U.S. DEPARTMENT OF THE INTERIOR
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PRELIMINARY GEOLOGIC MAP OF THE URSINE AND DEER LODGE CANYON QUADRANGLES, LINCOLN COUNTY, NEVADA, AND IRON COUNTY, UTAH

by

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UNIT DESCRIPTIONS

[Divisions of Pleistocene time are from provisional ages reported in Richmond and Fullerton (1986). Age assignments for surficial deposits are based chiefly on the degree of post-depositional modification of original surface morphology and degree of soil development, especially the morphology and thickness of calcium carbonate-enriched horizons. Stages of soil carbonate morphology correspond to those described by Gile and others (1966). Dry colors of the less-than-2-mm size fraction of surficial deposits were determined by comparison with Munsell Soil Color Charts (Munsell Color, 1973)].

Hill-slope deposits--Boulder to sand-sized rock fragments that have weathered out from bedrock or alluvium, moved downslope through creep and slopewash, and accumulated on hill slopes. Two types of hill-slope deposits have been mapped, but the hill-slope deposits in most areas have not been distinguished from the underlying bedrock.

Qt **Talus (Holocene)**--Hill-slope deposits of angular fragments of rhyolite derived from the rhyolite lava-flows member of the Blawn Formation (Tbr) in south-central part of map area and from andesite lava flows (Ta) along western edge. Rock fragments range from sand-size to boulders 1 m in diameter. Matrix is generally coarse sand, but locally there is no matrix. Thickness less than 5 m

Qc **Gravelly colluvium (Holocene and late and middle Pleistocene)**--Hill-slope deposits of unsorted, unstratified, subrounded to subangular, light-gray to reddish-brown volcanic pebbles, cobbles and boulders as large as 50 cm in a matrix of reddish-brown angular sand. Consists of a thin mantle of debris eroded from older alluvial deposits (QTf, Qp1, Qp2, Qs1, Qs2) and transported down hill slopes chiefly by creep. Generally overlies early Pleistocene and Pliocene fan alluvium (QTf) and Tertiary lacustrine basin-fill deposits (Te). Older deposits have a calcic soil horizon with laminated calcium carbonate in the upper part. The laminations parallel the hill slope. Calcium carbonate cements the oldest colluvium and completely fills interstices to 1 m depth. Thickness less than 5 m

Stream deposits--Silt, sand, and gravel that fill channels and form floodplains and terraces along Meadow Valley Wash and minor streams

Qal **Alluvium of ephemeral streams (Holocene)**--Channel and floodplain alluvium of small, ephemeral streams. Very pale brown (10YR 7/3) pebbly sand, moderately bedded and poorly sorted, intercalated with lenticular beds of channel-cross-bedded, sandy, pebbly, cobble gravel. Unit also includes alluvium and colluvium in small fans along valley sides. Maximum thickness about 3 m

Qsa **Floodplain and channel alluvium of Meadow Wash (Holocene)**--Floodplain deposits are interbedded very pale brown (10YR 7/3) pebbly sand, gray

(10YR 6/1) clayey silt, and dark-gray (10YR 4/1), organic-rich, clayey silt. Moderately well-bedded and poorly sorted with horizontal beds averaging about 0.5 m thick. Locally intercalated with the floodplain deposits are sparse channel deposits of channel-cross-bedded, sandy, pebbly, cobble gravel. Active channel generally incised as much as 1.5 m below floodplain surface but locally incised 4 m. Young organic-enriched soil horizons about 10 cm thick are formed in the upper part of the floodplain deposits. Maximum thickness greater than 5 m

Old stream alluvium of Meadow Valley Wash (late Pleistocene and middle Pleistocene)--About 60 percent very pale brown (10YR 7/3) pebbly coarse sand intercalated with lenticular beds of rounded to subrounded cobbles and pebbles that average 0.3 m thick and make up about 40 percent of the unit. Cobble beds are clast-supported, channel-cross-bedded, and moderately well-sorted. Clasts are predominantly light-gray to reddish-brown volcanic rocks, but include some very dark gray Paleozoic limestone. Gravel clasts average 7 cm in diameter, but include some boulders as large as 50 cm in diameter. Deposits are relics of two former, higher, relatively stable, local base levels. Lack of deposits at levels intermediate between the two indicates a long period during which local base level was not stable and Meadow Valley Wash incised 38 m. Since deposition of the lowest terrace deposits, another, shorter, period of lowering base level has caused Meadow Valley Wash to incise 12 m

