

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Geologic Map of the Clayton Quadrangle,
Custer County, Idaho
Description of map units

By

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This report is preliminary and has not been
edited or reviewed for conformity with U.S.
Geological Survey standards and nomenclature

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

- Qs SLUMPED BLOCK (HOLOCENE) OF CLAYTON MINE QUARTZITE (Ocm)
- Q1 YOUNG LANDSLIDE DEPOSITS (HOLOCENE)--Mass of rock material in source area displaced relatively short distances downslope by gravity. Comprise blocks, angular fragments, or disintegrated material of bedrock. Most numerous in bedded silicic tuff (Tt) of Challis Volcanics and in Ramshorn Slate (Or); characterized by irregular hummocky topography
- Qm MUDFLOW DEPOSITS (HOLOCENE)--Linear mass-movement landform comprising predominantly mud, silt, and sand-sized material but including small rock fragments and some angular cobble- and boulder-sized pieces. Produced by flowage of highly water-charged mass of earth material downslope or down stream valley. Largest and only one mapped is in valley of Aspen Creek in northwestern part of quadrangle
- Qal ALLUVIUM (HOLOCENE AND PLEISTOCENE)--Gravel, sand, silt, and clay associated with present drainage. Includes recent channel and flood-plain deposits of main river drainages and tributaries as well as locally thick fill-terraces and gravel-capped rock-cut terraces along main Salmon River whose tops are as much as 100 feet (31 m) above present river level. Higher rock-cut terraces and thick fill-terraces probably Pleistocene
- Q1o OLDER LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)--Similar to young landslide deposits (Q1) but with morphology subdued and modified by erosion. In places overridden by younger slides; in places include deposits same age as young landslide deposits (Q1)
- Qc COLLUVIUM (HOLOCENE AND PLEISTOCENE)--Loose and incoherent mass of soil material and rock fragments mantling flat or gently sloping surfaces and obscuring bedrock. Deposited by processes of mass-wasting; includes various proportions of soil and rock fragments. Locally includes scree where developed on quartzite bedrock at high elevations

- Qsu SURFICIAL DEPOSITS UNDIVIDED (HOLOCENE AND PLEISTOCENE)--Includes colluvium, landslide deposits, alluvium, and till(?) in densely wooded areas of upper Mill Creek
- Qso SOLIFLUCTION DEPOSITS (PLEISTOCENE)--Unsorted mixture of rock and soil of local derivation moved downslope by solifluction
- Qd DIAMICTON (PLEISTOCENE)--Bouldery till-like deposit of possible glacial origin. Mapped on slopes west of Mill Creek Campground and in small area east of Bayhorse Lake
- Qg OLDER GRAVELS (PLEISTOCENE?)--Gravels of local derivation occurring as isolated remnants along streams tributary to the Salmon River, usually on the valley sides well above present base level. Also a few isolated patches on crests of stream interfluves

CHALLIS VOLCANICS AND RELATED INTRUSIVES (EOCENE)

- Tv CHALLIS VOLCANIC UNDIVIDED--Volcanic rocks of unknown composition or indeterminate correlation

Challis Volcanics in western area

- Try RHYOLITE FLOWS AT MILL CREEK SUMMIT--Black, gray, and greenish-gray vitrophyric and gray- to pink-banded devitrified rhyolite lavas containing 1-5 percent phenocrysts as large as 2 mm of plagioclase and biotite. Also present are hornblende, allanite, zircon, apatite, opaque oxides, and minor potash feldspar. Vitrophyric rocks contain fresh perlitic glass. Four flow units with aggregate thickness of about 770 feet (235 m) are present in butte east of Mill Creek Summit. All flows have reverse magnetic polarity
- Tryb Vitrophyre breccia--Locally present at base of flow sequence
- Tryq Flow containing conspicuous quartz phenocrysts--Present on ridge south of summit
- Tt BEDDED SILICIC TUFF--Chiefly gray to white thin-bedded altered vitric and pumice tuff that contains crystals of plagioclase (andesine), biotite, hornblende, quartz, allanite, and, locally, fragments of slate or quartzite. Plant debris

locally present. Alkali feldspar present at southernmost exposure on divide between Squaw and Treavor Creeks and in exposures near Mill Creek Summit. Pumice fragments commonly replaced by clinoptilolite

- Tmr** MUDFLOW BRECCIA, CONGLOMERATE, AND LAVA OF ROUGH CREEK--Nearly monolithologic breccia and conglomerate containing reddish- and yellowish-brown-weathering subangular to rounded blocks as much as 4 feet (1.2 m) in diameter in yellow matrix, locally interstratified with thin red pyroclastic layers and sparse lava flows. Internal features and distribution suggest source beyond edge of quadrangle west of Rough Creek. Principal rock type is brown-weathering dark-gray to black K-rich andesite that contains 1-15 percent phenocrysts 0.5-4 mm in size of plagioclase (labradorite), orthopyroxene, clinopyroxene, olivine pseudomorphs, and quartz xenocrysts. Blocks of rhyolite similar to that in overlying rhyolite flows (Try, Tryq?) locally present near top of unit and in exposures on ridge northwest of Buster Lake. Lenses of lava in upper part of unit have reverse magnetic polarity. Near Willow Patch and Sheep Creek flows of olivine basalt and rhyodacite interstratified with unit; contact with units exposed to south arbitrary
- Trr** RHYODACITIC LAVA AND BRECCIA OF SMALL LAVA DOME(?) EAST OF TOLLGATE RUINS--Yellow- and gray-weathering gray to black locally glassy-appearing rock containing 10 percent phenocrysts as large as 4 mm of plagioclase (labradorite), orthopyroxene, clinopyroxene, amphibole, biotite, and apatite. Reverse magnetic polarity
- Trt** RHYODACITIC LAVA AND BRECCIA NORTH OF TRAIL CREEK--Brown-weathering gray and oxidized red rocks containing 10 percent phenocrysts as large as 2 mm of plagioclase (labradorite), orthopyroxene, clinopyroxene +biotite and +amphibole. One sample contained relict olivine. Normal magnetic polarity on and west of hill 8171; one reverse polarity station near Aspen Creek

