

## Description of map units,

## Mountain City 15' quadrangle, Nevada-Idaho

## Northwest quarter

- Qc COLLUVIUM, TALUS, AND SLOPE WASH (Quaternary)--Colluvium tends to be finer grained than other types of material in this unit. Development of colluvium is strongly controlled by direction of exposure, as the greater amount of vegetation on north-facing slopes, conditioned by greater net mixture available favors accumulation. Where material of a range of sizes is available, talus develops at upper end of mapped bodies, and finer material is washed out of talus and becomes colluvium
- Unconsolidated air-fall tuffs and unwelded phases of ignimbrites crop out very poorly and are commonly blanketed by coluvium over much of their total extent
- Qls LANDSLIDE DEPOSITS (Quaternary)--Typically very poorly sorted, commonly a mixture of larger fragments of resistant formations and underlying, less resistant material, in many places tuff or hydrothermally altered rock
- Qal ALLUVIUM (Quaternary)--Consists of sand, silt, and gravel along present stream courses. Generally quite shallow in valley of Owyhee, as indicated by outcrops in central part of valley; surface may be 5 or 6 ft above normal stream in summer time, thicker alluvium may be preent in some small valleys where rate of supply exceeds the transporting power of the stream

- Qtg TERRACE GRAVEL AND DISSECTED ALLUVIAL FANS (Quaternary)--Gravel accumulated on stream terraces higher than the present stream can rise in flood. In the valley of the Owyhee River, as much as 100 ft above the river, and of boulders as much as 2 ft in diameter, subangular to well-rounded. Thickness as much as 10 ft
- QTls LANDSLIDES, ROCKSLIDES, AND EARTHFLAWS (Tertiary and Quaternary)--Characterized by unsorted character, coarseness of maximum size, and, in younger bodies, by characteristic hummocky topography
- QTs\* UNCONSOLIDATED SEDIMENTARY ROCKS (Quaternary and Tertiary)--Includes material as alluvium, colluvium, talus, glacial moraine, glacial outwash
- Tb BIG ISLAND FORMATION (Miocene)--Theleitic olivine basalt, with overlying and underlying gravel. Minor amounts of rhyolite tuff are present directly beneath basalt in many places.

\*Appears only on geologic cross sections.



Tcp

COUGAR POINT WELDED TUFF (Miocene)--Upper part of formation is

phenorhyolitic to phenodacitic ignimbrite, purplish gray to dark brown, or black where glassy, and ranging from compact vitrophyres to friable welded tuff. Locally included as a vitrophyric unit (Tcpv), not everywhere separately mapped. Both vitrophyres and devitrified welded tuffs characterized by apatite, zircon and magnetite as accessories. In some of the compact vitrophyres, fayalite, and ferroaugite accompany sanidine or anorthoclase and plagioclase. Quartz is common but not ubiquitous. Ferroaugite may be accompanied or proxied by ferropigeonite, very rarely by hypersthene and hornblende. In less compact welded tuff, fayalite is always iddingsitized, pyroxene commonly argillized. The groundmass ranges from wholly glassy to cryptocrystalline. A potassium-argon age determined (DKA-1068) on a sample of sanidine from near the base of the welded tuff section on the cliffs of Yellow rock, east of the Owyhee River, in the Owyhee 15' quadrangle, by John Obvradovich (oral commun., 1965) gave a date of  $12.2 \pm 0.8$  m.y. May include gravel at the base of the section (Tcpg) not everywhere separately mapped. May include, generally above the gravel, and beneath the ignimbrite, rhyolitic air-fall tuff and lapilli tuff cream to buff in color, and dark carbonaceous tuffs, locally with fossil leaves, separately mapped as Jenny Creek Tuff, Tjt

 Tjt

JENNY CREEK TUFF

Tcpg

GRAVEL UNDER COUGAR POINT WELDED TUFF

Twt      WELDED LAPILLI TUFF OF WALL CREEK (Miocene)--Medium- to dark-gray welded tuff and welded lapilli tuffs, phenorhyodacitic to phenorhyolitic. Phenocryst combinations, different in distinct occurrences, include plagioclase, sanidine and ferroaugite, locally with ferropigeonite; plagioclase and ferroaugite; plagioclase and sanidine, locally with quartz; and plagioclase, sanidine, ferroaugite and quartz. Many bodies of small extent, with internal structures distorted by flowage, and rich in coarse, glassy lapilli. K-Ar age determinations on plagioclase-sanidine composite grains from five different localities, four by John Obradovich (oral commun., 1966) and one by Richard Marvin (oral commun., 1967) gave ages ranging from 15 to 16 m.y., all  $\pm 0.8$  m.y. locally underlain by white to cream air-fall tuff, Trt, a poorly stratified, fine-grained, unconsolidated, white to pale-gray tuff.

Tdp DANGER POINT TUFF (Miocene)--Ranging from andesitic to rhyolitic in composition, largely montmorillonitized, with substantial admixture of boulders picked up by surface flow. In the eastern part of the 15' quadrangle, the eastern facies (Tdpe), most boulders are Prospect Mountain quartzite. In the southwestern part of the 15' quadrangle, sedimentary admixture is finer, and most is of granitic material probably of local derivation, and has in part been mapped separately as western facies, Tdpw

Tsb SEVENTY SIX BASALT (Miocene)--Flows of porphyritic olivine basalt, with conspicuous clear phenocrysts of labradorite, up to 2 cm in size, in a subophitic groundmass with plates of purplish augite including grains of olivine, labradorite, magnetite, ilmenite, and apatite. Local patches of mesostasis made up of biotite and sanidine. In places rests upon a dull-greenish-gray tuff, Tsbt, now nontronitic, with plagioclase crystals like those in the flows. Crystals of plagioclase from the tuff on Roughtop Mountain gave an age of  $22.9 \pm 3$  m.y. (J. C. von Essen, Menlo Park Potassium-Argon age report 51, Oct. 15, 1969). Tuffaceous sandstone made up this basaltic material furnished horse remains of Barstovian age (C. A. Repenning, oral commun., 1965). Possibly some of the tuff was reworked in Barstovian time; the earlier age given by the K-Ar determinatin<sup>o</sup> is used here for the age of the volcanic rocks, but<sup>^</sup> this age needs confirmation by additional determinations

- Tmb MUSTANG BUTTE GRAVEL (Oligocene)--Chiefly coarse, poorly sorted boulder gravel, with angular fragments of granodiorite, Reservation Hill Formation, and Nelson and Banner Formations. Includes one thin ignimbrite that is a hornblende-biotite phenodacite welded tuff, with phenocrysts of biotite, hornblende, quartz, oligoclase, accessory amounts of zircon, apatite, and perrierite. Biotite from this bed was assigned an age of 38.0 m.y. by E. H. McKee (McKee and others, 1976, date no. 20). Locally the gravel may include some masses of tuff and gravel that are Miocene in age, postdating the Jarbridge Rhyolite. These have not been separated in mapping
- Tsd PHENODACITE AND PHENOANDESITE IGNIMBRITE OF SALMON SPRINGS (Eocene)--Crystal-vitric ignimbrite, generally recrystallized, and relatively fine in grain size, one phase consisting of quartz, plagioclase, and biotite, locally with sanidine, the plagioclase generally oligoclase; another cooling unit includes plagioclase, biotite, green hornblende, augite, and hypersthene. Rests on ignimbrite of Reed Creek, locally overlain by gravel of Mustang Butte
- Trc PHENORHYODACITE IGNIMBRITE OF REED CREEK (Eocene)--Phenocrysts abundant, principally quartz, plagioclase, and biotite, locally with hornblende. Magnetite, apatite, and zircon common accessories. One sanidine and one biotite from separate localities gave an age of  $39.6 \pm 2.0$  m.y. (Eocene or Oligocene) by K-Ar analyses (John Obradovich, written commun., 1965, Lab nos. DKA-1073 and DKA-1070). Locally opalized, bleached, and iron stained

- Tar      ANDESITE OF RUSSELL GULCH (Eocene)--Black, vitrophyric, phenoandesitic welded tuff, with andesite, augite, and hypersthene, plentiful apatite and magnetite, rare zircon, biotite, and green hornblende. Where devitrified, black to brown felsophyres. At base, locally small amounts of rhyolitic airfall tuff
- Tjc      VOLCANIC AND SEDIMENTARY ROCKS OF JONES CREEK (Eocene) INCLUDES  
DACITE OF JONES CREEK (Tjd)--The principal part of the formation consists of flows and tuff breccias of pyroxene andesite, hornblende-pyroxene andesite, hornblende-augite andesite and hornblende andesite, in descending order of frequency of occurrence. These rocks are dark gray to medium gray, commonly porphyritic. Gray air-fall tuffs are locally present. Total thickness may be several thousand feet. At base, a phenodacitic ignimbrite, Tjd, compact to moderately compact, with conspicuous phenocrysts of plagioclase, augite, hypersthene, hornblende, and biotite, grading by increase of quartz and sanidine into a phenorhyodacite
- Tyb      IGNIMBRITES OF YANKEE BILL SUMMIT (Eocene)--Welded phenoandesite and phenodacite tuff, ranging from light-brown to black dosemic to semihyaline, glassy constituents now partly crystallized with pectinate structures. Phenocrysts plagioclase hypersthene commonly augite, and hornblende sparse biotite and hornblende rare. Magnetite and apatite nearly ubiquitous. May include flows equivalent to the phenoandesite of Russell Gulch

- Tsa ANDESITE OF SUMMIT CREEK (Eocene)--Locally includes also underlying phenorhyolite air-fall tuff, Tst. Largely pyroxene andesite and pyroxene-hornblende-biotite andesite. Also biotite pyroxene dacite vitrophyre
- Ts1 PHENOANDESITE IGNIMBRITE OF SALMON CREEK (Eocene) INCLUDES ALSO THE VITROPHYRE OF ALDER MOUNTAIN (Tab) AND PHENOANDESITIC BRECCIA (Tlb)--Light-gray to light-brownish-red ignimbrites; but sparsely occurring phenocrysts are biotite and plagioclase, some units also have hornblende. Magnetite, apatite, and zircon are common accessories. Most units have undergone vapor-phase recrystallization and consequently have lithic groundmass textures. An exception is the biotite vitrophyre of Alder Mountain, Tab, in which the groundmass is glassy. The phenoandesitic breccia may be a crumble breccia or mudflow
- Kg GRANITE (IN THE BROAD SENSE ACCORDING TO STRECKEISEN, 1967) (Cretaceous) INCLUDES GRANODIORITE AND QUARTZ MONZONITE OF SOME AUTHORS, ALSO INCLUDES APLITE (Ka), PEGMATITE (Kp) AND MIGMATITE (Km)--Includes granodiorite and quartz monzonite of previous usage; includes marginal microcline-microperthite aplite, Ka, not everywhere separately mapped. Some pegmatite, Kp, not everywhere separately mapped. Migmatitic zones adjacent to country rock, Km, not everywhere separately mapped. Generally characterized by biotite and hornblende, locally with perthitic orthoclase megacrysts

PPrh

RESERVATION HILL FORMATION (PENNSYLVANIAN(?) AND PERMIAN(?))--Mostly fine grained dolomitic sandstone or siltstone, pale gray, weathering white or pale reddish brown, in beds 2 cm to 5 cm thick, interbedded regularly with thinner beds of graphitic phyllite. The dolomitic sandstone is metamorphosed to rocks composed of various combinations of quartz, calcite, tremolite, diopside, and wollastonite, the last locally coarsely prismatic. Also metagraywacke, micaceous and tremolitic quartzite, rare metachert, and quartzite, meta-andesite, now metamorphosed to actinolite-epidote-plagioclase schist, and hornblende-plagioclase schist. A few lenses of gray, siliceous dolomitic limestone, locally with coarse calcitic "eyes" suggesting former presence of crinoids

PPrh

Mc

CHAINMAN FORMATION (Mississippian)--Includes the Mountain City Formation (Coats, 1971). Largely quartz-muscovite biotite schist, locally with orthoclase, garnet, or graphite, rarely with andalusite, where thermally metamorphosed. In the western part of the quadrangle, includes thin limy beds, up to 2 ft thick, now rocks composed of various combinations of quartz, calcite, diopside, tremolite, and clinozoisite, orthoclase, and muscovite. In the eastern part of the quadrangle, contains a higher proportion of limy rocks. A bed, generally thin, of metarhyolite tuff, now quartz-plagioclase-orthoclase hornfels. In area northwest of Merritt Mountain, thicker masses of tuff, Mct, are present. In the southeastern quarter of the 15' quadrangle, includes much medium-grained, impure, poorly bedded sandstone that has furnished a brachiopod fauna

Mn NELSON FORMATION (Mississippian)--At the base, locally an extrusive breccia, possibly a peperite, with limy matrix, locally fossiliferous. Flows and tuff breccias of andesitic and basaltic composition. Also minor sills of diabase and one lens of rhyolitic tuff. Now largely a green schist of tremolite-actinolite, chlorite, epidote, calcite, ilmenite, and relict andesine, in part altered to albite. In the northern part of the Mountain City 15' quadrangle, amphibolite schist



Description of map units, Mountain City 15' quadrangle,

Nevada-Idaho

Northeast quarter

- ✓ Qc COLLUVIUM, TALUS, AND SLOPE WASH (Quaternary)--Colluvium tends to be finer grained than other types of material in this unit. Development of colluvium is strongly controlled by direction of exposure, as the greater amount of vegetation on north-facing slopes, conditioned by greater net mixture available favors accumulation. Where material of a range of sizes is available, talus develops at upper end of mapped bodies, and finer material is washed out of talus and becomes colluvium.
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- ✓ Qa ALLUVIUM (Quaternary)--Consists of sand, silt, and gravel along present stream courses. Generally quite shallow in valley of Owyhee, as indicated by outcrops in central part of valley; surface may be 5 or 6 ft above normal stream in summer time, thicker alluvium may be preent in some small valleys where rate of supply exceeds the transporting power of the stream.