Qs1 **Lower old stream alluvium (late Pleistocene)**--Forms benches on the east side of Eagle Valley about 12 m above the modern floodplain. Surface soil is slightly calcareous, and clasts within 20 cm of the surface have a calcium carbonate rind less than 3 mm thick on the underside. About 5 m thick

Qs2 **Higher old stream alluvium (middle Pleistocene)**--One isolated deposit capping a small bench on bedrock at 1720 m elevation, about 50 m above the modern floodplain just north of the narrow canyon between Eagle Valley and Rose Valley. Graded to the top of the bedrock ridge incised at Echo Canyon, 4 km to the south. Depositional form and soil largely obliterated by erosion, but identifiable by smoothly rounded cobbles of heterogeneous volcanic rocks. Locally the surface is littered with fragments of laminated pedogenic calcium carbonate eroded from a calcic soil horizon near the ground surface. Less than 4 m thick

Fan and pediment alluvium (Holocene to middle Pleistocene)--Fan-shaped deposits of sand and gravel. Pediment deposits thinly mantle relatively smooth pediment surfaces cut on underlying Tertiary lacustrine deposits (Te). Fan deposits are much thicker relative to their area of deposition, and may bury irregular erosional surfaces. Includes alluvium of active pediments and fans, alluvium on two generations of inactive pediments that was deposited when local base level stabilized at levels about 12 and 25 m higher than the present local base level for Meadow Valley Wash, and old alluvium in inactive fans that was thickly and extensively deposited during a period of aggradation when the upper level of deposition was about 130 m above the present floodplain of Meadow Valley Wash.

Qpa **Young fan and pediment alluvium (Holocene)**--Beds of fine pinkish-gray (7.5YR 7/2) subangular sand intercalated with lenses of poorly sorted, channel-cross-bedded, clast-supported, pebbly sand. Pebbly sand lenses make up about 20 percent of deposits. Calcareous and unconsolidated. Pebbles are heterogeneous volcanic rocks averaging 1 cm diameter but are as large as 6 cm. Unit has a sandy surface layer and no soil development. Where the deposits are derived primarily from old alluvial fan gravels (Fan alluvium of Flatnose Wash, QTf) with little contribution from fine basin-fill deposits of Eagle Valley (Te), as in the northeastern 1/4 of sec. 14, and the southeastern 1/4 of sec. 11, both in T. 1 N., R. 69 E., the gravel content is much greater, the gravel coarser, and the depositional surface is covered by a pavement of closely spaced cobbles. Thickness generally less than 2 m, but locally as thick as 5 m

Old pediment alluvium (late Pleistocene and middle Pleistocene)--Poorly sorted, poorly bedded, clast-supported, sandy pebble and cobble gravel that thinly mantles relatively smooth pediment surfaces cut on underlying Tertiary lacustrine deposits (Te). Gravel is predominantly light-gray to reddish-brown volcanic rocks reworked from older alluvial fan deposits (QTf). Gravel clasts are subrounded to subangular and average 3 cm in diameter, but include boulders as large as 50 cm. The sandy matrix is reddish-brown (5YR 5/3).

Qp1 **Lower old pediment alluvium (late Pleistocene)**--Mantles surfaces graded to a former base level about 12 m above the present level of Meadow Valley Wash. Soil is slightly calcareous, and clasts within 20 cm of the surface have a calcium carbonate rind less than 3 mm thick on their undersides. About 2 m thick

Qp2 **Higher old pediment terrace alluvium (middle Pleistocene)**--Mantles surfaces graded to a former base level about 25 m above the present level of Meadow Valley Wash. Strongly developed calcic soil includes a reddish-brown (5YR 5/4) argillic horizon from about 10 to 25 cm depth, laminar calcium carbonate (stage IV) from about 25 to 45 cm depth and a wavy, gravelly, carbonate-enriched horizon (stage III) that is locally strongly cemented from 45 to 200 cm depth. About 2 to 5 m thick