- Trbr RHYODACITE OF BUFFALO RIDGE--Brown-weathering lava containing 40-50 percent phenocrysts as large as 3 mm of plagioclase (andesine-labradorite), clinopyroxene, orthopyroxene, and rare oxidized biotite plus apatite, and quartz xenocrysts. Local flow direction toward north in exposures at head of Spruce Gulch. Normal magnetic polarity
- Tbt K-RICH OLIVINE BASALT OF UPPER TREALOR CREEK--Black, dark-brown, gray, and greenish-gray blocky to platy lava containing 1 percent reddish-brown olivine pseudomorphs as large as 1 mm in trachytic matrix that contains chiefly plagioclase and clinopyroxene microlites; quartz xenocrysts common. A flow on hill northeast of Spring Basin also contains orthopyroxene. Red oxidized pyroclastic facies prominent on ridge at headwaters of Treavor Creek (hills 8713 and 8783), and north of Trail Creek. Basal 60-80 feet (18-25 m) of unit northwest of Spring Basin is brown-weathering black nonporphyritic pillow lava with reverse magnetic polarity. Similar rocks (plus red breccia) occur near base of unit northeast of Martin Creek. Most of the unit has normal magnetic polarity
- Trsb RHYODACITE OF SPRING BASIN--Reddish-brown-weathering greenish-brown to light-brown lava containing as much as 40 percent phenocrysts < 3 mm in size of plagioclase (andesine-labradorite), clinopyroxene, mafic pseudomorphs (after orthopyroxene?), and granular magnetite plus minor apatite, quartz, and poorly crystallized biotite. Reverse magnetic polarity
- Trsc RHYODACITE OF SECOND CREEK-CABIN CREEK DIVIDE--Brown-weathering gray lava containing 20 percent phenocrysts as large as 3 mm of plagioclase (andesine-labradorite), oxidized biotite, and pseudomorphs after amphibole(?), plus minor apatite and zircon. Normal magnetic polarity
- Trs RHYODACITE OF UPPER SECOND CREEK--Gray- and reddish-brown-weathering gray lava and breccia containing 20-25 percent phenocrysts as large as 3 mm of plagioclase (andesine-labradorite), biotite, hornblende and hornblende pseudomorphs, and minor zircon. Reverse magnetic polarity

- Tbj OLIVINE BASALT OF RIDGE SOUTHWEST OF JULIETTE BASIN--Brown-
weathering gray lava with yellow-weathering scoriaceous top;
contains 25 percent phenocrysts, < 1 mm in length, of white
carbonate olivine pseudomorphs, clinopyroxene, plagioclase,
and rare pale-brown mica. Resembles rock in plug to the
northeast on south rim of Juliette Basin. Normal magnetic
polarity
- Trc RHYODACITE OF CASH CREEK--Chiefly dark-brown- to gray-weathering
dark-gray to purplish-gray lava containing 1-10 percent
phenocrysts < 0.5 mm in size of plagioclase (andesine-
labradorite) and altered mafic minerals (chiefly pyroxene?).
Rock high on hill north of Cinnabar Creek is light gray and
contains a few wisps of biotite. Mudflow breccia prominent
along Squaw Creek between Cash Creek and Trealor Creek.
Normal magnetic polarity
- Trf RHYODACITIC BRECCIA AND LAVA OF FANNYS HOLE--Brown, grayish-brown,
and gray; commonly oxidized; contains phenocrysts as large as
1 mm of plagioclase (andesine), oxidized biotite, and horn-
blende. Probably from source near Corkscrew Mountain, north-
east of quadrangle. Normal magnetic polarity
- Trbc RHYODACITIC LAVA OF BAYHORSE CREEK--Brown-weathering greenish-gray
and gray vitrophyric lava containing 20-25 percent phenocrysts
as large as 2 mm of plagioclase (andesine-labradorite), biotite,
amphibole, clinopyroxene, orthopyroxene, apatite, zircon,
reddish-brown olivine(?) pseudomorphs, quartz xenocrysts, and,
locally, slate(?) xenoliths. K-Ar age of biotite is 49.9 ± 1.7
m.y. (R. F. Marvin, written commun., 1973). Sample from divide
west of Juliette Basin is platy, gray, devitrified, and contains
plagioclase, biotite, quartz, amphibole(?), apatite, and zircon.
Normal magnetic polarity. Roadside exposures 1/4 mile (0.2 km)
southeast of Bayhorse Lake are altered, contain plagioclase,
biotite, and amphibole, and have reverse magnetic polarity