- Qtg TERRACE GRAVEL AND DISSECTED ALLUVIAL FANS (Quaternary)--Gravel accumulated on stream terraces higher than the present stream can rise in flood. In the valley of the Owyhee River, as much as 100 ft above the river, and of boulders as much as 2 ft in diameter, subangular to well-rounded. Thickness as much as 10 ft
- Qgm GLACIAL MORaine (Quaternary)--Boulders large, to very large, angular. Material unsorted. Typical cross-valley ridge of terminal moraine. In Mountain City quadrangle, present on east side of Bald Mountain and north and east sides of Merritt Mountain. No striated boulders observed
- Qgo GLACIAL OUTWASH (Quaternary)--Present as valley train in some valleys below morainal deposit. Distinguished from ordinary stream gravel by greater coarseness, boulders of a size beyond the carrying capacity of the present stream
- QTls LANDSLIDES, ROCKSLIDES, AND EARTHFLows (Tertiary and Quaternary)--Characterized by unsorted character, coarseness of maximum size, and, in younger bodies, by characteristic hummocky topography
- QTs\* UNCONSOLIDATED SEDIMENTARY ROCKS (Quaternary and Tertiary)--Includes material as alluvium, colluvium, talus, glacial moraine, glacial outwash

\*Appears only on geologic cross sections.

Tcp COUGAR POINT WELDED TUFF (Miocene)--Upper part of formation is phenorhyolitic to phenodacitic ignimbrite, purplish gray to dark brown, or black where glassy, and ranging from compact vitrophyres to friable welded tuff. Locally includes a vitrophyric unit (Tcpv), not everywhere separately mapped. Both vitrophyres and devitrified welded tuffs characterized by apatite, zircon and magnetite as accessories. In some of the compact vitrophyres, fayalite, and ferroaugite accompany sanidine or anorthoclase and plagioclase. Quartz is common but not ubiquitous. Ferroaugite may be accompanied or proxied by ferropigeonite, very rarely by hypersthene and hornblende. In less compact welded tuff, fayalite is always iddingsitized, pyroxene commonly argillized. The groundmass ranges from wholly glassy to cryptocrystalline. A potassium-argon age determined (DKA-1068) on a sample of sanidine from near the base of the welded tuff section on the cliffs of Yellow rock, east of the Owyhee River, in the Owyhee 15' quadrangle, by John Obvradovich (oral commun., 1965) gave a date of  $12.2 \pm 0.8$  m.y. Includes, in the northeast quarter, a slightly older sequence of similar ignimbrites, Tcpo. May include gravel at the base of the section (Tcpg) not everywhere separately mapped. May include, beneath the ignimbrite, rhyolitic air-fall tuff and lapilli tuff cream to buff in color, and dark carbonaceous tuffs, locally with fossil leaves, separately mapped in some places as Jenny Creek Tuff, Tjt

Tmf MUDFLOW OF MCCALL CREEK (Miocene)--Poorly sorted tuffaceous boulder gravel. Smaller boulders well rounded, larger ones (to 8 m max.) quite angular. Most boulders consist of Valmy quartzite

Twt WELDED LAPILLI TUFF OF WALL CREEK (Miocene)--Medium- to dark-gray welded tuff and welded lapilli tuffs, phenorhyodacitic to phenorhyolitic. Phenocryst combinations, different in distinct occurrences, include plagioclase, sanidine and ferroaugite, locally with ferropigeonite; plagioclase and ferroaugite; plagioclase and sanidine, locally with quartz; and plagioclase, sanidine, ferroaugite and quartz. Many flows of small extent, with internal structures distorted by secondary flowage, and rich in coarse, glassy lapilli. K-Ar age determinations on plagioclase-sanidine composite grains from five different localities, four by John Obradovich (oral commun., 1966) and one by Richard Marvin (oral commun., 1967) gave ages ranging from 15 to 16 m.y., all +0.8 m.y. Locally underlain by white to cream air-fall tuff, Trt, a poorly stratified, fine-grained, unconsolidated, white to pale-gray tuff.

Tjr

JARBIDGE RHYOLITE (Miocene)--Porphyritic rhyolite, with

cryptocrystalline or glassy groundmass, locally spherulitic.

Phenocrysts generally dominant over groundmass, quartz up to 5 mm in diameter, sanidine phenocrysts somewhat smaller and less numerous, oligoclase similar in size but scarcer. Clinopyroxene recognizable in glassy phases only, and is generally pigeonitic. Accessories include zircon, apatite, ilmenite, magnetite; very rarely topaz (which may be secondary) or pale pink garnet. Two K-Ar dates, one from Meadow Creek, in the Rowland quadrangle, of  $16.8 \pm 0.5$  m.y. (Coats, 1964, p. M11), the other from a basal vitrophyre in the Wildhorse quadrangle, of 15.4 m.y. (Eernden and others, 1964, p. 194). Total thickness may be 2,000 ft, but thicknesses are generally meaningless, because most of unit accumulated as volcanic domes, in the Wildhorse and Mountain City quadrangles, at least

Tsb SEVENTY SIX BASALT (Miocene)--Flows of porphyritic olivine basalt, with conspicuous clear phenocrysts of labradorite, up to 2 cm in size, in a subophitic groundmass with plates of purplish augite including grains of olivine, labradorite, magnetite, ilmenite, and apatite. Local patches of mesostasis made up of biotite and sanidine. In places rests upon a dull-greenish-gray tuff, Tsbt, now nontronitic, with plagioclase crystals like those in the flows. Crystals of plagioclase from the tuff on Roughtop Mountain gave an age of  $22.9 \pm 3$  m.y. (J. C. von Essen, Menlo Park Potassium-Argon age report 51, Oct. 15, 1969). Tuffaceous sandstone made up of this basaltic material furnished horse remains of Barstovian age (C. A. Repenning, oral commun., 1965). Possibly some of the tuff was reworked in Barstovian time; the earlier age given by the K-Ar determinatin is used here for the age of the volcanic rocks, but this age needs confirmation by additional determinations

Tmb MUSTANG BUTTE GRAVEL (Miocene)--Chiefly coarse, poorly sorted boulder gravel, with angular fragments of granodiorite, Reservation Hill Formation, and Nelson and Banner Formations. Includes one thin ignimbrite <sup>(Tm wt)</sup> that is a hornblende-biotite phenodacite welded tuff, with phenocrysts of biotite, hornblende, quartz, oligoclase, accessory amounts of zircon, apatite, and perrierite. Biotite from this bed was assigned an age of 38.0 m.y. by E. H. McKee (McKee and others, 1976, date no. 20). Locally the gravel may include some masses of tuff and gravel that are Miocene in age, postdating the Jarbidge Rhyolite. These have not been separated in mapping

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- Tyb IGNIMBRITES OF YANKEE BILL SUMMIT (Eocene)--Welded phenoandesite and phenodacite tuff, ranging from light-brown to black dosemic to semihyaline, glassy constituents now partly crystallized with pectinate structures. Phenocrysts plagioclase, hypersthene, commonly augite, rare hornblende, and sparse biotite. Magnetite and apatite nearly ubiquitous. May include flows equivalent to the phenoandesite of Russell Gulch
- Tmt MICACEOUS IGNIMBRITE (Eocene)--Includes underlying gravel in places (Tmg). Found only on west slope of Alder Mountain, near base of Tertiary section. Medium-gray vitrophyric crystal-vitric welded tuff, with marked fissility. Phenocryst-rich with andesine ( $An_{37-46}$ ), biotite, hornblende, hypersthene, augite. Minor magnetite, quartz, apatite, and zircon. Not more than 50 ft thick. Locally underlain by gravel, Tmg. Date of 43.5 m.y. determined on biotite from tuff by John Obradovich (DKA-1074)
- Ts1 PHENOANDESITE IGNIMBRITE OF SALMON CREEK (Eocene) INCLUDES ALSO THE VITROPHYRE OF ALDER MOUNTAIN (Tab) AND PHENOANDESITIC BRECCIA (Tlb)--Light-gray to light-brownish-red ignimbrites; but sparsely occurring phenocrysts are biotite and plagioclase, some units also have hornblende. Magnetite, apatite, and zircon are common accessories. Most units have undergone vapor-phase recrystallization and consequently have lithic groundmass textures. An exception is the biotite vitrophyre of Alder Mountain, Tab, in which the groundmass is glassy. The phenoandesitic breccia may be a crumble breccia of mudflow



Kg GRANITE (IN THE BROAD SENSE ACCORDING TO STRECKEISEN, 1967)  
(Cretaceous) INCLUDES GRANODIORITE AND QUARTZ MONZONITE OF SOME  
AUTHORS, ALSO INCLUDES APLITE (Ka), PEGMATITE (Kp) AND MIGMATITE  
(Km)--Includes granodiorite and quartz monzonite of previous usage;  
includes marginal microcline-microperthite aplite, Ka, not  
everywhere separately mapped. Some pegmatite, Kp, not everywhere  
separately mapped. Migmatitic zones adjacent to country rock, Km,  
not everywhere separately mapped. Generally characterized by  
biotite and hornblende, locally with perthitic orthoclase  
megacrysts

Jd DIORITE, QUARTZ DIORITE, AND GRANODIORITE (Jurassic(?))--Includes  
diorite consisting of andesine and hornblende, with accessory  
apatite and sphene, secondary chlorite clinozoisite, calcite, and  
sphene. Paulopost shearing suggested by partial recrystallization  
of hornblende to pale-green actinolite. Also includes hornblende-  
biotite quartz diorite. A sample of biotite from the Enright Hill  
Stock was dated by E. H. McKee (written commun., 1979) at  
110.9±1 m.y. The shearing and partial recrystallization of  
hornblende from this body suggest that the age may have been  
modified by subsequent metamorphism and the effect of adjacent  
Cretaceous intrusions; for this reason an age of Jurassic(?) is  
assigned

PPrh      RESERVATION HILL FORMATION (PENNSYLVANIAN(?) AND PERMIAN(?))--Mostly fine grained dolomitic sandstone or siltstone, pale gray, weathering white or pale reddish brown, in beds 2 cm to 5 cm thick, interbedded regularly with thinner beds of graphitic phyllite. The dolomitic sandstone is metamorphosed to rocks composed of various combinations of quartz, calcite, tremolite, diopside, and wollastonite, the last locally coarsely prismatic. Also metagraywacke, micaceous and tremolitic quartzite, rare metachert, and quartzite, meta-andesite, now metamorphosed to actinolite-epidote-plagioclase schist, and hornblende-plagioclase schist. A few lenses of gray, siliceous dolomitic limestone, locally with coarse calcitic "eyes" suggesting former presence of crinoids