QTf **Fan alluvium of Flatnose Wash (early Pleistocene? and Pliocene?)**--Poorly sorted, clast-supported, cobble and boulder conglomerate interbedded with less than 50 percent light-brownish-gray (10YR 6/2), coarse, angular, pebbly sand. Gravel beds are prominently cross-bedded in channels averaging 10 m wide and 1 m deep and are commonly strongly cemented by calcium carbonate, especially near the base and the top of the unit. Clasts are predominantly light-gray to reddish-brown volcanic rocks derived from the bedrock of the mountains to the east and north. Gravel clasts are subrounded to subangular and average 7 cm in diameter, but include boulders as large as 50 cm. Very strongly developed calcic soil is exposed at the top of the unit in a few localities. Laminar layers of calcium carbonate (stage IV) in the upper 1.5 m strongly cement the soil and retard downward movement of water. Strong cementation by pedogenic calcium carbonate extends deeper than 7 m, completely permeating gravel beds (stage III) and partly engulfing the few sand beds in a web-like network of calcium-carbonate filled fractures (stage II).

In the Ursine quadrangle this unit grades downward conformably into the underlying basin-fill deposits of Eagle Valley (Te), which are predominantly lake deposits of silt and fine sand. Deposited as alluvial fans in a closed basin that contained a lake along its western margin. During the final stages of deposition, the Eagle Valley basin was filled to the level of the threshold separating it from the adjacent Lake Valley basin to the west, and the depositional surface in the Eagle Valley basin became graded to the fill in the Lake Valley basin. This depositional surface is extensively preserved more than 130 m above modern drainage levels. It extends from fan apices near 2000 m elevation along the eastern side of the Ursine quadrangle down to 1770 m elevation near the western edge of the Ursine quadrangle. In the Deer Lodge Canyon quadrangle, deposits of this unit are generally thinner and were graded to depositional levels in the open Escalante Desert basin to the east. Depositional surfaces occur at two levels, a few surfaces are graded to the same level as surfaces in the Ursine quadrangle, but most of the deposition surfaces in southwestern Deer Lodge Quadrangle are graded to a level about 60 m higher, implying that they are older than the surfaces in the Ursine Quadrangle. Maximum thickness greater than 65 m

Lake deposits--Mostly silt and fine sand that accumulated in a body of still water in the ancestral Eagle Valley. The lake was probably formed by the same events that produced lakes downstream in the Panaca and Lake Valley basins, and perhaps was an arm of the Panaca Lake. Uppermost part of the deposit represents a transition from lacustrine to alluvial deposition and includes some coarse sand and gravel.

Te **Basin-fill deposits of Eagle Valley (Pliocene? to upper Miocene?)**--Mostly poorly to moderately consolidated, thin-bedded, pink (5YR 7/3) sandy silt and silty sand coarsening upward to pinkish-gray (7.5YR 7/2) interbedded coarse sand and pebbly cobble gravel. Includes at least 5 pinkish-white (7.5YR 8/2) tephra beds 20 to 150 cm thick, and common reddish-yellow (5YR 7/6), pumice-rich, sandstone beds within a 17-m-thick zone, the top of which is 28 m below the top of the unit. Silt-rich beds are noncalcareous to weakly calcareous. A few thin sandstone beds in the lower part and cobble conglomerates near the top are strongly cemented by calcium carbonate. Unit is conformable with and grades into the overlying fan alluvium (QTf). The proportion of pebble and cobble beds increases upward, and the contact is drawn at the level where such beds make up the majority of the map unit. This contact generally occurs between 1780 and 1800 m elevation, and locally it is marked by strongly cemented cobble and boulder conglomerate beds that form a rimrock protecting cliffs of alternating sand and gravel beds. Unit is probably correlative with Panaca Formation in the Panaca basin 18 km to the southwest (Rowley and Shroba, 1991). Exposed thickness 110 m

-C- **Tephra layer C (Pliocene)**--3-cm-thick, white, ash-fall deposit of fine-sand and silt-sized glass shards and biotite overlain by 28 to 60 cm of pinkish-gray reworked tephra locally cemented by calcium carbonate. The third lowest tephra layer found. Consistently 10.4 m above tephra layer A. Bed can be consistently traced, but its purity and contrast with deposits above and below varies along outcrop but are generally less than for tephra layer A. Beds above and below layer C contain as much as 35 percent white pumice fragments averaging about 5 mm diameter but including some as large as 8 cm. One 8-cm long pumice clast was found within the ash-fall layer. Electron microprobe analyses indicates that the major element composition of glass shards in the tephra is somewhat similar to that of the Point of Rocks tuff near Lathrop Wells in southwestern Nevada. Seven radiometric ages determined for the Point of Rocks Tuff vary from 142 Ma to 11.5 ± 1.3 Ma, but most of the samples are thought to be contaminated with older grains, so the actual age is probably much less than 12 Ma (Andrei Sarna-Wojcicki, 1992, written commun.). Tephra layers observed 5.3 m (D) and 6.4 m (E) above, and 7.6 m (B) below tephra layer C could not be consistently traced and mapped.