Intrusive rocks related to
Challis Volcanics in western area

INTRUSIONS EAST OF SUMMIT ROCK

- Tir Rhyolite--Gray to white, locally hematite- or goethite-stained; 1-10 percent phenocrysts as large as 4 mm of quartz, plagioclase (andesine), biotite, and alkali feldspar plus sphene, zircon, apatite, and allanite(?). Most outcrops explosively shattered or brecciated to varying degrees; dike-like body capping hill 8496 emplaced as mass of fragments. Apparent normal magnetic polarity
- Tid Rhyodacitic(?) breccia plug--Yellowish-brown-weathering matrix contains subrounded blocks as much as 1 m in diameter of gray dense lava containing < 1 percent phenocrysts < 1 mm in size of clinopyroxene, plagioclase, and opaque minerals plus cognate(?) inclusions containing plagioclase, clinopyroxene, and biotite phenocrysts. Baked contact zone in tuff at plug margin has reverse magnetic polarity
- Tib K-RICH BASALT DIKES AND PLUGS--Dark-brown- and grayish-brown-weathering, dark-gray and bluish-gray; < 1-25 percent phenocrysts < 1-4 mm in size of olivine or olivine pseudomorphs and clinopyroxene in matrix of plagioclase, granular opaque minerals, and altered glass. Carbonate commonly replaces olivine and groundmass. Quartz xenocrysts or granular clinopyroxene clusters after quartz common. Both normal and reverse polarity; large plug southwest of Mill Creek Campground contains orthopyroxene, has normal magnetic polarity; bodies 1/2 mile (0.3 km) northeast of Tollgate ruins reversely polarized
- Tit PLUGS ON UPPER TREALOR CREEK--Chiefly light-brown to pale-gray brittle flaky to fine blocky aphanitic rock containing prominent quartz xenocrysts as large as 2 mm, some of which are polycrystalline (derived from quartzite?); also contains apatite, plus 10 percent pseudomorphs after plagioclase, pyroxene(?), biotite, and amphibole. Normal magnetic polarity. Southeast slope of northeastern plug also

exposes a riblike outcrop of dark-brown-weathering dark-gray fine-grained basaltic rock containing amphibole "xenocrysts," plagioclase, clinopyroxene, opaque oxides, and carbonates. Reverse magnetic polarity

- Tri PLUG BETWEEN COAL AND CABIN CREEKS--Reddish-brown-weathering bluish-gray rhyodacite containing 2 percent phenocrysts as large as 1 mm of plagioclase (labradorite), orthopyroxene, clinopyroxene, and pseudomorphs after hornblende, with minor granular opaque minerals, carbonate, apatite, and pale-brown biotite. Reverse magnetic polarity
- Tia ALTERED DIKELIKE MASS ON RIDGE NORTH OF CINNABAR CREEK--Gray to white highly altered compact rock containing partly altered biotite phenocrysts; locally fractured and goethite stained
- Tibr INTRUSIVE BRECCIA NORTH OF BUSTER LAKE--Reddish-orange- and brown-weathering well-cemented pipelike mass of angular moderately pumiceous lava fragments as large as 5 cm. Grayish-purple fragments, commonly altered white and goethite stained, contain phenocrysts of plagioclase (labradorite) and goethitic mafic pseudomorphs

Challis Volcanics in eastern area

- Tyr RHYOLITIC ASH-FLOW TUFF--Part of Yankee Fork Rhyolite of Ross (1937). Red, reddish-purple, and yellowish-brown densely welded devitrified ash-flow tuff containing 5-20 percent crystals as large as 3 mm of iridescent alkali feldspar and smoky quartz in fine shardy matrix. Visible only in thin section are sparse zircon, allanite, and biotite. Lithoidal, brittle, blocky to platy, readily frost rived; crops out as rounded ridgecap with few exposures of undisturbed rock. Maximum thickness in this quadrangle 120 feet (37 m). Correlative with part of ash-flow sequence exposed near Grandview Canyon, about 10 miles (16 km) to the northeast; relationship to ash-flow tuff at Challis unknown. Normal magnetic polarity

Trd RHYODACITE LAVAS AND BRECCIAS--Part of latite-andesite of Ross (1937); yellowish- and reddish-brown-weathering; 20-40 percent phenocrysts (3-5 mm) of plagioclase (andesine-labradorite), biotite, clinopyroxene, orthopyroxene, apatite, and magnetite in devitrified commonly zeolitized (stilbite, heulandite) groundmass. Locally altered to celadonite. Brittle blocky to crumbly rock; weathers readily; occurs as thick flows and domelike masses extruded chiefly from vents located beneath and near Blue Mountain; unit locally includes some thin flows of K-rich olivine basalt, most notably east of North Fork of Birch Creek and on north shoulder of Blue Mountain. Thickness extremely variable, probably seldom much in excess of 2,000 feet (610 m). Normal and reversed magnetic polarities. K-Ar age determinations by R. L. Armstrong (1974): 44.7 ± 1.0 m.y., 46.4 ± 1.6 m.y., and 48.0 ± 1.0 m.y. The 44.7-m.y. age (whole rock) appears anomalously young; rock at this sample locality contains abundant zeolites, which may account for apparent discrepancy

Tb K-RICH OLIVINE BASALT--Brown- and reddish-brown-weathering dark-gray to dark-greenish-gray lava and reddish- or yellowish-brown pyroclastic breccias; porphyritic and microporphyritic; 1-20 percent phenocrysts < 0.5 mm-2 mm in size of olivine (commonly altered) and clinopyroxene in matrix of plagioclase, clinopyroxene, opaque oxides, interstitial glass or glass alteration-product, and rare apatite(?) needles. Some flows contain quartz xenocrysts. Occurs as discrete local accumulations, generally 500 feet (153 m) or less thick, interstratified with the silicic bedded tuff (Tt); between Wood Creek and Mud Spring Gulch, fills a stream channel developed along the unconformity between the silicic bedded tuff (Tt) and adjacent prevolcanic rocks. K-Ar age determinations on basalt near base of local volcanic stratigraphic section northeast of Daugherty Spring, exposed in roadcut on Garden Creek Road northeast of BM 6175: 49.2 ± 1.8 m.y. and 48.7 ± 1.8 m.y. (R. L. Armstrong, 1974)