Mdc      DIAMOND PEAK AND CHAINMAN FORMATIONS, UNDIVIDED (Mississippian)--In the northeast and southeast quarters of the 15' quadrangle, the Diamond Peak and Chainman appear to intergrade; in the extreme southeastern corner of the quadrangle only a medium-grained dark massive sandstone is present, which is poorly fossiliferous but has been correlated with the Diamond Peak. West and south of Enright Hill, in the northeast quarter, the sandstone facies is more fossiliferous, and the age assignment is on a firmer basis

Mc      CHAINMAN FORMATION (Mississippian)--Includes the Mountain City Formation (Coats, 1971). Largely quartz-muscovite biotite schist, locally with orthoclase, garnet, or graphite, rarely with andalusite, where thermally metamorphosed. In the western part of the quadrangle, includes thin limy beds, up to 2 ft thick, now rocks composed of various combinations of quartz, calcite, diopside, tremolite, and clinozoisite, orthoclase, and muscovite. In the eastern part of the quadrangle, contains a higher proportion of limy rocks. A bed, generally thin, of metarhyolite tuff, now quartz-plagioclase-orthoclase hornfels. In area northwest of Merritt Mountain, thicker masses of tuff, Mct, are present. In the southeastern quarter of the 15' quadrangle, includes much medium-grained, impure, poorly bedded sandstone that has furnished a brachiopod fauna

- Mn NELSON FORMATION (Mississippian)--At the base, locally an extrusive breccia, possibly a peperite, with limy matrix, locally fossiliferous. Flows and tuff breccias of andesitic and basaltic composition. Also minor sills of diabase and one lens of rhyolitic tuff. Now largely a green schist of tremolite-actinolite, chlorite, epidote, calcite, ilmenite, and relict andesine, in part altered to albite. In the northern part of the Mountain City 15' quadrangle, amphibolite schist. *includes one lens of limestone, Mn!*
- Mb BANNER FORMATION (Mississippian)--Soft massive bluish-gray limestone, containing solitary and colonial corals, brachiopods, and bryozoans. Grades downward through medium- to fine-grained brownish quartz arenite and gray tan-weathering siliceous siltstone through arenaceous limestone into conglomerate with rounded white quartzite boulders as much as 15 cm in diameter. Maximum thickness 200 m. Overlies Valmy and Grossman Formations, underlies <sup>Ne Gon</sup> ~~Chairman~~ Formation
- Mg GROSSMAN FORMATION (Mississippian(?))--Coarse conglomerate with clasts of gray quartzite, black chert, phyllite, and magnetitiferous siltstone. Sandstone, siltstone, and phyllite. Formerly regarded as Devonian or Mississippian, but presence of numerous clasts derived from the Valmy suggests that it is younger than the Antler Orogeny. It underlies unconformably the Banner, of Osagian or Meramecian age (mid-Mississippian)

Ov

VALMY FORMATION (Ordovician) INCLUDES QUARTZITE, Ovq, AND GREENSTONE, IN PART DERIVED FROM GABBRO, Ovg--Micaceous quartz-calcareous sandstone, locally containing phyllocarid shells and small lenticular masses of thin-bedded chert with slaty partings, and ranging in color from light to dark gray, rarely black or grayish green; locally phosphatic or baritic. Also contains hard well-bedded micaceous siltstone and black quartzose phyllite. Numerous irregular masses of greenstone (meta-andesite), now quartz-albite-chlorite schist, and of gabbro and diabase (Ovg), in which original texture and some of the primary pyroxene and plagioclase are preserved. Micaceous phyllitic limestone, locally phosphatic. Also includes quartzite (Ovq), gray to black, locally tan, fine-grained with interlocking textures; rare detrital tourmaline and zircon and, in the dark-colored quartzite, black carbonaceous material interstitially and disseminated through the quartz grains

Description of map units, Mountain City 15' quadrangle,

Nevada-Idaho

Southwest quarter

- Qf      ARTIFICIAL FILL (Quaternary)--Includes tailings ponds and mine dumps of the Rio Tinto mine, and the garbage dump of Rio Tinto village. (Since the map was made, the tailings have been reworked and moved down stream to location adjacent to that shown on the map.)
- Qc      COLLUVIUM, TALUS, AND SLOPE WASH (Quaternary)--Colluvium tends to be finer grained than other types of material in this unit. Development of colluvium is strongly controlled by direction of exposure, as the greater amount of vegetation on north-facing slopes, conditioned by greater net mixture available favors accumulation. Where material of a range of sizes is available, talus develops at upper end of mapped bodies, and finer material is washed out of talus and becomes colluvium. Unconsolidated air-fall tuffs and unwelded phases of ignimbrites crop out very poorly and are commonly blanketed by colluvium over much of their total extent
- Qls      LANDSLIDE DEPOSITS (Quaternary)--Typically very poorly sorted, commonly a mixture of larger fragments of resistant formations and underlying, less resistant material, in many places tuff or hydrothermally altered rock

- Qa ALLUVIUM (Quaternary)--Consists of sand, silt, and gravel along present stream courses. Generally quite shallow in valley of Owyhee, as indicated by outcrops in central part of valley; surface may be 5 or 6 ft above normal stream in summer time, thicker alluvium may be present in some small valleys where rate of supply exceeds the transporting power of the stream.
- Qtg TERRACE GRAVEL AND DISSECTED ALLUVIAL FANS (Quaternary)--Gravel accumulated on stream terraces higher than the present stream can rise in flood. In the valley of the Owyhee River, as much as 100 ft above the river, and of boulders as much as 2 ft in diameter, subangular to well-rounded. Thickness as much as 10 ft
- Qgm GLACIAL MORaine (Quaternary)--Boulders large to very large, angular. Material unsorted. Typical cross-valley ridge of terminal moraine. In Mountain City quadrangle, present on east side of Bald Mountain and north and east sides of Merritt Mountain. No striated boulders observed
- QTls LANDSLIDES, ROCKSLIDES, AND EARTHFLows (Tertiary and Quaternary)--Characterized by unsorted character, coarseness of maximum size, and, in younger bodies, by characteristic hummocky topographyQTs\*  
UNCONSOLIDATED SEDIMENTARY ROCKS (Quaternary and Tertiary)--Includes material as alluvium, colluvium, talus, glacial moraine, glacial outwash
- QTs\* UNCONSOLIDATED SEDIMENTARY ROCKS (Quaternary and Tertiary)--Includes material as alluvium, colluvium, talus, glacial moraine, glacial outwash

\*Appears only on geologic cross sections.

- Tcp COUGAR POINT WELDED TUFF (Miocene)--Upper part of formation is phenorhyolitic to phenodacitic ignimbrite, purplish gray to dark brown, or black where glassy, and ranging from compact vitrophyres to friable welded tuff. Locally includes a vitrophyric unit (Tcpv), not everywhere separately mapped. Both vitrophyres and devitrified welded tuffs characterized by apatite, zircon and magnetite as accessories. In some of the compact vitrophyres, fayalite, and ferroaugite accompany sanidine or anorthoclase and plagioclase. Quartz is common but not ubiquitous. Ferroaugite may be accompanied or proxied by ferropigeonite, very rarely by hypersthene and hornblende. In less compact welded tuff, fayalite is always iddingsitized, pyroxene commonly argillized. The groundmass ranges from wholly glassy to cryptocrystalline. A potassium-argon age determined (DKA-1068) on a sample of sanidine from near the base of the welded tuff section on the cliffs of Yellow rock, east of the Owyhee River, in the Owyhee 15' quadrangle, by John Obvradovich (oral commun., 1965) gave a date of  $12.2 \pm 0.8$  m.y. includes, in the northeast quarter, a slightly older sequence of similar ignimbrites, Tcpo. May include gravel at the base of the section (Tcpg) not everywhere separately mapped. May include, beneath the ignimbrite, rhyolitic air-fall tuff and lapilli tuff cream to buff in color, and dark carbonaceous tuffs, locally with fossil leaves, separately mapped in some places as Jenny Creek Tuff, Tjt
- Tcb TUFFS AND SEDIMENTS OF CALIFORNIA CREEK BASIN (Miocene)--White to creamy tuff and gravelly tuff, locally rich in petrified wood, including logs up to 32 ft in diameter



Tcs PHENORHYOLITE OF COLDSPRING MOUNTAIN (Miocene)--Largely a light gray, massive, phenocryst poor phenorhyolite, making up the mass of three domes in the southeastern quarter of the Mountain City quadrangle, Rough Mountain, Coldspring Mountain, and an unnamed mountain north of Allegheny Creek, aligned with the other two on a north-northwest trending axis. Two other masses, Haystack Peak and Jenneman Peak, in the southwestern quarter, appear to be related. The dome of Coldspring Mountain is underlain by poorly consolidated air-fall tuff, Tcst, similar in composition, but locally with much accidental material of Jarbidge Rhyolite and Seventy Six Basalt, as well as cognate vitrophyre. In Rough Mountain the phenorhyolite also includes a considerable thickness of glassy welded tuff, that underlies the volcanic dome. The recognizable minerals include quartz, sanidine, oligoclase ( $An_{19}$ ), hornblende, and perrierite, a rare-earth titanium mineral. Biotite and augite are sparse and occasional

Tjr JARBIDGE RHYOLITE (Miocene)--Porphyritic rhyolite, with cryptocrystalline or glassy groundmass, locally spherulitic. Phenocrysts generally dominant over groundmass, quartz up to 5 mm in diameter, sanidine phenocrysts somewhat smaller and less numerous, oligoclase similar in size but scarcer. Clinopyroxene recognizable in glassy phases only, and is generally pigeonitic. Accessories include zircon, apatite, ilmenite, magnetite; very rarely topaz (which may be secondary) or pale pink garnet. Two K-Ar dates, one from Meadow Creek, in the Rowland quadrangle, of  $16.8 \pm .5$  m.y. (Coats, 1964, p. M11), the other from a basal vitrophyre in the Wildhorse quadrangle, of 15.4 m.y. (Evernden and others, 1964, p. 194). Total thickness may be 2,000 ft, but thicknesses are generally meaningless, because most unit accumulated as volcanic domes, in the Wildhorse and Mountain City quadrangles, at least

Tmf MUDFLOW OF MCCALL CREEK (Miocene)--Poorly sorted tuffaceous boulder gravel. Smaller boulders well rounded, larger ones (to 8 m max.) quite angular. Most boulders consist of Valmy quartzite

Twt      WELDED LAPILLI TUFF OF WALL CREEK (Miocene)--Medium- to dark-gray welded tuff and welded lapilli tuffs, phenorhyodacitic to phenorhyolitic. Phenocryst combinations, different in distinct occurrences, include plagioclase, sanidine and ferroaugite, locally with ferropigeonite; plagioclase and ferroaugite; plagioclase and sanidine, locally with quartz; and plagioclase, sanidine, ferroaugite and quartz. Many bodies of small extent, with internal structures distorted by flowage, and rich in coarse, glassy lapilli. K-Ar age determinations on plagioclase-sanidine composite grains from five different localities, four by John Obradovich (oral commun., 1966) and one by Richard Marvin (oral commun., 1967) gave ages ranging from 15 to 16 m.y., all  $\pm 0.8$  m.y. locally underlain by white to cream air-fall tuff, Trt, a poorly stratified, fine-grained, unconsolidated, white to pale-gray tuff.

Tdp DANGER POINT TUFF (Miocene)--Ranging from andesitic to rhyolitic in composition, largely montmorillonitized, with substantial admixture of boulders picked up by surface flow. In the eastern part of the 15' quadrangle, in the eastern facies (Tdpe), most boulders are Prospect Mountain quartzite. In the southwestern part of the 15' quadrangle, sedimentary admixture is finer, and most is of granitic material probably of local derivation, and has in part been mapped separately as western facies, Tdpw. Locally interbedded with Seventy Six Basalt tuff.

Tsb SEVENTY SIX BASALT (Miocene)--Flows of porphyritic olivine basalt, with conspicuous clear phenocrysts of labradorite, up to 2 cm in size, in a subophitic groundmass with plates of purplish augite including grains of olivine, labradorite, magnetite, ilmenite, and apatite. Local patches of mesostasis made up of biotite and sanidine. In places rests upon a dull-greenish-gray tuff, Tsbt, now nontronitic, with plagioclase crystals like those in the flows. Crystals of plagioclase from the tuff on Roughtop Mountain gave an age of  $22.9 \pm 3$  m.y. (J. C. von Essen, Menlo Park Potassium-Argon age report 51, Oct. 15, 1969). Tuffaceous sandstone made up of this basaltic material furnished horse remains of Barstovian age (C. A. Repenning, oral commun., 1965). Possibly some of the tuff was reworked in Barstovian time; the earlier age given by the K-Ar determination is used here for the age of the volcanic rocks, but this age needs confirmation by additional determinations.

