale, and fine-grained sandstone. Thickness 800–1,000 ft

TRd **Dinwoody Formation (Lower Triassic)**—Lithology similar to Dinwoody north of Jackson thrust fault. Thickness 450–600 ft

Pp **Phosphoria Formation and related rocks (Permian)**—Lithology similar to Phosphoria north of Jackson thrust fault. Thickness 230–260 ft

PPPM **Wells and Amsden Formations**

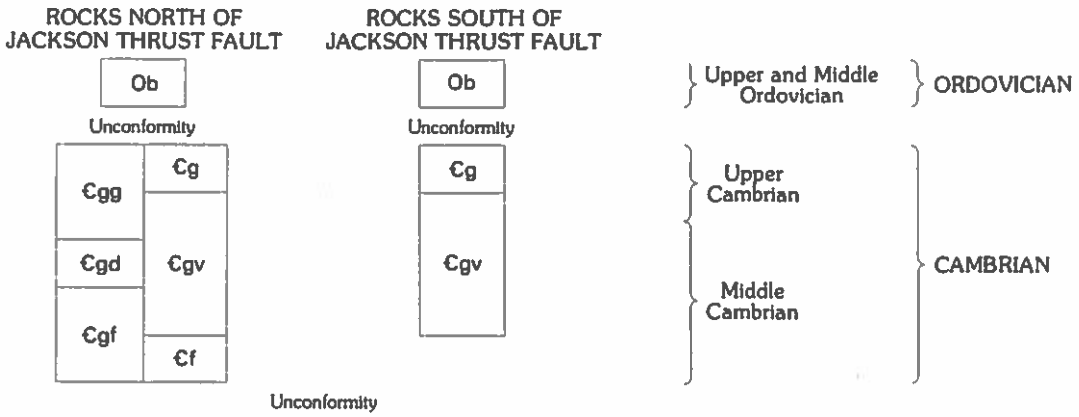
Wells Formation (Lower Permian and Upper and Middle Pennsylvanian)—Light-gray hard fine-grained sandstone; contains gray limestone beds which are more abundant in lower part. In places, uppermost part contains chalky-white brittle very fine grained dolomite and gray chert. Grades into Amsden Formation. Thickness 450–1,000 ft

Amsden Formation (Middle and Lower Pennsylvanian and Upper Mississippian)—Bluish-gray hard limestone, interbedded with red and green shale and tan to white fine-grained sandstone; conspicuous red and mustard-yellow chert nodules and thin lenses. Thickness 450–700 ft

Mm **Madison Limestone (Upper and Lower Mississippian)**—Lithology similar to Madison north of Jackson thrust fault. Thickness 1,100–1,500 ft

Dd **Darby Formation (Upper Devonian)**—Lithology similar to Darby north of Jackson thrust fault. Thickness 285–450 ft

ORDOVICIAN AND CAMBRIAN SEDIMENTARY ROCKS



North and (or) south of Jackson thrust fault

Ob **Bighorn Dolomite (Upper and Middle Ordovician)**—Light- and dark-gray mottled siliceous dolomite; forms ragged gray cliffs. Leigh Dolomite Member, about 50 ft thick, forms slope at top of cliffs, consists of chalky-white very fine grained brittle dolomite. Thickness variable, 200–500 ft

Cg **Gallatin Limestone (Upper Cambrian)**—Dark-gray hard limestone, weathering tan mottled with yellow splotches; some green shale near middle; lower part contains flat-pebble "edge-wise" conglomerate; some beds glauconitic. Forms cliffs. Thickness 200–250 ft

Cgg **Gallatin Limestone and Park Shale Member of Gros Ventre Formation**

Cgv **Gros Ventre Formation (Upper and Middle Cambrian)**—As mapped in Gros Ventre Range includes Park Shale, Death Canyon Limestone, and Wolsey Shale Members

Park Shale Member (Upper and Middle Cambrian)—Olive-green soft flaky micaceous shale; contains thin beds of flat-pebble limestone conglomerate; basal part has numerous large and small algal heads. Thickness 150–350 ft