- Tar RHYOLITIC ASH-FLOW TUFF OF JOHN GULCH--White, densely welded, devitrified; about 20 percent crystals as large as 4 mm of quartz and iridescent alkali feldspar plus sparse magnetite and zircon. Locally contains flattened pumice 1-4 cm in diameter. Weathers reddish brown and yellowish brown. Locally veined with white quartz, accompanied by bright red and yellow colors (caused by fumarolic? activity). Normal magnetic polarity. Zone of dense welding overlain directly and replaced laterally by bedded tuff (Tt) of different composition, suggesting erosional interval. Three-foot (1-m) gravel layer near top of bedded tuff unit contains well-rounded pebbles of densely welded tuff indistinguishable in thin section from the rhyolitic ash-flow tuff of John Gulch (Tar)
- Tt BEDDED SILICIC TUFF--Part of Germer Tuff of Ross (1937). Chiefly gray, greenish-gray, and yellowish-brown thick- to thin-bedded vitric pumice tuff and lapilli tuff containing crystals of quartz, plagioclase (chiefly andesine), biotite, hornblende, clinopyroxene, apatite, and, locally, allanite, in addition to fragments of porphyritic lava, slate, and quartzite. Plant debris common, but especially abundant in exposures along the Salmon River between Bayhorse Creek and Wood Creek and in vicinity of Malm Gulch. Diagenetic alteration common, but especially complete near Bradshaw Gulch and northeast of Sink Creek. Alteration products include montmorillonite-group clays, chlorite, clinoptilolite, and potash feldspar. One locally prominent subaqueous pyroclastic flow, exposed in Bradshaw Gulch, on spur southeast of Centennial Flat, and east across the Salmon River, is greenish gray weathering, rich in altered glass and pumice, and contains 30-40 percent crystals as large as 2 mm of quartz, andesine, biotite, zircon, sphene (or leucoxene), apatite, and, locally, hornblende. Much of unit was deposited from thin turbidity flows in standing water. Fluvial gravel is rare, found at only three localities. One locality, on ridge northeast

of Rattlesnake Creek, where gravel containing boulders as much as 4 feet (1.2⁴m) in diameter of quartzite, slate, and gabbro is exposed, marks the course of a stream draining the immediately adjacent ridge of prevolcanic rocks. Another, of locally derived quartzite, slate, and plagioclase porphyry gravel along margins of channel-filling basalt flows between Wood Creek and Mud Spring Gulch, marks the course of a former stream channel developed parallel to the unconformable contact of the bedded silicic tuff (Tt) and prevolcanic rocks. The third locality, on hilltop in SE 1/4 sec. 19, T. 11 N., R. 19 E., near southeast corner^{of} quadrangle, exposes gravel near the top of the unit (Tt) containing cobbles of granitic rock, vein quartz, and a variety of volcanic rocks foreign to the quadrangle; this deposit may mark the beginning of throughgoing drainage that ended subaqueous tuff deposition. About 1 mile (0.6 km) to the north and at somewhat lower elevation the silicic bedded tuff (Tt) is overlain by the subaerial rhyolitic ash-flow tuff (Tyr)

Trf? RHYODACITE BRECCIA AND LAVA--Possibly equivalent to rhyodacite breccia and lava of Fannys Hole (Trf) described under volcanics in western area

Tm MUDFLOW BRECCIA AND CONGLOMERATE NEAR DAUGHERTY GULCH--Green and bluish-green; weathers green to greenish gray; contains angular and rounded blocks locally as much as 4 ft (1.2 m) in diameter of[#] porphyry with phenocrysts of plagioclase, biotite, and pseudomorphs after amphibole(?) in poorly sorted matrix containing green and red oxidized volcanic rock fragments as large as 5 mm (subrounded, porphyritic, some pumiceous) with plagioclase, biotite, and amphibole(?) pseudomorphs. Hydrothermally altered rock (kaolinite-quartz) of this unit that occurs at fluorspar mine near National Forest boundary northwest of Daugherty Spring (2,100 feet or 640 m south of southeast corner sec. 33, T. 14 N., R. 18 E.) was used by Anderson (1954) as evidence that the fluorspar mineralization was not prevolcanic

Intrusive basaltic rocks related to
Challis Volcanics in eastern area

Tib BASALT--Dark-gray, gray, and greenish-gray aphanitic to sparsely porphyritic (< 5 percent; < 2 mm in size) K-rich basalt containing altered olivine or olivine pseudomorphs, clinopyroxene, opaque oxides, and plagioclase (labradorite). Large sheetlike mass exposed north and south of Bradshaw Gulch contains both clinopyroxene and orthopyroxene phenocrysts. Variably altered to pale-green phyllosilicates and carbonate; highly altered rock weathers readily. Occurs as dikes, plugs, and irregular quasi-concordant sheets, often with marginal envelopes of altered rock. Some concordant sheets, not readily distinguished from flows, appear to have been emplaced under shallow cover of water-saturated sediment. Upper contacts of basalt sheets locally provide direct evidence for intrusive emplacement:

- 1) Overlying sediments are deformed and slightly altered in exposures in draw east of Highway 93 one-half mile (0.3 km) south of Malm Gulch, on south border of sec. 19, T. 12 N., R. 19 E.;
- 2) Slabs of overlying tuff are enclosed in upper part of sheet exposed in north wall of Bradshaw Gulch 2,500 feet (762 m) southeast of highway bridge across gulch. Highly altered mass exposed on south slope of spur southeast of Centennial Flat appears to be an altered palagonite breccia complex, and is considered intrusive by analogy with more clearly intrusive irregular sheets and masses at similar elevations immediately south across the river. Plugs along Salmon River north of Bayhorse Creek are pale greenish gray, contain secondary silica in addition to pale-green phyllosilicates and carbonate, and locally contain a little pyrite introduced along fractures. Less altered parts of larger plug are dark gray to black. K-Ar ages of samples of body exposed on Highway 93 one-half mile (0.3 km) north of Malm Gulch: 46.6±1.5 m.y. and 47.2±1.8 m.y. (R. L. Armstrong, 1974)

MESOZOIC INTRUSIVE ROCKS

- Kgd GRANODIORITE AND QUARTZ MONZONITE OF JULIETTE CREEK (CRETACEOUS)
--Equigranular to porphyritic moderately coarse grained gray to pink granitic rock containing (in variable proportions) quartz, potash feldspar, plagioclase, biotite, hornblende, apatite, sphene, zircon, and magnetite. Some specimens contain minor amounts of sericite, chlorite, and pyrite (often altered to hematite). Main body is of less than one-half-mi² (1.3-km²) area on west side of Juliette Creek; several smaller bodies in same vicinity, especially between Skylark mine and Little Bayhorse Lake. Larger bodies in contact with Ramshorn Slate are surrounded by prominent contact aureoles that contain metamorphic biotite, sericite, chlorite, andalusite, and cordierite
- gb GABBRO (CRETACEOUS OR JURASSIC)--Dark-grayish-green medium- to coarse-grained rock containing primary mineral assemblage of calcic plagioclase, clinopyroxene, and magnetite whose texture is overprinted by alteration assemblage of chlorite, pale-green acicular amphibole, albite, and sphene, plus small amounts of apatite, prehnite(?), pumpellyite(?), carbonate, and (or) secondary quartz. Occurs as numerous small irregular dikes, small plugs, and tabular masses scattered over the western two-thirds of the quadrangle, but always in or near the upper part of the Ramshorn Slate or the mixed lithology sequence (Om) between the Ramshorn and the Clayton Mine Quartzite. Considered to be Cretaceous or Jurassic but could be older

PALEOZOIC ROCKS

Mcb COPPER BASIN FORMATION (MISSISSIPPIAN)--Medium- to dark-gray argillite, siltstone, and fine-grained sandstone; local grit and carbonate layers. Weathers tan, medium brown to dark brown, and some light-gray, blue-gray and pink colors. Sandstone is predominantly very fine to fine grained; some medium sand and grit layers; localized thin beds of chertlike very siliceous argillite. Many beds or laminae are well sorted, but some are seriate or comprise grains of coarse sand and grit in very fine matrix. Rock composed of different proportions of quartz (predominant), clay minerals, carbonaceous material, sericite, mica, feldspar (usually only a few percent), lithic fragments (argillite, shale, chert, fine-grained quartzite), various accessory minerals, and carbonate. Carbonate occurs in places as a minor constituent and, west of quadrangle boundary, localized beds of nearly pure black limestone as much as 50 feet (15 m) thick. Bedding thin to medium; some thick beds. Faint to prominent lamination in most places with cross lamination, current bedding, and sole structures in some fine-grained sandstone beds and laminae. Dark colors related to amount of carbonaceous material, which ranges from nil to a few impure coaly seams. Base of sequence as exposed in quadrangle is a thrust fault; presumably overlain by Wood River Formation in areas to west. Thickness and sequence of units indeterminate because of isoclinal folding and thrust faulting, but could be many thousands of feet. Age of fossiliferous limestone interbed at Deer Springs Gulch three miles (4.8 km) west of Clayton Ranger Station is early Late Mississippian (late Meramec or early Chester) (J. T. Dutro, Jr., John W. Huddle, written commun., 1971; Betty Skipp, written commun., 1971). Correlated with Copper Basin Formation of Ross (1962) on basis of lithologies and age

Osm SATURDAY MOUNTAIN FORMATION (UPPER TO UPPER MIDDLE ORDOVICIAN)--

Predominantly fine-grained fossiliferous carbonate unit comprising dark-blue-gray platy limestone, light-gray silty limestone, thin- to medium-bedded light- to dark-gray cherty dolomite; and massive olive-gray to tan sandy dolomite. Contains several zones as much as 200-300 feet (60-90 m) thick of gray-green partly calcareous fissile shale, as well as many thin interlayers and laminae of shaly and silty material through rest of section. At mouth of Bruno Creek, at least one highly fossiliferous black siliceous graptolitic shale zone, 20-30 feet (6-9 m) thick, in lower part. Part of section is medium-bedded nearly black crystalline dolomite with a high carbonaceous content and fetid petroliferous odor. A few light-tan medium- to coarse-grained quartzite beds are gradational into dolomite above and below. Sequence and thickness of various components not determinable with precision because of extensive faulting and crumpling of beds. Unit may be as much as 3,000 feet (914 m) thick. Limestone and shale appear to be more predominant in lower part; upper part more dolomitic with increase in sand and silt toward top. Basal contact with Kinnikinic Quartzite presumed to be conformable but faulting along or subparallel to contact obscures relations. Upper contact concealed by overthrust Copper Basin Formation; overlain conformably by Silurian Roberts Mountains(?) Formation in Lone Pine Peak quadrangle to east. Upper part of section below thrust fault on east slope of Saturday Mountain may be Silurian