-A- **Tephra layer A (Pliocene)**--3-cm-thick, white, ash-fall deposit of fine-sand and silt-sized glass shards and biotite overlain by 17 to 150 cm of pinkish-gray reworked tephra, generally laminated, but showing ripple marks in exposures near the center of sec. 14, T. 1 N., R. 69 E.. Generally nearly horizontal, but drops southward from 1735 m elevation at northernmost exposure to 1733 m just north of Immigration Wash, and 1725 m just south of Immigration Wash. The lowest tephra layer found and the one with the most consistent and distinct basal ash-fall bed.

Steamboat Mountain Formation (Miocene)--Bimodal assemblage of high-silica rhyolite and basaltic trachyandesite (IUGS classification of Le Maitre, 1989) of middle Miocene age (12 to 10 Ma) first recognized and described to the east of map area (Best, 1987; Best and others, 1987b; 1987c). Consists of informal members, only the rhyolite of which is exposed in map area

Tsr **Rhyolite lava-flows member**--Light gray, pale pink, and very pale purple lava flows and domes. Mostly aphanitic and slightly porphyritic but locally vitrophyric and flow-layered and in a few places contain small (less than 1 cm diameter) spherulites and lithophysae. Phenocrysts make up less than 10 percent of rock and include quartz and lesser plagioclase and sanidine; biotite is rare. Vapor-phase quartz and topaz less than a few millimeters long occur in rocks along eastern margin of map area. Vapor-phase quartz and spessartine garnet as much as 3 cm in diameter occur in large flow extending southwestward from Mahogany Peak. Fission track age of zircon from lava flow in adjacent Prohibition Flat quadrangle to south is 11.7 ± 1.0 Ma (Best and others, 1991). Thickness as much as 200 m

Tr **Rhyolite of Deer Lodge Canyon**--White to very light gray rhyolite dike exposed between head of Deer Lodge Canyon and Nevada-Utah state line. Flow-layered, slightly altered, and contains less than 10 percent phenocrysts of quartz and feldspar in a microcrystalline matrix. Possibly a feeder to rhyolite lava-flows member of Steamboat Mountain Formation (Tsr)

Tt **Clastic rocks (Miocene)**--Heterogeneous sequence of porous, generally weakly consolidated pyroclastic, reworked pyroclastic, and epiclastic deposits that mostly underlie the rhyolite lava-flows member of the Steamboat Mountain Formation. Generally poorly exposed, manifest only as pebble- and cobble-size pieces on hill slopes, except northward of Little Summit to Serviceberry Canyon where bedded ledges are widespread. Exposures are inadequate to map contact between upper part, which at least locally is probably Steamboat Mountain age, from lower part that is correlative with tuff member of the Blawn Formation (Tbt). Unit is most commonly a very light gray to pale yellow-brown, partially welded, crystal-poor, lapilli ash-flow tuff that contains sparse phenocrysts less than 2 mm in diameter of quartz, feldspar, and sparse biotite. Lapilli and blocks of pumice and dark volcanic rock are common and locally make up nearly one-half of rock. Tuff was probably mostly emplaced during explosive eruptions that preceded extrusion of rhyolite lava-flows members of the Steamboat Mountain and Blawn Formations (units Tsr and Tbr). In some places, tuff is seen to grade upward into bedded, reworked pyroclastic and epiclastic deposits that include very light brown to very light gray, crudely stratified and sorted to well-bedded and locally cross-bedded, well-sorted sandstone, conglomerate (volcanic clasts as much as 10 cm in diameter), and minor siltstone. Siltstone is locally prominent in upper part of unit where it may be correlative with Te. Thickness as much as 140 m

Blawn Formation (Miocene)--An assemblage of high-silica rhyolite and trachyandesitic rocks (IUGS classification of Le Maitre, 1989) of early