- Tac Tuff and sedimentary rocks of Allegheny Creek (Miocene)--Light creamy to pale-green tuff, locally biotitic with small lenses of fine gravel and tuffaceous gravel, containing a fauna (the Rizzi Ranch local fauna) of early Miocene age (C. A. Repenning, written commun., 1966). As the Allegheny Creek beds are overlain by Seventy Six Basalt, the early Miocene date on the faunas is consistent with the potassium-argon date for the Seventy Six basalt
- Tba BIEROTH ANDESITE OF BUSHNELL (1967) (Miocene)--At the type locality (Bieroth Spring, near the western edge of the Rowland quadrangle) is a biotite-hypersthene phenocryst welded tuff, with plentiful phenocrysts of plagioclase, sanidine, brown biotite, nontronite after (?)hypersthene. Shard structure clear, but pectinate recrystallization common. Glassier phases may have olive-green hornblende and may lack sanidine and quartz. Rests on volcanic rocks and sediments of Big Springs, Tbs, overlain by Seventy Six Basalt and Danger Point Tuff, and by younger volcanic rocks. May include as mapped some older volcanic rocks

- Thh BIOTITE PHENORHYODACITE OF HUBER HILL (Oligocene(?))--Occurs as the volcanic dome of Huber Hill, in the southwest quadrant of the Mountain City quadrangle. Pale-grayish-red to pale-pinkish-gray biotite phenorhyodacite, with sparse phenocrysts, mostly under 0.5 mm in size, of black biotite, reddish brown, and partially resorbed in section, of oligoclase. Groundmass generally cryptocrystalline. As mapped may include some ignimbrite of similar lithology
- Thg TUFF OF HARRIS GULCH (Oligocene)--Biotite phenorhyolite tuff, with quartz, plagioclase, biotite, and sanidine. Apparently accumulated in a complex graben extending from Harris Gulch, east of Mountain City, to near the old Bieroth Ranch, on California Creek. Biotite locally bleached and altered to vermicular kaolinite; secondary barite present locally. This alteration is believed related to the gold-silver mineralization at Mountain City. Sanidine from the tuff was dated by J. C. von Essen (written commun., Oct. 15, 1969) at  $30.1 \pm 1$  m.y.. This is believed to reflect the date of eruption, but alteration and mineralization dates may not differ in age by much
- Tbr BUTLER RANCH PHENORHYOLITE VITROPHYRE (Oligocene)--Massive pale-gray vitrophyre, locally perlitic, poor in rhyolite, sanidine, quartz, and oligoclase. Forms a dome near Butler Ranch (Bieroth Ranch on map) and may also form some ignimbrites, that may be interbedded with tuff of Harris Gulch

- Tjc VOLCANIC AND SEDIMENTARY ROCKS OF JONES CREEK (Eocene) INCLUDES
- DACITE OF JONES CREEK (Tjd)--The principal part of the formation consists of flows and tuff breccias or pyroxene andesite, hornblende-pyroxene andesite, hornblende-augite andesite and hornblende andesite, in descending order of frequency of occurrence. These rocks are dark gray to medium gray, commonly porphyritic. Gray air-fall tuffs are locally present. Total thickness may be several thousand feet. At base, a phenodacitic ignimbrite, Tjd, compact to moderately compact, with conspicuous phenocrysts of plagioclase, augite, hypersthene, hornblende, and biotite, grading by increase of quartz and sanidine into a phenorhyodacite
- Tar ANDESITE OF RUSSEL GULCH (Eocene)--Black, vitrophyric, phenoandesitic welded tuff, with andesite, augite, and hypersthene, plentiful apatite and magnetite, rare zircon, biotite, and green hornblende. Where devitrified, black to brown felsophyres. At base, locally small amounts of rhyolitic airfall tuff
- Trd PHENORHYOLITE IGNIMBRITE OF RABBIT DRAW (Eocene)--White biotitic air-fall and welded tuff, with dark smoky quartz, black biotite, sanidine, and oligoclase. Rests on Ordovician volcanic or Mesozoic plutonic rocks; underlies andesite of Russel Gulch
- Tpr GRAVEL OF PECK RANCH (Eocene[?])--Cobble gravel, overwhelmingly made up of tan-weathering jasperoid apparently derived from the Van Duzer Limestone of Decker, where the limestone has been silicified near the Lime Creek Thrust. Overlain by tuff and sedimentary rocks of Allegheny Creek

- Trg      ANDESITE OF ROCKY GULCH (Eocene[?])--Pyroxene andesite porphyritic, holocrystalline, with plagioclase (andesine to labradorite, with oscillatory zoning, augite, hypersthene, and magnetite. The groundmass contains plagioclase, hypersthene, magnetite, and alkali feldspar
- Trs      ANDESITE NEAR THE RANGER STATION (Eocene[?])--Dark-gray, porphyritic, diopatic hornblende phenocandesite, plagioclase (An<sub>70-75</sub>) and hornblende, olive green to brown in thin section, with 0.03 mm resorption border, apatite, and magnetite. Groundmass cryptocrystalline, plagioclase, clinopyroxene(?) and sanidine(?), about 0.001 mm. Lies just beneath the andesite of Rocky Gulch, and presumably conformable with it



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- Tsa ANDESITE OF SUMMIT CREEK (Eocene)--Locally includes also underlying phenorhyolite air-fall tuff, Tst. Largely pyroxene andesite and pyroxene-hornblende-biotite andesite. Also biotite pyroxene dacite vitrophyre
- Kg GRANITE (IN THE BROAD SENSE ACCORDING TO STRECKEISEN, (1967) (Cretaceous) INCLUDES GRANODIORITE AND QUARTZ MONZONITE OF SOME AUTHORS, ALSO INCLUDES APLITE (Ka), PEGMATITE (Kp) AND MIGMATITE (Km)--Includes granodiorite and quartz monzonite of previous usage; includes marginal microcline-microperthite aplite, Ka, not everywhere separately mapped. Some pegmatite, Kp, not everywhere separately mapped. Migmatitic zones adjacent to country rock, Km, not everywhere separately mapped. Generally characterized by biotite and hornblende, locally with perthitic orthoclase megacrysts

PPrh      RESERVATION HILL FORMATION (PENNSYLVANIAN(?) AND PERMIAN(?))--Mostly  
fine grained dolomitic sandstone or siltstone, pale gray,  
weathering white or pale reddish brown, in beds 2 cm to 5 cm  
thick, interbedded regularly with thinner beds of graphitic  
phyllite. The dolomitic sandstone is metamorphosed to rocks  
composed of various combinations of quartz, calcite, tremolite,  
diopside, and wollastonite, the last locally coarsely  
prismatic. Also metagraywacke, micaceous and tremolitic  
quartzite, rare metachert, and quartzite, meta-andesite, now  
metamorphosed to actinolite-epidote-plagioclase schist, and  
hornblende-plagioclase schist. A few lenses of gray, siliceous  
dolomitic limestone, locally with coarse calcitic "eyes"  
suggesting former presence of crinoids

Mc      CHAINMAN FORMATION (Mississippian)--Includes the Mountain City  
Formation (Coats, 1971). Largely quartz-muscovite biotite schist,  
locally with orthoclase, garnet, or graphite, rarely with  
andalusite, where thermally metamorphosed. In the western part of  
the quarangle, includes thin limy beds, up to 2 ft thick, now rocks  
composed of various combinations of quartz, calcite, diopside,  
tremolite, and clinozoisite, orthoclase, and muscovite. In the  
eastern part of the quadrangle, contains a higher proportion of  
limy rocks. A bed, generally thin, of metarhyolite tuff, now  
quartz-plagioclase-orthoclase hornfels. In area northwest of  
Merritt Mountain, thicker masses of tuff, Mct, are present.

- Mn NELSON FORMATION (Mississippian)--At the base, locally an extrusive breccia, possibly a peperite, with limy matrix, locally fossiliferous. Flows and tuff breccias of andesitic and basaltic composition. Also minor sills of diabase and one lens of rhyolitic tuff. Now largely a green schist of tremolite-actinolite, chlorite, epidote, calcite, ilmenite, and relict andesine, in part altered to albite. In the northern part of the Mountain City 15' quadrangle, amphibolite schist
- Mb BANNER FORMATION (Mississippian)--Soft massive bluish-gray limestone, containing solitary and colonial corals, brachiopods, and bryozoans. Grades downward through medium- to fine-grained brownish quartz arenite and gray tan-weathering siliceous siltstone through arenaceous limestone into conglomerate with rounded white quartzite boulders as much as 15 cm in diameter. Maximum thickness 200 m. Overlies Valmy and Grossman Formations, underlies Chainman Formation
- Mg GROSSMAN FORMATION (Mississippian[?])--Coarse conglomerate with clasts of gray quartzite, black chert, phyllite, and magnetitiferous siltstone. Sandstone, siltstone, and phyllite. Formerly regarded as Devonian or Mississippian, but presence of numerous clasts derived from the Valmy suggests that it is younger than the Antler Orogeny. It underlies unconformably the Banner, of Osagian or Meramecian age (mid-Mississippian)

Ov VALMY FORMATION (Ordovician) INCLUDES QUARTZITE, Ovq, AND GREENSTONE, IN PART DERIVED FROM GABBRO, Ovg--Micaceous quartz-calcarenite and calcareous sandstone, locally containing phyllocarid shells and small lenticular masses of thin-bedded chert with slaty partings, and ranging in color from light to dark gray, rarely black or grayish green; locally phosphatic or baritic. Also contains hard, well-bedded micaceous siltstone and black quartzose phyllite. Numerous irregular masses of greenstone (meta-andesite), now quartz-albite-chlorite schist, and of gabbro (ovg) and diabase (Ovdb), in which original texture and some of the primary pyroxene and plagioclase are preserved. Micaceous phyllitic limestone, locally phosphatic. Also includes quartzite (Ovq), gray to black, locally tan, fine-grained with interlocking textures; rare detrital tourmaline and zircon and, in the dark-colored quartzite, black carbonaceous material interstitially and disseminated through the quartz grains

Pvd      VAN DUZER LIMESTONE (Pennsylvanian)--Dominantly thin bedded to very thin bedded medium- to dark-gray calcarenite and quartzose calcarenite, locally grading to quartzite. Chertification of calcareous beds is common. Minor flows of meta-andesite, now chlorite-muscovite-albite calcite schist. Thin films of micaceous and graphitic material form laminae within the thicker calcareous beds. Van Duzer Limestone was defined by Decker (1962, p. 29-21, p. 1) for rocks in Van Duzer Creek, the type locality. The type section is designated the ridge top in secs. 6 and 7, T. 44. N., R. 53 E. The total thickness is about 7,000 ft. A single fossil locality from Trail Creek, just south of the southwest corner of the Mountain City quadrangle, furnished brachiopods and conodonts, with ages that overlapped in the Desmoinesian

# Photos N. 64

- 81.1-1 Looking NW 20° E at  
summit of Little 197,  
showing top of what  
was above postish  
PPH. (Last bar mineral  
unit N. of postish point  
N. 2. from N.E. end of the 197,  
Looking N to Ryan's overthrust  
1.3 at S.E. of Ryan's overthrust gate at  
4 } Ryan's thrust  
5 }  
6 }  
7 Portal to tunnel  
8 Vol 4 Knippack (3121)  
9 Looking S, at Pe. st. lites  
from Knippack.  
10. Dk gray, silty gteite 35° N 20° W,  
with tough x-bedding, at mouth  
schist over or  
11. Looking SW at "Disc. Mon.  
in unmineralized variegated  
Rhyolite. Mon schist at Disc.  
20' from May. Sept 3 1978  
12. Looking N 80° E, Pinnacle & foreground  
blue bottle 14" high is 100% of a lot  
10' a big RM fault. Sample 81N 122  
here of mineralized fault. Since  
unmineralized to S.E. then Rg. Fragile  
Seal.