Ok KINNIKINIC QUARTZITE (MIDDLE ORDOVICIAN)--Medium- to thick-bedded exceptionally pure quartzite composed of very fine grained to medium-grained very well sorted and well-rounded vitreous quartz grains cemented into a mosaic by secondary overgrowths of silica. In many specimens the original rounded shape of the sand grains is distinctly visible with hand lens. Subvitreous to vitreous on fresh surfaces and breaks with conchoidal fracture. Rock is

mostly light gray to white, but locally is medium gray with some very dark layers. Exposed surfaces are same color but nonvitreous. Rare widely scattered grains of magnetite and zircon and a very few thin shale or shaly sandstone partings are the only impurities. Rests with stratigraphic conformity on the Ella Dolomite. Faulting along and near upper contact appears both to duplicate and cut out beds and makes an estimated 700- to 800-foot (200- to 250-m) thickness only approximate. Fossils collected from beds both below and above the quartzite date it as late Middle Ordovician. Best exposures of the unit occur along U.S. Highway 93A on the west limb of a large anticline about 2 miles (3 km) west of Clayton. A few isolated exposures occur northward from the river for about 8 miles (13 km). Two small outcrops occur near Alkali Springs in the southeast corner of the quadrangle

- Oe ELLA DOLOMITE (MIDDLE ORDOVICIAN)--Medium- to medium-dark-gray or brownish-gray predominantly medium- to thick-bedded fine-grained dolomite. Weathers tan, brown, or yellowish gray. Most contains some silt and sand, usually in thin laminae that form fine ribbing or hackly texture on weathered surfaces. Some local layers are lighter gray and some are dark gray to nearly black; coarsely crystalline and very dark gray near base. At least one 20- to 30-foot- (6.1- to 9.14-m) thick zone, several hundred feet above the base, is more siliceous and comprises fine-grained quartzite, sandy dolomite, and some chert that replaces other material; a few thin zones of silicified subspherical algal structures resembling oolites. Fossils from near base and from 450 feet (137 m) above it are early Middle to Middle Ordovician. Best exposed on west side of lower part of Kinnikinic Creek and between lower Kinnikinic Creek and Squaw Creek; also exposed in small outcrops in Alkali Springs area. At least 700 feet (213 m) thick where measured northwest of Clayton. Rests in apparent conformity on upper conglomeratic part of Clayton Mine Quartzite

Ocm CLAYTON MINE QUARTZITE (LOWER ORDOVICIAN OR OLDER)--A sequence of dominantly quartzitic rocks that are heterogeneous in composition, degree of sorting, and bedding characteristics. Most is composed of poorly sorted coarse- to medium-grained feldspathic quartzite that includes conglomerate layers, pebbly quartzite, and scattered pebbles in the upper two-thirds of the section. A widespread conglomeratic zone several hundred feet thick marks the top. Very thin shale partings occur throughout; lower half contains several zones of shale as much as 40 feet (12.2 m) thick. Two thin dolomite layers occur near the base of incomplete exposure near Clayton. Pebbles comprise quartz, much of which is a glassy dark gray or characteristic blue gray, quartzite, and lesser amounts of chert, feldspar and siltite; pebbles well rounded and range from one-fourth inch (0.6 cm) to a few two inches (5 cm) in diameter. Feldspar, usually more angular than the quartz grains, is distributed throughout the section and most is highly altered. Bedding ranges from very thick to thin; a few zones of flagstone. Cross lamination in both thin to very thick beds occurs throughout, but more common in lower half. Quartzite ranges from medium or very light gray to light yellowish orange or light pink in the western part of the quadrangle to more dominant light reddish gray, reds, and purples in the east. Shale and siltstone is mainly pale yellowish green, but includes some grayish green, dark purplish gray, and deep maroon. A section 1,980 feet (602.5 m) thick was measured beneath the Ella Dolomite west of Clayton where the base is concealed. More than 3,500 feet (1067 m) were measured in Rattlesnake Creek in the eastern part where the base is a thrust fault and the top concealed by Challis Volcanics. Base in thrust contact with Ramshorn Slate (Or) or mixed lithology sequence (Om) in southern half of quadrangle; appears to grade from mixed lithology sequence in north-central part of quadrangle

Ocmu CLAYTON MINE(?) QUARTZITE (LOWER ORDOVICIAN OR OLDER)--Correlation uncertain

- Om** INTERBEDDED SILTSTONE AND QUARTZITE (ORDOVICIAN)--Siltstone and quartzite in various proportions with subordinate dolomite; occurs as a group of beds between overlying Clayton Mine Quartzite (Ocm) and underlying Ramshorn Slate (Or); in places as much as 900 feet (275 m) thick but thinned locally and cut out by thrusting. Quartzite very light to light gray, mostly very fine grained to fine grained, feldspathic in part. Occurs as individual thin to very thick beds or groups of beds separated by green micaceous shaly partings; some few thick beds. Siltstone and mudstone is light gray to medium light gray or greenish gray, some yellowish green and grayish red, partly sandy and faintly laminated, slabby with some argillaceous partings; in places, phyllitic. Dolomite medium gray, brown weathering; some nearly pure, some silty or sandy; thick bedded, usually in isolated beds. In upper Garden Creek and Bayhorse Creek the unit may grade from Clayton Mine Quartzite into underlying Ramshorn Slate; the lower contact may be sedimentary or bedding plane thrust. South of Bayhorse Creek the sequence is involved in a zone of thrust faulting and may be cut out, deformed, or moved as part of the overriding block
- Oms** INTERBEDDED SILTSTONE, QUARTZITE, AND DOLOMITE OF UPPER SAWMILL CREEK AND POVERTY FLAT (ORDOVICIAN)--Heterogeneous sequence of siltstone, quartzite, and dolomite. Upper 600 feet (183 m) comprises grayish-yellow-green, light-greenish-gray, and grayish-green siltstone; weathers yellowish brown and reddish brown; most finely laminated with some micaceous bedding surfaces; contains a few thin interbeds of speckled nonfeldspathic white quartzite and some sandy dolomite; some wavy bedding in sandstone laminae. Underlain by approximately 730 feet (223 m) of light-gray and light-grayish-orange quartzite; commonly speckled with limonite; fine to coarse grained with a few pebble zones; feldspathic throughout; mainly thick bedded with much cross lamination as marked by