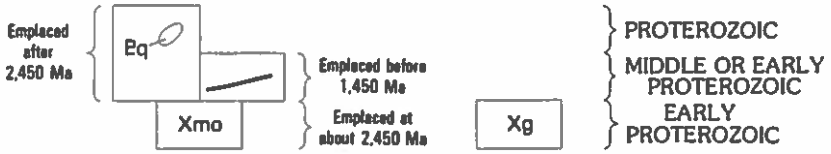
Cgd **Death Canyon Limestone Member (Middle Cambrian)**—Blue- to dark-gray, mottled with brown and tan irregular splotches, fine-grained hard dense thin-bedded cliff-forming limestone; middle part contains 30 ft of flaky green shale having abundant trilobites; locally, at base, a distinctive bed of brown-weathering dolomite. Thickness 300–370 ft

Wolsey Shale Member (Middle Cambrian)—Green to gray-green soft highly fissile micaceous shale; more silty near base; lower part is very glauconitic and interbedded with sandstone; glauconite weathers to red hematitic color. Contact transitional with underlying Flathead Sandstone (Cf). Thickness 100–130 ft

Cgf **Wolsey Shale Member of Gros Ventre Formation and Flathead Sandstone**

Cf **Flathead Sandstone (Middle Cambrian)**—Indurated white, tan, brown, and maroon crossbedded hard sandstone, locally quartzitic, and locally conglomeratic near base; forms cliffs. Thin partings of green micaceous shale in upper part. Thickness 200–300 ft

PROTEROZOIC INTRUSIVE ROCKS



Veins and dikes

Eq **Quartz veins**—White to light-pink quartz, massive to strongly foliated and lineated. Emplaced after 2,450 Ma

Diabase dikes (Middle or Early Proterozoic)—Medium- to dark-gray or gray-green fine- to medium-grained diabase; dikes commonly contain tabular phenocrysts of plagioclase 1–5 mm long. Dikes are undeformed but slightly metamorphosed and display chilled margins. Probably emplaced before 1,450 Ma (Reed and Zartman, 1973)

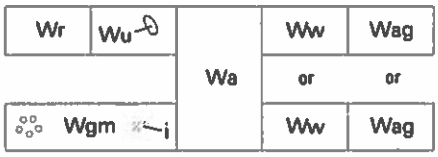
Granitic rocks

Xmo **Mount Owen Quartz Monzonite (Early Proterozoic) and associated pegmatite**—Medium- to fine-grained light-colored massive to weakly flow-foliated biotite quartz monzonite containing dikes, pods, and irregular masses of muscovite- and biotite-bearing pegmatite. Quartz monzonite is relatively uniform in central parts of larger plutons; near margins and in smaller bodies pegmatite is very abundant and tabular inclusions of wallrocks a few inches to tens of feet across comprise nearly 50 percent of the volume of the rock. Near large plutons of quartz monzonite, pegmatite and aplite dikes comprise nearly 50 percent of the volume of the wallrocks; in these areas, contacts between Mount Owen Quartz Monzonite containing abundant inclusions of country rock and country rocks containing abundant dikes of pegmatite and aplite are largely arbitrary. Emplaced at about 2,450 Ma (age recalculated from Reed and Zartman, 1973, using new constant)

Xg **Granitic rocks of the Gros Ventre Range**—Fine- to medium-grained massive to faintly foliated light-colored biotite quartz monzonite containing abundant inclusions of migmatitic biotite gneiss, foliated granitic gneiss, and layered biotite and amphibole gneiss. Locally contains conspicuous large crystals of potassium feldspar 12–25 mm in diameter. Cut by abundant dikes of muscovite- and biotite-bearing pegmatite. May be equivalent to Mount Owen Quartz Monzonite of Teton Range

LATE ARCHEAN METAMORPHIC ROCKS

[Metamorphosed at about 2,815 Ma (age recalculated from Reed and Zartman,1973, using new constant)]



Wr **Rendezvous Metagabbro**—Gray to dark-green coarse-grained nonlayered weakly foliated metagabbro, typically having a blotchy appearance produced by irregular clots of dark-green hornblende 2–5 cm in diameter in a matrix of light-gray plagioclase; locally contains layers and inclusions of wallrocks. Pods and lenses of similar metagabbro, probably fragments of deformed dikes and sills, are abundant in nearby country rocks