Description of map units,

Mountain City 15' quadrangle, Nevada-Idaho

Southeast quarter

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- Qgm GLACIAL MORaine (Quaternary)--Boulders large, to very large, angular. Material unsorted. Typical cross-valley ridge of terminal moraine. In Mountain City quadrangle, present on east side of Bald Mountain on Merritt Mountain. No striated boulders observed

- Qgo GLACIAL OUTWASH (Quaternary)--Present as valley train in some valleys below morainal deposit. Distinguished from ordinary stream gravel by greater coarseness, boulders of a size beyond the carrying capacity of the present stream
- QTs\* UNCONSOLIDATED SEDIMENTARY ROCKS (Quaternary and Tertiary)--Includes such material as alluvium, colluvium, talus, glacial moraine, glacial outwash
- Tcb TUFFS AND SEDIMENTS OF CALIFORNIA CREEK BASIN (Miocene)--White to creamy tuff and gravelly tuff, locally rich in petrified wood, including logs up to 3 ft in diameter
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- Tjr JARBIDGE RHYOLITE (Miocene)--Porphyritic rhyolite, with cryptocrystalline or glassy groundmass, locally spherulitic. Phenocrysts generally dominant over groundmass, quartz up to 5 mm in diameter, sanidine phenocrysts somewhat smaller and less numerous, oligoclase similar in size but scarcer. Clinopyroxene recognizable in glassy phases only, and is generally pigeonitic. Accessories include zircon, apatite, ilmenite, magnetite; very rarely topaz (which may be secondary) or pale pink garnet. Two K-Ar dates, one from Meadow Creek, in the Rowland quadrangle, of  $16.8 \pm 0.5$  m.y. (Coats, 1964, p. M11), the other from a basal vitrophyre in the Wildhorse quadrangle, of 15.4 m.y. (Evernden and others, 1964, p. 194). Total thickness may be 600 m, but thicknesses are generally meaningless, because most unit accumulated as volcanic domes, at least in the Wildhorse and Mountain City quadrangles
- Tdp DANGER POINT TUFF (Miocene)--Ranging from andesitic to rhyolitic in composition, largely montmorillonitized, with substantial admixture of boulders picked up by surface flow. In the eastern part of the 15' quadrangle, in the eastern facies (Tdpe), most boulders are Prospect Mountain quartzite. In the southwestern part of the 15' quadrangle, sedimentary admixture is finer, and most is granitic material probably of local derivation, and has in part been mapped separately as western facies, Tdpw. Locally interbedded with Seventy Six Basalt tuff.

Tsb SEVENTY SIX BASALT (Miocene)--Flows of porphyritic olivine basalt, with conspicuous clear phenocrysts of labradorite, up to 2 cm in size, in a subophitic groundmass with plates of purplish augite including grains of olivine, labradorite, magnetite, ilmenite, and apatite. Local patches of mesostasis made up of biotite and sanidine. In places rests upon or underlies a dull-greenish-gray tuff, Tsbt, now nontronitic, with plagioclase crystals like those in the flows. Crystals of plagioclase from the tuff on Roughtop Mountain gave an age of  $22.9 \pm 3$  m.y. (J. C. von Essen, Menlo Park Potassium-Argon age report 51, Oct. 15, 1969). Tuffaceous sandstone made up this basaltic material furnished horse remains of Barstovian age (C. A. Repenning, oral commun., 1965). Possibly some of the tuff was reworked in Barstovian time; the earlier age given by the K-Ar determination is used here for the age of the volcanic rocks, but this age needs confirmation by additional determinations. Tuff combined with basalt and shown as Tsb on sections.

Ttc TELEPHONE CREEK RHYOLITE (Miocene)--Exposed in southeastern quarter of Mountain City 15' quadrangle, near the head of Telephone Creek. Interbedded with Seventy Six Basalt and Seventy Six Basalt Tuff, underlies Jarbidge Rhyolite. Thickness not determinable, but at least 100 m. Phenocrysts of quartz, sanidine, oligoclase and brown biotite. Biotite plates very small, about 0.1 mm in diameter. Rock distinguished by secondary topazification, made more conspicuous by bleaching of certain areas of the normally light-gray groundmass, and development of spongy topaz and light-green biotite in the groundmass. Topaz crystals up to 2 mm long, developed in such cavities, are sherry colored when freshly exposed, but quickly bleached by light. Some secondary fluorite also present

Tac TUFF AND SEDIMENTARY ROCKS OF ALLEGHENY CREEK (Miocene)--Light creamy to pale-green tuff, locally biotitic, with small lenses of fine gravel and tuffaceous gravel, containing a fauna (the Rizzi Ranch local fauna) of early Miocene age (C. A. Repenning, written commun., 1966). As the Allegheny Creek beds are overlain by Seventy Six Basalt, the early Miocene date on the faunas is consistent with the potassium-argon date for the Seventy Six basalt

Tba      BIEROTH ANDESITE OF BUSHNELL (1967) (Miocene)--At the type locality (Bieroth Spring, near the western edge of the Rowland quadrangle) is a biotite-hypersthene phenodacite welded tuff, with plentiful phenocrysts of plagioclase, sanidine, brown biotite, nontronite after (?)hypersthene. Shard structure clear, but pectinate recrystallization common. Glassier phases may have olive-green hornblende and may lack sanidine and quartz. Rests on volcanic rocks and sediments of Big Springs, overlain by Seventy Six Basalt and Danger Point Tuff, and by younger volcanic rocks. May include as mapped some older volcanic rocks

Tbs      VOLCANIC AND SEDIMENTARY ROCKS OF BIG SPRINGS CREEK (Oligocene)--Partially exposed on Pixley Creek, at the uranium mine, where tuffaceous sediments and lignite overlie granodiorite. The sediments have furnished an abundant pollen flora, determined by Estella Leopold (written commun., Mar. 25, 1971) as probably Oligocene. Farther west, on Big Springs Creek, a face exposed in an open pit for uranium. Here clayey pumiceous tuff rests on granodiorite, dipping steeply southeast. This is overlain by a lenticular tuffaceous agglomerate with heterogeneous volcanic boulders. This in turn overlain by a vitrophyre, fragmental at the base, welded toward the top. The top of the cliff is a dosemic hornblende-biotite phenodacite vitrophyre, containing andesine, biotite, and hornblende in a typical vitroclastic welded texture. The vitrophyre next below is a typical hypersthene-augite phenodacite welded tuff

PPrh

RESERVATION HILL FORMATION (PENNSYLVANIAN(?) AND PERMIAN(?))--Mostly fine grained dolomitic sandstone or siltstone, pale gray, weathering white or pale reddish brown, in beds 2 cm to 5 cm thick, interbedded regularly with thinner beds of graphitic phyllite. The dolomitic sandstone is metamorphosed to rocks composed of various combinations of quartz, calcite, tremolite, diopside, and wollastonite, the last locally coarsely prismatic. Also metagraywacke, micaceous and tremolitic quartzite, rare metachert, and <sup>z</sup>quartzose meta-andesite, now metamorphosed to actinolite-epidote-plagioclase schist, and hornblende plagioclase schist. A few lenses of gray, siliceous dolomitic limestone, locally with coarse calcitic "eyes" suggesting former presence of crinoids

PPs

STRATHEARN FORMATION (Pennsylvanian and Permian)--In the Rowland and Mt. Velma quadrangles, Bushnell (1967) and Coash (1967) described a unit, including conglomerate, sandstone, and clastic limestone, of Pennsylvanian and Permian age, as the Sunflower Formation. This is here regarded as the equivalent of the Strathearn Formation. It crops out in the Mountain City quadrangle only in the southeastern corner. The conglomerate member of the Sunflower consists of quartzite- and chert-pebble conglomerate, quartzite, and sandstone. The rocks characteristically weather brownish gray and grayish red. The middle limestone member has a thickness of 530 ft in the Mt. Velma quadrangle (Coash, 1967). It is medium to dark gray, weathering dusky yellow. It grades into the underlying conglomerate member. The upper sandstone member is conformable on the limestone member. In the Mt. Velma quadrangle (Coash, 1967) it comprises about 1,400 ft of fine-grained sandstone, micaceous siltstone, and thin beds of silty limestone

Pvd VAN DUZER LIMESTONE (Pennsylvanian)--Dominantly thin bedded to very thin bedded medium- to dark-gray calcarenite and quartzose calcarenite, locally grading to quartzite. Chertification of calcareous beds is common. Minor flows of meta-andesite, now chlorite-muscovite-albite calcite schist. Thin films of micaceous and graphitic material form laminae within the thicker calcareous beds. Van Duzer Limestone was defined by Decker (1962, p. 29-21, p. 1) for rocks in Van Duzer Creek, the type locality. The type section is designated the ridge top in secs. 6 and 7, T. 44. N., R. 53 E. The total thickness is about 7,000 ft. A single fossil locality from Trail Creek, just south of the southwest corner of the Mountain City quadrangle, furnished brachiopods and conodonts, with ages that overlapped in the Desmoinesian

Mdc DIAMOND PEAK AND CHAINMAN FORMATIONS, UNDIVIDED (Mississippian)--In the northeast and southeast quarters of the 15' quadrangle, the Diamond Peak and Chainman appear to intergrade; in the extreme southeastern corner of the quadrangle only a medium-grained dark massive sandstone is present, which is poorly fossiliferous but has been correlated with the Diamond Peak. West and south of Enright Hill, in the northeast quarter, the sandstone facies is more fossiliferous, and the age assignment is on a firmer basis

Mc

CHAINMAN FORMATION (Mississippian)--Includes the Mountain City Formation (Coats, 1971). Largely quartz-muscovite biotite schist, locally with orthoclase, garnet, or graphite, rarely with andalusite, where thermally metamorphosed. In the western part of the quadrangle, includes thin limy beds, up to 2 ft thick, now rocks composed of various combinations of quartz, calcite, diopside, tremolite, and clinozoisite, orthoclase, and muscovite. In the eastern part of the quadrangle, contains a higher proportion of limy rocks. One bed, generally thin, of metarhyolite tuff, now quartz-plagioclase-orthoclase hornfels. In area northwest of Merritt Mountain, thicker masses of tuff, Mct, are present. In the southeastern quarter of the 15' quadrangle, includes much medium-grained, impure, poorly bedded sandstone that has furnished a brachiopod fauna

Mn

NELSON FORMATION (Mississippian)--At the base, locally an extrusive breccia, possibly a peperite, with limy matrix, locally fossiliferous. Flows and tuff breccias of andesitic and basaltic composition. Also minor sills of diabase and one lens of rhyolitic tuff. Now largely a green schist of tremolite-actinolite, chlorite, epidote, calcite, ilmenite, and relict andesine, in part altered to albite. In the northern part of the Mountain City 15' quadrangle, amphibolite schist



Mb BANNER FORMATION (Mississippian)--Soft massive bluish-gray limestone, containing solitary and colonial corals, brachiopods, and bryozoans. Grades downward through medium- to fine-grained brownish quartz arenite and gray tan-weathering siliceous siltstone through arenaceous limestone into conglomerate with rounded white quartzite boulders as much as 15 cm in diameter. Maximum thickness 200 m. Overlies Valmy and Grossman Formations, underlies Chainman Formation

Mg GROSSMAN FORMATION (Mississippian(?))--Coarse conglomerate with clasts of gray quartzite, black chert, phyllite, and magnetitiferous siltstone. Sandstone, siltstone, and phyllite. Formerly regarded as Devonian or Mississippian, but presence of numerous clasts derived from the Valmy suggests that it is younger than the Antler Orogeny. It underlies unconformably the Banner, of Osagian or Meramecian age (mid-Mississippian)

Ov VALMY FORMATION (Ordovician) INCLUDES QUARTZITE, Ovq, AND GREENSTONE, IN PART DERIVED FROM GABBRO, Ovg--Micaceous quartz-calcarenite and calcareous sandstone, locally containing phyllocarid shells and small lenticular masses of thin-bedded chert with slaty partings, and ranging in color from light to dark gray, rarely black or grayish green; locally phosphatic or baritic. Also contains hard well-bedded micaceous siltstone and black quartzose phyllite. Numerous irregular masses of greenstone (meta-andesite), now quartz-albite-chlorite schist, and of gabbro and diabase (Ovg), in which original texture and some of the primary pyroxene and plagioclase are preserved. Micaceous phyllitic limestone, locally phosphatic. Also includes quartzite (Ovq), gray to black, locally tan, fine-grained with interlocking textures; rare detrital tourmaline and zircon and, in the dark-colored quartzite, black carbonaceous material interstitially and disseminated through the quartz grains

Og GOODWIN LIMESTONE OF THE POGONIP GROUP (Ordovician)--Massive white to light-gray or light-pinkish-gray calcarenite, sparse fragments of clastic quartz suggest a calcarenitic origin. Now sheared and recrystallized, locally silicified to a jasperoid

- 06tm      TENNESSEE MOUNTAIN FORMATION OF BUSHNELL (1967)--Highly deformed, interbedded thinly bedded limestone and argillaceous rocks. Limestone typically thin beds of medium-gray aphanitic limestone and silty limestone separated by very thin phyllite laminae. Phyllite beds from 10 to 50 ft thick locally interbedded with the limestones. Phyllite ranges in color from yellowish gray to greenish to gray green. Cleavage has obliterated the bedding in the phyllite. Two collections of fossils from the formation in the Mountain City quadrangle were examined by A. R. Palmer, who determined the age of one collection as probably Cambrian or Lower Ordovician
- 06sl\*      SHALY AND LIMY ROCKS (Ordovician and Cambrian)--May include such units as the Goodwin Limestone, various Middle and Upper Cambrian units above the Prospect Mountain Quartzite. May be in part equivalent to the Tennessee Mountain Formation of Bushnell (1967)
- 6ls\*      LIMY AND SHALY ROCKS (Cambrian)--May include units such as Windfall Formation and Dunderberg Shale
- 6ld\*      LIMY, DOLOMITIC, AND SHALY ROCKS (Cambrian)--May include units such as Hamburg Dolomite, Secret Canyon Shale, Geddes Limestone, Eldorado Dolomite, and Pioche Shale
- 6pm\*      PROSPECT MOUNTAIN QUARTZITE (Lower Cambrian)

\*Appears only on geologic cross sections.