layering of limonite specks; few thin beds of finely laminated very fine grained quartzite and several beds of silty medium-gray dolomite weathering yellowish to reddish brown. Lower 600 feet (183 m) comprised of dolomitic sandstone and some dolomite; medium to thick bedded; some thin-bedded speckled fine-grained quartzite and green siltstone intervals as much as 150 feet (56 m) thick. Top eroded; base is a thrust fault. Age unknown, but may be correlative with siltstone, sandy siltstone, and quartzite of Rob Roy Mine area (Orr)

Orr SILTSTONE, SANDY SILTSTONE, AND QUARTZITE OF ROB ROY MINE AREA (ORDOVICIAN?)--Mixed lithologies comprising interbedded siltstone and quartzite, and subordinate dolomite and dolomitic siltstone and sandstone. Quartzite, fine- to medium-grained; some pure, near white, and speckled; but most impure, light gray, grayish orange, or pink, with silt partings and wavy lamination and bedding planes; feldspar present but sparse; very local pebble beds in a few places. Siltstone sandy, rich-medium-brown color, thinly laminated with wavy light-gray-brown fine-grained sandy laminae; comprises about one-third of exposed sequence. A few thin beds of nearly pure to sandy and silty dolomite at places in lower part of section; one zone of dolomitic siltstone several hundred feet thick. Sequence characterized by dominance of wavy lamination in both siltstone and impure quartzite, by general speckled character of the pure quartzite layers, by presence of carbonate as thin beds or disseminated in siltstone, and by general low level of feldspar. Top unknown; base, where seen, is in thrust contact with Ella Dolomite. Estimated exposed thickness at least 2,000 feet (610 m)

Or RAMSHORN SLATE (ORDOVICIAN?)--Mostly thin-bedded well-laminated argillaceous and phyllitic rock with well-developed cleavage at an angle to the bedding; includes thin slabby impure sandstone layers mostly in upper part; a thick lens of basal conglomerate in the Garden Creek-Bayhorse Creek area. Slate is

medium to dark gray, greenish gray, and purple, locally light greenish gray to silvery gray or dark brownish gray, weathers gray and brown; comprises very fine quartz, sericite, chlorite, and clay minerals; some carbonate in widely scattered sandy layers; small isoclinal folds prevalent throughout the unit with well-developed axial plane cleavage; breaks on cleavage into small plates and slabs that mantle outcrop areas

Orc Conglomerate--Well-rounded pebbles of white vein quartz and light-gray quartzite in a dark siliceous matrix; pebbles as large as 3 inches (7.6 cm) in diameter but mostly smaller; includes scattered lenses of shaly sandstone and slate without pebbles; more than 500 feet (152 m) maximum thickness in Garden Creek and Daugherty Gulch area but fingers into slate to north and south

Ramshorn Slate-conglomerate sequence overlies Bayhorse Dolomite (Obh) on erosional unconformity; overlain by mixed lithologies (Om) on what may be a conformable sedimentary contact or by Clayton Mine Quartzite in thrust contact. Total thickness indeterminate because of complex internal folding, but probably in excess of 2,000 feet (610 m)

Obh BAYHORSE DOLOMITE (LOWER ORDOVICIAN?)--A predominantly carbonate unit, dolomitic in upper part and limy in lower, but the proportions range widely. Dolomite is light creamy gray, yellowish gray, medium to very thick bedded with some massive and some thin platy zones; weathers pale yellowish brown to pale orange or light gray. Finely crystalline, nearly pure to silty with local faint laminations on weathered surfaces. Contains dark-gray silicified oval structures resembling pisolites in several layers ranging from a few inches to 30 feet (8 cm-9 m) in thickness. At least two medium-dark-gray partly laminated siltstone and argillite intervals 40 to 50 feet (12-15 m) thick in upper part. Limestone is medium gray to dark gray, generally thin bedded, fine grained, and faintly laminated; contains thin

interbeds and laminae of siltstone and fine-grained sandstone that weather out as ribs. Top of Bayhorse is an erosional disconformity characterized by a zone of brecciated, vuggy, and deeply weathered material that probably represents a fossil karst topography; basal contact with underlying Garden Creek Phyllite conformable and in places gradational. Minimum of 1,300 feet (396 m) of section measured on Bayhorse Creek. Original thickness indeterminate. Tentatively considered early Ordovician age on basis of a few very fragmentary fossils