Wu **Ultramafic rocks**—Pods and small tabular bodies of serpentinized dunite or peridote and associated uralitized gabbro, a few feet to a few hundred feet in diameter. Locally contain veins of talc (soapstone) as wide as 7 ft and veins of asbestos with fibers as long as 1 ft

Wa **Amphibolite**—Fine- to medium-grained massive to well-foliated and well-lineated dark-green to greenish-gray amphibolite, locally containing large crystals of plagioclase or garnet

Wgm **Layered gneiss and migmatite**—Complexly interlayered fine- to medium-grained biotite gneiss and schist, quartz-plagioclase gneiss, amphibole gneiss and schist, and amphibolite. Layers range from 0.5 in. to tens of feet in thickness; some extend only a few feet and others are continuous for hundreds of feet. Adjacent to larger masses of Mount Owen

Quartz Monzonite (Xmo), the gneisses grade into light-colored less conspicuously layered migmatites that contain abundant large microcline crystals and thin lenses of quartz and feldspar

i **Magnetite iron-formation and associated anthophyllite schist, cordierite gneiss, and impure marble**

oo **Biotite gneiss with magnetite eyes**—Medium-gray biotite gneiss containing magnetite aggregates 0.5–1 cm in diameter surrounded by bleached haloes lacking biotite ("bright-eyed gneiss" of Bradley, 1956)

++ **Areas where gneiss contains abundant pods and lenses of metagabbro**

Ww **Webb Canyon Gneiss**—Medium- to coarse-grained strongly foliated nonlayered biotite- and hornblende-bearing quartz monzonite gneiss containing abundant allanite. Commonly cut by small discordant dikes of hornblende-bearing pegmatite. Rock mapped as Webb Canyon Gneiss in the large body north and east of Eagles Rest Peak and the easternmost small body near mouth of Snowshoe Canyon is very strongly foliated migmatitic biotite gneiss that lacks hornblende and allanite (S.H. Scott, oral commun., 1985). These bodies, and perhaps some of the rocks mapped as Webb Canyon Gneiss near Rammel Mountain, probably should have been included in a separate map unit

Wag **Augen gneiss**—Medium-grained, strongly foliated and lineated, rudely layered to nonlayered, medium- to dark-gray biotite gneiss containing conspicuous ovoid crystals (augen) of white microcline 1–4 cm long. Locally contains thin layers of amphibolite and biotite gneiss lacking feldspar augen

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Table 1.–*Dates and related information for some Quaternary through Lower Cretaceous rocks in and near Grand Teton National Park, Wyoming*

[Leaders (—) indicate either no USGS sample No. or USGS sample No. unavailable]

Lithologic unit	Map symbol	System or series	Age	Type of determination	USGS sample No.	Type of sample	Remarks	Source of data
Lacustrine and related deposits.	Qla	Holocene	8,800±250 yrs	^{14}C	W-393	Mollusk shells	White marl and clay on floor of Jackson Hole southeast of Signal Mountain.	Meyer Rubin, *in* Love (1956, p. 150).
			9,580±250 yrs	^{14}C	W-392	—do—	—do—	Do.
Loess	Ql	Pleistocene	15,300±500 yrs	^{14}C	W-1071	Gastropods	Several localities	Love and Taylor (1962, p. D139).
			13,980±700 yrs	^{14}C	W-1078	—do—	—do—	Do.
			15,000±600 yrs	^{14}C	W-1556	—do—	—do—	Meyer Rubin, *in* Love, Richmond, and others (1965, p. 40).
			19,000 yrs	^{14}C	W-1560	—do—	—do—	Do.
Drift of glaciation 3.	Qg_3	—do—	27,100±800 yrs	^{14}C	W-312	Carbonized wood	From silt at top	Meyer Rubin, *in* Love (1956, p. 149).
			>33,000 yrs	^{14}C	W-1273	—do—	—do—	Meyer Rubin (written commun., 1963).
Lava Creek Tuff, member B.	Qlab	—do—	620,000 yrs	K-Ar	——	Tuff	Locality in Yellowstone National Park	Izett and Wilcox (1982).
Lewis Canyon Rhyolite.	Qlc	—do—	900,000 yrs	K-Ar	——	Rhyolite	—do—	R.L. Christiansen (written commun., 1975).
Huckleberry Ridge Tuff.	Th	Pliocene	2.02 Ma	K-Ar	——	Tuff	—do—	Izett and Wilcox (1982).
Conant Creek Tuff[1].	Tcc	—do—	4.2±0.7 Ma	(2)	——	Obsidian	From near base	G.A. Izett (written commun., 1975, *in* Christiansen and Love, 1978, p. C8).
Rhyolite	Tr	Miocene	8.06±0.08 Ma	K-Ar	DKA3328	Obsidian	Southeast of Teton Pass; intruded into rhyolite.	Naeser and others (1980, p. 23).
Andesite and basalt	Tab	—do—	8.1±0.9 Ma	K-Ar	——	Andesite	Southeast of Teton Pass	Chevron USA Inc. (written commun., 1985).