3260 0108

To make identical copy of document already on disk:

Menu - S (special function  
C (copy)  
name document/new name

then return only for standard copy.

For Bob Coats Mountain City description of map units, now Document 1, 2, 3, 4

Phrase document 2, 3, 4, and put them all in document 1.

there will now be one long document.

Go thru with binder and add and delete as necessary to duplicate master list.

*Description of Map units,  
Mountain city 15' quadrangle, Nev.-Idaho*

~~Banner Formation~~

( Numbers in blue ink after the formation name on the dividers indicated  
the quarter of the Mountain City 15' quadrangle in which the formation appears,  
and in the ~~explains in~~ <sup>for the 15' quadrangle</sup> Description of Map Units for which the description in  
the Description of Map Units <sup>^</sup> should be repeated, as follows:

1 = NE quarter

2 = NW quarter

3 = SW quarter

4 = SE quarter

From one to all four of these numbers may appear, indicating the  
repetition of the map units in the several quarters of the quadrangle. )

Artificial fill 23  
(qr)

### Artificial Fill

Includes tailings ponds and mine dumps of the Rio Tinto Mine, and the garbage dump of Rio Tinto village . (Since the map was made, the tailings have been reworked and moved downstream to a location adjacent to that shown on the map.)

Colluvium, talus, and slope wash  
(Qo) 1, 2, 3, 4



EXISTING

Colluvium, talus and slope wash.

Colluvium tends to be finer grained than other types of material in this unit. Development of colluvium is strongly controlled by direction of exposure, as the greater amount of vegetation on north-facing slopes, conditioned by greater net moisture available favors accumulation. Where material of a range of sizes is available, talus develops at upper end of mapped bodies, and finer material is washed out of talus and becomes colluvium.

Unconsolidated air-fall tuffs and unwelded phases of ignimbrites crop out very poorly and are commonly blanketed by colluvium over much of their total extent.

Landslide deposits  
(Qls)

2,  
1, 3, 4  
1

## Landslide deposits

(Qls)

Typically very poorly sorted, commonly a mixture of ~~1/~~larger fragments of resistant formations and underlying, less resistant material, in many places tuff or hydrothermally altered rock.

Alluvium  
(Qa)

1, 2, 3, 4

Alluvium  
(Qa1)

Consists of sand, silt, and gravel along present stream courses.

Generally quite shallow in valley of Owyhee, as indicated by outcrops in central part of valley; ~~may~~ surface may be 5 or 6 feet above normal stream in summer time, thicker alluvium may be present in some small valleys where rate of supply exceeds the transporting power of the stream.



and dissected alluvial fans  
Terrace gravel 1, 3  
(Qtz) ^

Terrace gravel and dissected alluvial fans

(Q<sub>1g</sub>)

Gravel accumulated on stream terraces higher than the present stream can rise in flood. In the Valley of the Owyhee River, as much as 1-00 feet above the river, and of boulders as much as 2 foot in diameter, subangular to well-rounded. Thickness as much as 10 feet.

Glacial moraine

(Qgm)

1, 3, 4



Glacial Moraine

(Qgm)

Boulders large, to very large, angular. Material unsorted.

~~Moraine~~ Typical cross-valley ridge of terminal moraine. In Mountain  
east  
C ty quadrangle, present on ~~west~~ side of Bald Mountain and north ~~and~~ east  
sides of Merritt Mountain. No striated boulders observed.

Glacial outwash  
(Qgo)

14

Glacial outwash

Q90

Present as valley train in some valleys below morainal deposit. Distinguished from ordinary stream gravel by greater coarseness, boulders of a size beyond the carrying capacity of the present stream.

Landslides, <sup>1, 2, 3</sup> rock slides, and earth flows.

(QT1a)



Landslides, rockslides and earthflows.

Characterized by unsorted character, coarseness of maximum size,  
and, in ~~more~~ younger bodies, by characteristic hummocky topography.

Big Island Formation

2,

(Tbd)

BIG ISLAND FORMATION (MIOCENE)

Tholeiitic olivine basalt, with overlying and underling gravel. Minor  
amounts of rhyolite tuff <sup>y</sup> are present directly beneath basalt in many places.

Includes basaltic cinder, tuff, and lava cones, Tbc; also Basalt flows, sepately  
mapped locally. Tb.



Cougarp Point Welded Tuff

1, 2

(Top)



## COUGAR POINT WELDED TUFF

(Top)

~~xxxxx~~ Upper part of formation is phenorhyolitic to phenodacitic ignimbrite, purplish gray to dark brown, or black where glassy, and ranging from compact vitrophyres to friable welded tuff. Locally included as a vitrophyric unit (Topv), not everywhere separately mapped. Both vitrophyres and devitrified welded tuffs characterized by apatite, zircon and magnetite as accessories. In some of the compact vitrophyres, fayalite and ferroaugite accompany sanidine ~~and~~ or anorthoclase and plagioclase. Quartz is common but not ubiquitous. Ferroaugite may be accompanied or proxied for by ferropigeonite, very rarely by hypersthene and hornblende. In less compact welded tuff, fayalite is always iddingsitized, pyroxene commonly argillized. The groundmass ranges ~~from~~ from wholly glassy to cryptocrystalline. A potassium-argon age determination (DKA-1068) on a sample of sanidine from near the base of the welded tuff section on the cliffs of Yellow rock, east of the Owyhee River, in the Owyhee 15' quadrangle, by John Obradovich (oral communication, 1965) gave a date of  $12.2 \pm 0.8$  m.y. May include grave 1 at the base of the section (Topg) not everywhere separately mapped. May include ~~at/tn~~, generally above the gravel, and beneath the ignimbrite, rhyolitic air-fall tuff and lapilli tuff cream to buff in color, and dark carbonaceous tuffs, locally with fossil leaves.

Tjt.

Vitrophytic phase of Cougar Point  
Welded Tuff (1)

(Topv)

Jehny Creek Tuff

(Tjt)

1, 2



Gravel under Cougar Point Welded Tuff

(Topg)

1/2

Tuffs and sediments of California Creek Basin

(Tab)

34

Tuff and sedimentary rock of California Creek basin

(Tob)

White to creamy tuff and gravelly tuff, locally rich in petrified wood, including logs up to 3 feet in diameter.



~~Phenocrhyolite~~ Cold Spring <sup>Mountain</sup> Rhyolite 3. 4

(Tos)

Phenorhyolite of Coldspring Mountain

3, 4

(Tcs)

Largely a light gray, massive pheno-cryst poor phenorhyolite, making up the mass of three domes in the southeastern quarter of the Mountain City quadrangle, Rough Mountain, Coldspring Mountain, and an un-named mountain north of Allegheny Creek, aligned with the other two on a north-north-west trending axis. Two other masses, Haystack Peak and <sup>Jenneman</sup> Peak, in the southwestern quarter, appear to be related. The ~~Dome~~ of Coldspring Mountain is underlain by poorly consolidated airfall tuff, similar in composition, but locally with much accidental material of Jarbidge Rhyolite and Seventy Six Basalt, as well as ~~vitrophyre~~ cognate vitrophyre, /Test. The phenorhyolite also includes, in rough mountain, a considerable thickness of glassy welded tuff, that underlies the volcanic dome. The recognizable minerals include quartz, sanidine, oligoclase (An<sub>19</sub>), hornblende and perrierite, a rare-earth titanium mineral. Biotite and augite are sparse and occasional.



Tuff under Cold Spring Rhyolite of *Mountain 3.4*  
(test)

Volcanic and sedimentary rocks -

Andesite of McCall Creek

5

(Tmo)

## Volcanic and sedimentary rocks of McCall Creek

Hornblende-Biotite hypersthene dacite, vitrophyric near base, with large proportion of phenocrysts. Overlain by flows of hornblende andesite and pyroxene andesite. Beneath the dacite, a poorly sorted coarsely tuffaceous boulder gravel, apparently a mudflow, ~~not~~ Tmf. This may be correlated with the Danger Point Tuff.

Mud flow of McCall Creek

1.3

(Tmf)

Mudflow of McCall Creek

(Tmf)

Poorly sorted tuffaceous boulder gravel. Smaller boulders well-rounded, larger ones (to ~~24/100~~ 24 m. max.) quite angular. Most Boulders consist of Valley quartzite



Welded lapilli tuff of wall creek 1, 3.

(Twt)

Welded lapilli tuff of Wall Creek

Medium- to dark-gray welded tuff and welded lapilli tuffs, phenorhyodacitic to phenorhyolitic. Phenocryst combinations, different in distinct occurrences, include plagioclase, sanidine and ferroaugite, locally with ferropigeonite, ; plagioclase and ferroaugite; plagioclase and sanidine, locally with quartz; a and plagioclase, sanidine, ferroaugite and quartz. Many <sup>flows</sup> bodies of small extent, with internal structures distorted by <sup>secondary</sup> flowage, and rich in coarse, glassy lapilli. K<sub>2</sub>Ar age determinations on plagioclase-sanidine composite grains from five different localities, four by John Obradovich (oral commun., 1966) and one by Richard Marvin (oral communication, 1967) gave ages ranging from  $\times$  15 to 16 m.y., all  $\pm 0.8$  m.y. ~~all~~ locally underlain by white to cream air-fall tuff/ Trt.

~~Airfall~~ rhyolitic tuff

13

Trt



~~Airfall~~ phenorhyolite tuff

Trt

Poorly stratified, fine grained, unconsolidated, white to pale gray tuff.  
Underlies the welded lapilli tuff of Wall Creek in many places.

Jarbridge Rhyolite

1, 4

Tjr

## Jarbridge Rhyolite

Tjr

Porphyritic rhyolite, with cryptocrystalline or glassy groundmass, locally spherulitic. Phenocrysts generally dominant over groundmass, quartz up to 5 mm in diameter, sanidine phenocrysts somewhat smaller and less numerous, oligoclase similar in size but scarcer. Clinopyroxene recognizable in glassy phases only, and is generally pigeonitic. Accessories include zircon, apatite, ilmenite, magnetite; very rarely topaz (which may be secondary) or pale pink garnet. Two K-Ar dates, one from Meadow Creek, in the Rowland Quadrangle, in the Rowland Quadrangle, of  $16.8 \pm 0.5$  m.y. (Coats, 1964, p. M11), the other from a basaltic vitrophyre in the Wildhorse Quadrangle, of 15.4 m.y. (Verne/ Evernden and others, 1964, p. 194). Total thickness may be 2000 feet, but thicknesses are generally meaningless, because most of unit accumulated as volcanic domes, in the Wildhorse and Mountain City quadrangles, at least.