- 06gc GARDEN CREEK PHYLLITE (CAMBRIAN?)--Dark-gray to nearly black phyllite with silvery sericite on cleavage surfaces; some slightly calcareous; bedding indistinct and in many places crenulated; weathers to medium-gray smooth flakes and chips; usually poorly exposed. Overlies in apparent conformity an unnamed massive dolomite (06d) exposed only in Bayhorse Creek. Crumpling and crenulations of indistinct bedding makes contact relations and thickness difficult to determine. Between 500 and 1,000 feet (152-305 m) of section estimated in Bayhorse Creek
- 06d LOWER DOLOMITE OF BAYHORSE CREEK (ORDOVICIAN OR CAMBRIAN)--Exposed only in bed of Bayhorse Creek between 1,500 and 3,000 feet (557-914 m) above the old town of Bayhorse. Very light gray to medium-gray fine-grained to very fine grained fairly pure dolomite; weathers grayish orange tan to dark yellowish brown; bedding commonly indistinct, mostly very thick to massive in upper 30 feet (9 m); more distinct thin to medium bedding in lowest observable outcrops. Base concealed. A maximum of 60 feet (18 m) exposed below upper contact, but at least 200 additional feet (61 m) determined below creek bed from drill core
- 06q QUARTZITE-SILTITE LITHOLOGIES OF UPPER CASH CREEK (ORDOVICIAN OR CAMBRIAN)--Sequence of heterogeneous, predominantly quartzitic rocks containing siltstone and silty shale as scattered interbeds and with at least one interval about 300 feet (91 m) thick.

Quartzite is well bedded in layers from a few inches to several feet (6 cm-1 m) thick and locally massive; predominantly medium- to coarse-grained subvitreous scattered small quartz pebbles and local conglomerate lenses; feldspar in most layers, abundant in some and locally very coarse grained; some beds of fine to medium grain size resemble Kinnikinic Quartzite. Mostly light to medium dark gray, pinkish gray, purplish gray, light orange, or light tan. Weathers to similar colors. Siltite and silty shale are greenish gray, grayish yellow green, grayish olive, and reddish to brownish gray; mostly silt-size grains and finer, but includes some fine sand at places; locally concentrations of light-colored mica on bedding surfaces; some beds with small pyrite cubes or voids after pyrite; thin to medium bedded; laminations fairly common but only locally prominent; partly phyllitic; cleavage generally good, both parallel and transverse to bedding; forms platy or thinly slabby float. Closely resembles Clayton Mine Quartzite in many respects, but correlation uncertain because of differences in lithologic sequence, character and thickness of different quartzite and siltstone components, relation to underlying Middle Cambrian sequence, and isolation from main body of the Clayton Mine Quartzite. Upper contact not preserved; overlies carbonate of upper Cash Creek (€c) and Cash Creek Quartzite (€cq) on probable thrust fault

€c UPPER CARBONATE (CAMBRIAN?)--Heterogeneous sequence of dolomite, silty dolomite, and dolomitic sandstone. Dolomite is light to medium light gray with some dark gray; locally cream colored; weathers light brownish gray; aphanitic to fine grained with a few coarse-grained beds; medium bedded with some thick beds near top, faintly laminated; some sandy layers in lower part. Appears to rest with sedimentary contact on both the shale of Cash Creek area (€cs) and Cash Creek Quartzite (€cq). Contact probably an unconformity. Estimated 500 feet (152 m) exposed; total thickness unknown. Occurs in upper Cash Creek and in small area west of Squaw Creek and south-southwest of mouth of Cash Creek

- €cs SHALE (MIDDLE CAMBRIAN)--Fissile, slabby micaceous siltstone and silty shale; medium gray, olive drab to gray green, with many reddish to brick-red layers; weathers grayish red, yellowish gray, and brown; some lamination. Contains lower Middle Cambrian fauna. Conformable with underlying Cash Creek Quartzite (€cq)
- €cq CASH CREEK QUARTZITE (MIDDLE OR LOWER CAMBRIAN)--Yellowish-gray, brownish-gray, light-orange, pink, and purplish-gray glassy quartzite with a few intervals of nearly white or light-gray color; fine to coarse grained, fair to poorly sorted with scattered pebbly layers and isolated pebbles; upper two-thirds nearly pure quartzite, lower third contains as much as 5 percent altered feldspar; medium to thick bedded with cross lamination prominent in lower part. Conformable with an underlying unnamed carbonate sequence (€cc). Total thickness from measurement of interrupted section estimated to be 1,200-1,300 feet (366-396 m). Considered Middle or Lower Cambrian on basis of lower Middle Cambrian fauna in overlying shale unit
- €cc LOWER CARBONATE (CAMBRIAN?)--Heterogeneous sequence of predominantly carbonate rocks comprising, from top to bottom: 130 feet (40 m) of mottled-gray to tannish-gray massive to medium-bedded fine- to medium-grained dolomite and silty dolomite; 300 feet (91 m) consisting mainly of very thin bedded impure limestone, strikingly banded in shades of light gray, greenish gray, and brown, highly micaceous, fissile and highly cleaved, and partly of thin- to medium-bedded limy siltstone; 65 feet (19.8 m) of thin-bedded micaceous gray, greenish-gray, and purplish-gray slate and siltstone with some layers of micaceous quartzitic flagstone. Transition lithologies separate the above distinct units. Upper contact brecciated in part; conformable lithologic in part. Rests in sharp stratigraphic conformity on quartzite of Boundary Creek (€bq). Total thickness 570 feet (173.7 m). Tentatively assigned to Lower Cambrian on basis of stratigraphic position

~~E~~bq QUARTZITE OF BOUNDARY CREEK AREA (CAMBRIAN?)--Light-grayish-orange to nearly white medium-bedded to very thick bedded quartzite with large-scale cross lamination in many beds; ranges from fine to coarse grained, mostly in medium range; some altered feldspar throughout; local thin layers and partings of medium-gray laminated micaceous siltstone; lower hundred feet comprises mixed lithologies of thick siltstone beds, pebble-bearing quartzite, dolomitic sandstone, and coarse dolomite containing scattered small pebbles. Base not exposed but lowest outcrops highly brecciated and may be faulted. Several hundred feet (100 m) thick. Tentatively assigned to Lower Cambrian