Obsidian pipes	To	—do—	8.48±0.08 Ma	K-Ar	DKA3331	Obsidian	—do—	Naeser and others (1980, p. 23).
Teewinot Formation.	Tte	—do—	9.2 Ma	K-Ar	——	—do—	From near top of formation	Evernden and others (1964, sample KA-929).
			10.3±0.6 Ma	K-Ar	——	—do—	From lower part of formation	D.W. Burbank (oral commun., 1985).
White River Formation.	Twr	Oligocene	35.8±0.8 Ma	K-Ar	71-0-14	Biotitic tuff	About 3.5 mi east of northeast corner of map area.	J.D. Obradovich (written commun., 1972, *in* Love, McKenna, and Dawson, 1976, p. A-13).
Wiggins Formation.	Twi	Eocene	45.9±0.5 Ma	K-Ar	DKA2887	Biotite-rich clayey sandstone.	Thickness 2 ft; on East Fork Pilgrim Creek	J.D. Obradovich (written commun., 1975).
Hominy Peak Formation.	Thp	—do—	48.6±0.7 Ma	K-Ar	DKA2982	Basalt	Grand View Point, Grand Teton National Park.	J.D. Obradovich (written commun., 1975, *in* Love, Leopold, and Love, 1978).
Basalt breccia	Tbb	—do—	49.4±1.0 Ma	K-Ar	——	Basalt breccia	Pinyon Peak	M.C. McKenna (written commun., 1970).
Pinyon Conglomerate.	TKp	Paleocene	——	——	——	Pollen	Basal nonconglomeratic beds; 7.6 mi southeast of Mount Leidy and 2 mi east of map area.	Love (1973a).
	Upper	67.0±0.7 Ma Cretaceous.	K-Ar		DKA2892	White tuff	Thickness 100 ft; 300 ft above base of the basal 800-ft nonconglomeratic gray sandstone, dark-gray claystone, and tuff; east side of Gravel Peak about 3 mi east of map area and 4.5 mi southeast of Pinyon Peak.	J.D. Obradovich (written commun., 1975).
		—do—	——	——	——	Dinosaur tooth	150 ft above base; 2 mi east of Pinyon Peak	McKenna and Love (1970).
Meeteetse Formation.	Kme	—do—	73.1±0.7 Ma	K-Ar	——	White biotite-rich tuff.	Along outlet channel of Emma Matilda Lake.	J.D. Obradovich (written commun., 1975).
Mowry Shale	Kmt	Lower Cretaceous.	99.7±1.0 Ma	K-Ar	DKA2888	Biotite-rich tuff.	37 ft above base; 2 mi north of map area	J.D. Obradovich (written commun., 1986).

[1]Age borne out by K-Ar ages of 4.1±0.1 Ma to 4.8±0.3 Ma (Morgan and others, 1984) on tuffs in the Kilgore area of eastern Idaho, which have the same composition and lithology as the Conant Creek Tuff and are believed by Morgan and R.L. Christiansen to be the Conant Creek Tuff (L.A. Morgan, oral commun., 1985).

[2]Fission-track determination.