Danger Point Tuff

2, 4

(Tdp)

(Includes eastern facies, Tdpe, and western facies, Tdpw )

Danger Point Tuff

(Tdp)

*in composition*  
~~Of composition~~ ~~to~~ Ranging from andesitic to rhyolitic, largely  
montmorillonitized, with substantial admixture of boulders picked up by surface  
flow. In the eastern part of the <sup>15'</sup> quadrangle, the eastern facies (Tdp<sub>e</sub>),  
most boulders are Prospect Mountain quartzite. In the southwestern part of  
the <sup>15'</sup> quadrangle, sedimentary admixture is finer, and most is of  
granitic material probably of local derivation, and has in part been mapped  
separately as western facies, ~~Tpw~~/Tdpw.



Seventy Six Basalt

1, 2, 3, 4

(Tsb)

(Includes tuff and lapillituff (Tsb<sup>st</sup>) associated with Tsb. May include in some places sediments reworked from such tuff

## Seventy Six Basalt

(Tsb)

Flows of phorphyritic alkali olivine basalt, with conspicuous clear phenocrysts of labradorite, up to 2 cm. in size, in a subophitic groundmass with plates of purplish augite including grains of olivine, labradorite, magnetite, ilmenite, and apatite. Local patches of mesostasis made up of biotite and ~~orthoclase~~ sanidine. In places rests upon a dull greenish gray tuff ~~of tuffaceous sandst~~, Tsb, now not rhyolitic, with plagioclase crystals like those in the flows. Crystals of plagioclase from the tuff gave an age of  $22.9 \pm 3$  m.y. (J. C. von Essen, Menlo Park Potassium-Argon age report 51, Oct. 15, 1969). Tuffaceous sandstone made up of this basaltic material furnished horse remains of Barstovian age (C. A. Repenning, oral communication, 1965). Possibly some of the tuff was reworked in Barstovian time; the earlier age given by the K-Ar determination is used here for the age of the volcanic rocks, but this age needs confirmation by additional determinations.

Telephone Creek Rhyolite  
(Tto)

✓



Telephone Creek rhyolite

(Ttc)

Exposed in southeastern quarter of Mountain City 15' quadrangle, near the head of Telephone Creek. Rests on Seventy Six Basalt, underlies Jarbidge Rhyolite. Thickness not determinable, but at least several hundred feet. Phenocrysts of quartz, sanidine, oligoclase and ~~plagioclase~~ brown biotite. Biotite plates very small, about 0.1 mm. in diameter. Rock distinguished by secondary topazification, ~~plagioclase~~ made more conspicuous by bleaching of certain areas of the normally light gray groundmass, and development of spongy topaz and light green biotite in the groundmass. Topaz crystals up to 2 mm long, developed in such cavities, are sherry colored when freshly exposed, but quickly<sup>c</sup><sub>^</sub> bleached by light. Some secondary fluorite also present.

Tuff and sedi mentary rocks of Allegheny Creek

(Tao)

3, 4

Tuff and sedimentary rocks of Allegheny Creek.

Light ~~creamy~~ to pale green tuff, locally biotitic, with small lenses of fine gravel and tuffaceous gravel, containing a fauna (the Rizzi Ranch local fauna) of early Miocene age (C. A. Repenning, written communication, 1966). As the Allegheny Creek <sup>beds</sup> ~~rocks~~ are overlain by Seventy Six Basalt, the Early Miocene date on the faunas is consistent with the potassium-argon date for the Seventy Six Basalt.

Bieroth Andesite of Bushnell (1967) 5, 3, 4

Bieroth Andesite of Bushnell (1967)

At the type locality (Bieroth Spring, near the western edge of the Rowland Quadrangle) is a biotite-hypersthene phenocryst welded tuff, with plentiful phenocrysts of plagioclase, sanidine, brown biotite, and nontronite after (?) hypersthene. Shard structure clear, but pectinate recrystallization common. Glassier phases may have olive-green hornblende and may lack sanidine and quartz. Rests on Volcanic rocks and sediments of Big Springs, overlain by Seventy Six Basalt and Danger Point Tuff, and by younger volcanic rocks. May include some older volcanic rocks as mapped.



<sup>0</sup>  
Volcanic and sedimentary rocks of Big Springs Creek

(Tbs)

Volcanic and sedimentary rocks of  
Big Springs Creek.

(Tbs)

partially exposed on Pixley Creek, at the uranium mine, <sup>where</sup> tuffaceous sediments and lignite overlie granodiorite. The sediments have furnished an abundant pollen flora, determined by Estella Leopold (written communication Mar. 25, 1971) as probably Oligocene. Farther west, on Big Springs Creek, a face exposed in an open pit for Uranium. Here clayey pumiceous tuff rests on granodiorite, dipping steeply southeast. This is overlain by a lenticular tuffaceous agglomerate with heterogeneous volcanic boulders. This in turn overlain by a vitrophyre, fragmental at the base, welded toward the top. The top of the cliff is a dosemic hornblende-biotite vitrophyre. Underlies typical tuff of Haystack Creek. The hornblende-biotite vitrophyre is a phenodacite, containing andesine, biotite and hornblende in a typical vitroclastic welded texture. The vitrophyre next below is a typical hypersthene-augite phenodacite welded tuff.

Biotitic phenorhyodacite ignimbrite

3

(Trb)



Biotitic phenorhyodacite ignimbrite

(TRb)

An ignimbrite, ~~phenocrysts~~ with a small proportion of phenocrysts of red-brown biotite, partially resorbed, and of ~~plagioclase~~ oligoclase, plus ~~zircon~~ accessory zircon, magnetite and apatite. Generally pale red-brown in color, groundmass has typical collapsed-shard structure, with pectinate ~~recrystallization~~. Less than ~~100~~ 30 meter s in thickness everywhere.

*biotite* Phenorhyodacite of Huber Hill  
(Thh)

3

## Biotite phenorhyodacite of Huber Hill

Occurs as the volcanic dome of Huber Hill, in the southwest quadrant of the Mountain City quadrangle. Pale grayish red to pale pinkish gray biotite phenorhyodacite, with sparse phenocrysts, mostly under  $\frac{1}{8}$  mm in size, of black biotite, reddish brown and partly resorbed in section, and of oligoclase. Groundmass generally cryptocrystalline. As mapped may include some ignimbrite of similar lithology.

Tuff of Harris Gulch  
(Tng)

3



## Tuff of Harris Gulch

(Thg)

Biotite phenorhyolite tuff, with quartz, plagioclase, biotite and sanidine. Apparently accumulated in a complex graben extending from Harris Gulch, east of Mountain City, to near the old Bieroth Ranch, on California Creek. Biotite locally bleached and altered to vermicular kaolinite; secondary barite present locally. This alteration is believed related to the gold-silver mineralization at Mountain City. Sanidine from the tuff was dated by J. C. von Essen (written communication Oct. 15, 1969) at  $30.1 \pm 1$  m.y. This is believed to reflect the date of eruption, but alteration and mineralization dates may not differ in age by much.

Butler Ranch phenorhyolite vitrophyre 3

(Tbr)

Butler Ranch phenorhyolite vitrophyre

(Tbr)

Massive ~~glassy~~ pale gray vitrophyre, locally perlitic, poor in rhyolite, sanidine, quartz and oligoclase. Forms a dome near Butler Ranch (Bieroth Ranch on map) and may also form some ignimbrites, that tuff of may be interbedded with Harris Gulch.

Mustang Butte Gravel

(Tmb) 1, 2



## Gravel of Mustang Butte

(Tmb)

Chiefly coarse, poorly sorted boulder gravel, with angular fragments of granodiorite, Reservatim Hill Formation, and Nelson and Banner Formations. Includes one thin ~~bed~~ ignimbrite that is a hornblende-biotite phenocryst welded tuff, with phenocrysts of biotite, hornblende, quartz, plagioclase, accessory amounts of zircon, apatite, and perrierite. ~~This was~~ Biotite from this bed was ~~dated at~~ was assigned an age of 38.0 million years by E. H. McKee (McKee and others, 1976 date no. 20). ~~XXXXXX~~ Locally, the gravel may include some masses of tuff and gravel that are Miocene in age, post-dating the Jarbidge Rhyolite. These have not been separated in mapping.

Phenodacite and phenoandesite tuff of ~~Salmon Springs~~  
Salmon Springs *4* 1, 2

(Tsd)

Phenocryst and phenocryst ignimbrite  
of Salmon Springs

Crystal-vitric ignimbrite, generally recrystallized, and relatively fine in grain size, one phase consisting of quartz, plagioclase and biotite, locally with sanidine, the plagioclase generally oligoclase; another ~~unit~~ cooling unit includes plagioclase, biotite, green hornblende, augite, and hypersthene. Rests on ignimbrite of Reed Creek, locally overlain by gravel of Mustang Butte.

*phenocrysts*

~~Rhyolitic~~ ignimbrite of Reed Creek

1, 2

Phenorhyodacite    Ignimbrite of ~~Red~~ Reed Creek  
(Tro)

Phenocrysts abundant, principally q uartz, plagioclase, and biotite,  
locally with hornblende. Magnetite, apatite, and zircon common accessories.

One sanidine and one biotite from separate localities gave an age of  
 $39.6 \pm 2.0$  m.y., (Eocene or Oligocene ) by K-Ar Analysis (John Obradovich,  
written communication, 1965, Lab Nos. DKA -1073 and -1070), Locally  
opalized, bleached and iron stained.



Andesite of Russel Gulch

(Tar) 2, 3

1.C. Pheno Andesite of Russel Gulch

(Tar)

pheno

Black, vitrophyric, andesitic welded tuff, with andesite, a gite, and hypersthene, plentiful apatite and magnetite, rare zircon, biotite, and green hornblende. Where devitrified, black to brown felsophyres. At base, locally, small amounts of rhyolitic airfall tuff.

Phenocryst ignimbrite of Rabbit Draw  
(Trd) (3)



Phenocrhyolite ignimbrite of Rabbit Draw

(Trd)

White biotitic airfall and welded tuff, with dark smoky quartz, black biotite, sanidine, and oligoclase. Rests on Ordovician volcanic or Mesozoic plutonic rocks; underlies andesite of Russel Gulch.

of Peck Ranch (Gravel)

(Tpr) (3)

Gravel of Peck Ranch

(Tpr)

Cobble gravel, overwhelmingly made up of tan-weathering jasperoid apparently derived from the Van Duzer Limestone of Decker, where the limestone has been silicified near the ~~R/berts Mountains~~ Lime Creek Thrust. Overlain by tuff and sedimentary rocks of Allegheny Creek.



Andesite of Rocky Gulch  
(Trg) (g)

Andesite of Rocky Gulch

(Trg)

Pyroxene andesite porphyritic, holocrystalline, with plagioclase (andesine to labradorite, with oscillatory zoning, augite, hypersthene, and magnetite. The groundmass contains plagioclase, hypersthene, magnetite, and alkali feldspar.

Ranber Station Andesite near the

(Trs) 3

Andesite near the Ranger Station

(Trs).

Dark gray, porphyritic, dopatic ~~phenocryst~~ hornblende phenocandesite, plagioclase (An<sub>70-75</sub>) and hornblende, olive green to brown in thin section, with 0.03 mm resorption border, apatite, and magnetite. Groundmass cryptocrystalline, plagioclase, clinopyroxene (?) and sanidine(?) , about 0.001 mm. Lies just beneath the andesite of Rocky Gulch, and presumably conformable with it.



Volcanic and sedimentary rocks of Jones Creek

(Tjo)<sup>2</sup><sub>3</sub> #

Includes Da cite of Jones Creek (Tjd) /



## Volcanic and sedimentary rocks of Jones Creek

(Tje)

The principal part of the formation consists of flows and tuf-breccias of pyroxene andesite, hornblende-pyroxene andesite, hornblende-augite andesite and hornblende andesite, in descending order of frequency of occurrence. These rocks are dark gray to medium gray, commonly porphyritic. Gray airfall tuffs are locally present. Total thickness may be several thousand feet. At base, a phenocrystic ignimbrite, Tjd, compact to moderately compact, with conspicuous phenocrysts of plagioclase, augite, hypersthene, hornblende and biotite, grading by increase of quartz and sanidine into a phenorhyodacite.

Phenodacitic ignimbrite of Haystack Creek (3,

Phenodacitic ignimbrite of Haystack Creek.

(The)

Black, biotite-hornblended-pyroxene phenodacitic vitrophyric welded tuff. Phenocryst rich, with well-marked shard structure.

Plagioclase is oligoclase ( $An_{33-37}$ ) . A K-Ar age measured on biotite by E. H. McKee was 42.3 m.y.

*1971/1972*  
~~Phenocandates~~ of Yankee Bill Summit

1. 2

(Tyb)

## Ignimbrites of Yankee Bill Summit

Welded phenoandesite and phenodacite tuff, ranging from light brown to black, ~~is~~ dosemic to semihyaline, glassy constituents now partly crystallized with pectinate structures. Phenocrysts plagioclase hypersthene commonly, augite, and hornblende ~~are~~ sparse, biotite and hornblende rare. Magnetite and apatite nearly ubiquitous. May include flows equivalent to the phenoandesite of Russell Gulch.



Micaceous ~~tuff~~ *ignimbrite* 1.  
(Tmt)

Includes underlying gravel (tmg)

Micaceous ~~tuff~~/ignimbrite

(Tmt)

Includes underlying gravel in places (Tmg)

Found only on west slope of Alder Mountain, near base of Tertiary section.

Medium gray vitrophyric crystal-vitric welded tuff, with marked  
fissility. ~~Characterized by~~ Phenocryst -rich, with andesine (An<sub>37-46</sub>),  
biotite, hornblende, hypersthene, a gite. Minor magnetite, quartz, ~~a~~  
apatite and ~~magnetite~~ zircon. Not more than 50 feet thick. Locally  
underlain by gravel, Tmg. Date of 43.5 m.y. determined on biotite from  
tuff by John Obraiovich (DKA 1074).



Andesite of Summit Creek  
(Tsa)

2, 3

Includes ~~xxxxxxx~~ the  
underlying airfall tuff, (Tst)

2, 3

Andesite of Summit Creek

(Tsa)

Locally includes also underlying phenocrystic airfall tuff, Tst

Largely pyroxene andesite and pyroxene-hornblende -biotite andesite.

Also biotite pyroxene dacite vitrophyre.

*andesite ignimbrite*  
1.2 Phenolite of Salmon Creek  
(Tsl) biotite

Includes also the vitrophyre of Alder Mountain  
/ (Tab), and *1/4* ~~phenolitic~~ *andesitic* breccia (Tlb) /

Phenoandesite ignimbrite of Salmon Creek

(Tsl).

Includes also the biotitic vitrophyre of Alder Mountain (Tab)  
and phenoandesitic breccia (Tlb)

Light gray to light brownish red ignimbrites; ~~common~~ but sparsely occurring phenocrysts are biotite and plagioclase, some units also have hornblende. Magnetite, apatite and zircon are common accessories. ~~PH~~ Most units have undergone vapor-phase recrystallization and consequently have lithic groundmass textures. An exception is the biotite vitrophyre of Alder Mountain, Tab, in which the groundmass is glassy. The phenol~~atitic~~ andesitic breccia may be a crumble breccia or a mudflow.

Granite(in the broad sense)  
(Kg)

623

Includes granodiorite and quartz monzonite of some authors,  
also includes aplite (Ka) , Pegmatite (Kp) and Migmatite,  
(Km)

Granite (in the broad sense, according to  
Steckeisen [1967])

Includes granodiorite and quartz monzonite of previous usage;  
~~microcline-microperthite~~  
includes marginal aplitic material; Ka, not everywhere separately mapped.

Some pegmatite, Kp, not everywhere separately mapped. Migmatitic zones  
adjacent to country rock, Km, not everywhere separately mapped. Generally character-  
ized by biotite and hornblende, locally with perthitic orthoclase ~~ph~~/ megacrysts.



Diorite, quartz diorite, and granodiorite /

(Jd)

Jd

Diorite , quartz diorite, and granodiorite.

Includes diorite consisting of andesine, and hornblende, with accessory apatite and sphene, secondary chlorite clinoisite, calcite and sphene.

Post shearing suggested by partial recrystallization of hornblende to paleo green actinolite. Also includes hornblende-biotite quartz diorite.

A sample of biotite from the Enright Hill Stock was dated by E. H.

McKee (written communication, 1979) at  $110.9 \pm 1$  m.y. The shearing and partial recrystallization of hornblende from this body suggest that the age may have been modified by subsequent metamorphism and the effect of adjacent Cretaceous intrusions; for this reason an age of Jurassic(?) is assigned.

Reservation Hill Formation

~~XIPERY~~ (PPrh)

Reservation Hill Formation (Permian(?) and Pennsylvanian(?))

(PPrh0)

1, 2, 3, 4

Reservation Hill Formation (Permian(?) and Pennsylvanian(?))

(P.P.H.)

Mostly fine-grained dolomitic sandstone or siltstone, ~~white~~ pale gray, weathering white or pale reddish brown, in beds ~~1/2 to 1/4~~ 2 cm to 5 cm thick, interbedded regularly with thinner beds of graphitic phyllite. The dolomitic sandstone is metamorphosed to rocks composed of various combinations of quartz, calcite, tremolite, diopside, and wollastonite, the last locally coarsely prismatic. Also metagreywacke, micaceous and tremolitic quartzite, rare metachert and quartzite, meta-andesite, now metamorphosed to actinolite-epidote-plagioclase schist, or hornblende plagioclase schist. A few lenses of gray, siliceous dolomitic limestone, locally with coarse calcitic "eyes" suggesting former presence of crinoids.

Diamond Peak and Chairman Formations, undivided

( Mdo)

14  
~~124~~



Diamond Peak and Chainman Formations, undifferentiated

Mdc

In the northeast and southeast quarters of the 15' quad angle, the Diamond Peak and Chainman appear to intergrade; in the extreme southeastern corner of the quadrangle only a medium grained dark, massive sandstone is present, which is poorly fossiliferous but has been correlated with the Diamond Peak. West ~~of Enright~~ and south of Enright Hill, in the northeast quarter, the sandstone facies is more fossiliferous, and the age assignment is on a firmer basis.

~~Diary and Beak and~~ Chairman Formations, ~~undifferentiated~~  
(Mc) (etc) Mc

no number  
inserted in 1, 2, 3, 4.

### Chairman Formation

Included the Mountain City Format on (Gaatz, 1971). Largely quartz-muscovite biotite schist, locally with orthoclase, garnet, or graphite, rarely with andalusite, when thermally metamorphosed. In the western part of the quadrangle, includes thin limy beds, up to 2 feet thick, now rocks composed of various combinations of quartz, calcite, diopside, tremolite, and clinozoisite, orthoclase, and muscovite. In the eastern part of the quadrangle, contains a higher proportion of limy rocks. A ~~few thin~~ beds, generally thin, of metarhyolite tuff, now quartz-plagioclase-orthoclase hornfels. In the northwest of Merritt Mountain, thicker masses of tuff are present. In the southeastern quarter of the 15' quadrangle, includes much medium-grained, impure, poorly bedded sandstone that has furnished a brachiopod fauna.



Nelson Formation  
(Mn)

12.9

### Nelson Formation

At the base, locally an extrusive breccia, possibly a peperite, with limy matrix, locally fossiliferous. Flows ~~of~~ and tuff-breccias of andesitic and basaltic composition. Also minor sills of diabase and one lens of rhyolitic tuff. Now largely a green schist of tremolite-actinolite, chlorite, epidote, calcite, ilmenite, and relict andesine, in part altered to albite.

In the northern part of the Mountain City 15' quadrangle, amphibolite schist.

Banner Formation

1,3

Mb



Banner Formation (Mississippian)

... — Black slate member underlain by soft massive bluish-gray limestone, containing solitary and colonial corals, brachiopods, and bryozoans. Grades downward through medium- to fine-grained brownish quartz arenite and gray tan-weathering siliceous siltstone through arenaceous limestone into conglomerate with rounded white quartzite boulders as much as 6 inches in diameter. <sup>15 cm</sup> Maximum thickness

40-200 meters. overlies Valmy and Grossman Formations, underlies Chainman Formation

Grossman Formation  
(Mg)

1/4

Grossman Formation (Mississippian(?))  
(Mg)

Coarse conglomerate with clasts of gray quartzite, black chert, phyllite, and magnetitiferous siltstone. Sandstone, siltstone, and phyllite. Formerly regarded as Devonian or Mississippian, but presence of numerous clasts derived from the Valmy suggests that it is younger than the Antler Orogeny. It underlies unconformably the Banner, of Osagian or Meramecian age (MidMississippian).

Valmy Formation

1, 3, 4

(Ov)

Includes quartzite, Ovq, and greenstone, in part derived from gabbro (Ovg).

## Valmy Formation

Ov

*Valmy Formation.* — Micaceous quartz-calcarenite and calcareous sandstone, locally containing phyllocarid shells and small lenticular masses of thin-bedded chert with slaty partings, and ranging in color from light to dark gray, rarely black or grayish green; locally phosphatic or baritic. Also contains hard well-bedded micaceous siltstone and black quartzose phyllite. Numerous irregular masses of greenstone (meta-andesite), now quartz-albite-chlorite schist, and of gabbro and diabase, in which original texture and some of the primary pyroxene and plagioclase are preserved. ~~Micaceous phyllitic limestone,~~ locally phosphatic. Also includes quartzite, gray to black, locally tan, fine-grained with interlocking textures, rare detrital tourmaline and zircon and, in the dark-colored quartzite, black carbonaceous material interstitially and disseminated through the quartz grains.

Strathearn Formation  
(PPs)

4



Strathearn Formation (Pennsylvanian and Permian)

~~xxRiiPxx~~ ~~BXXZZ~~ ~~(Pxx)~~

In the Rowland and Mt. Velma quadrangles, Bushnell (1967) and Coash (1967) described a unit, including conglomerate, sandstone, and clastic limestone, of Pennsylvanian and Permian age, as the Sunflower Formation. This is here regarded as the equivalent of the Strathearn Formation. It crops out in the Mountain City quadrangle only in the southeastern corner. The conglomerate member of the Sunflower consists of quartzite- and chert-pebble conglomerate, quartzite, and sandstone. The rocks characteristically weather brownish gray and grayish red. The middle limestone member has a thickness of 530 feet in the Mt. Velma quadrangle (Bushnell/ Coash, 1967). It is medium to dark gray, weathering dusky yellow. It grades into the underlying conglomerate member. The upper sandstone member is conformable on the limestone member. In the Mt. Velma quadrangle (Coash, 1967) it comprises about 1400 feet of fine-grained sandstone, micaceous siltstone, and thin beds of silty limestone.

Van Duzer Limestone  
(Pvd)

34

Van Duzer Limestone

(Pennsylvanian)

(Pvd)

~~Van Duzer Limestone.~~ — Dominantly thin bedded to very thin bedded medium- to dark-gray calcarenite and quartzose calcarenite, locally grading to quartzite. Chertification of calcareous beds is common. Minor flows of meta-andesite, now chlorite-muscovite-albite calcite schist. Thin films of micaceous and graphitic material form laminae within the thicker calcareous beds. Van Duzer Limestone was defined by Decker (1962, p. 29-21, pl. 1) for rocks in Van Duzer Creek, the type locality. The type section is designated the ridge top in secs. 6 and 7, T. 44 N., R. 53 E. The total thickness is about 7,000 feet. No direct evidence for the age of the Van Duzer Limestone has been found; its age is inferred from its position in a sequence of four formations, none of which has furnished paleontologic evidence. An upper limit is set by the Mississippian(?) age of the Roberts Mountains thrust.

A single fossil locality from Trail Creek, just ~~xxxxx~~ south of the southwest corner of the Mountain City quadrangle, furnished brachiopods and corodonts, with ages that overlapped in the Des Moinesian.

Goodwin Limestone

(Og)

no number,  
if inserted in 1, 2, 3, 4

Goodwin Limestone of the Pogonip Group

(Og)

Massive, ~~light~~ white to light gray or light pinkish gray calcarenite, sparse fragments of clastic quartz suggest a calcarenitic origin. Now sheared and recrystallized, locally silicified to a sjasperoid.

Tennessee Mountain Formation of Bushnell  
(O<sup>CM</sup>)

4



Tennessee Mountain Formation of Bushneell (1967)

(00 tm)

Highly deformed, interbedded thinly-bedded limestone and argillaceous rocks. Limestone typically thin beds of medium-gray aphanitic limestone and silty limestone separated by very thin phyllite laminae. Phyllite beds from 10 to 50 feet thick locally interbedded with the limestones. Phyllite ranges in color from yellowish gray to greenish to gray-green. Cleavage has obliterated the bedding in the phyllite. Two collections of fossils from the formation in the Mountain City quadrangle were examined by A. R. Palmer, who determined the age of one collection as probably Cambrian or Lower Ordovician.