Miocene age first recognized and described to the east of map area (Best, 1987; Best and others, 1987b; 1987c; 1989c) and also to north (Willis and others, 1987) where it consists of informal members of rhyolite tuffs, rhyolite lava flows, rhyolite intrusions, mafic lava flows, and minor epiclastic deposits. None of the mafic lava flows are exposed in map area. Isotopic ages of rhyolitic units in areas to east and north range from 24 to 18 Ma

Tbr **Rhyolite lava-flows member**--White, very light gray, and pinkish-gray aphanitic rhyolite lava flows and domes. Locally black, brownish-black, and dark-green perlite. Differ from rhyolite lava flows of younger Steamboat Mountain Formation in that the Blawn (1) is generally more crystal-rich and consists of 10 to 20 percent phenocrysts of quartz, plagioclase, sanidine, and minor biotite, (2) commonly weathers to a pavement of angular fragments 1 to 2 cm in diameter, (3) is not as pervasively flow-layered, and (4) has rare lithophysae and spherulites that are larger (5 to 15 cm) and commonly lined with chalcedony or clear quartz. The most distinctive difference in the field is that biotite is rarely seen in hand samples of the Steamboat Mountain rhyolite lava flows but is conspicuous in the Blawn; this distinction is consistent to the east (Best and others, 1987b) of the map area. Locally, base of unit includes a few meters of tuff of Gold Springs member (Tbg). Fission track age of zircon on unit just to south of map area is 16.5 ± 1.4 Ma (Best and others, 1991). Thickness as much as 230 m

Tbri **Rhyolite intrusive member**--Light-gray to very pale purple porphyritic rhyolite dikes and other shallow intrusions. Phenocrysts make up about 20 percent of rock and include smokey quartz, plagioclase, sanidine, and a trace of Fe-Ti oxides. Minor biotite was also present but a weak to moderate overprint of phyllic-argillic alteration has obliterated most of this phase. Unit 2-3 km northwest of Gold Springs was emplaced in vent area of tuff of Gold Springs member (Tbg) that implies a comagmatic relation of these two members of the Blawn Formation. Minimum isotopic age is 16.5 ± 1.1 Ma (Keith, 1980) on partially altered biotite from an intrusion just to north of map area in the Rice Mountain quadrangle (Keith and others, 1992)

Tbrb **Breccia member**--Dike-shaped lenses of dark-red, pink, and very pale brown clast-supported breccia. Angular to subangular fragments are 0.1-20 cm in diameter and consist of wall rock and rhyolite flows. Commonly silicified and stained by iron oxides and locally by manganese oxides

Tbt **Tuff member**--Very light gray to pale-yellowish-brown, partially welded, crystal-poor, lapilli ash-flow tuff and minor, crudely bedded and sorted, reworked pyroclastic and epiclastic deposits. Tuff contains sparse phenocrysts less than 2 mm in diameter of quartz, feldspar, and minor biotite. Lapilli and blocks of pumice and dark volcanic rock are common and locally make up nearly one-half of rock. Tuff was probably mostly emplaced during explosive eruptions that preceded extrusion of rhyolite lava-flows member of Blawn Formation (unit Tbr). Probably correlative with lower part of clastic rock unit (Tt)

Tbg **Tuff of Gold Springs member**--Moderately welded, very pale purple and pink and brown lapilli ash-flow tuff and minor reworked pyroclastic and epiclastic deposits. Tuff contains about 20 percent phenocrysts of quartz, sanidine, plagioclase, trace of magnetite, and sparse, possibly xenocrystic, biotite. Typically contains 5-10 percent fragments of rhyolite and intermediate composition lava flows (including probably unit Tlf) in addition to compacted pumice. Thickness of unit within Gold Springs depression (see Discussion of Geology) that marks its source is as much as 300 m. Within a kilometer or so of vent, unit is as much as 80 m thick but thins to as little as a few meters in more distant parts of map area

Tsc **Intermediate rocks of Serviceberry Canyon (Miocene) Lava-flows member-**-Dacite and minor rhyolite lava flows that are very light purple and very light gray where devitrified and dark green where glassy. Rocks contain about 25 percent phenocrysts of plagioclase, sanidine, biotite, and trace amounts of Fe-Ti oxides, titanite, allanite, and zircon; quartz and augite occur in places but not together. Bulk chemical composition of flows is variable; weight percent silica ranges from 65 to 72. Unit includes 10-20 m of ash-flow tuff of similar composition that underlies lava flows north of Serviceberry Canyon, where total thickness of unit is as much as 300 m, and just east of Deer Lodge

Tsci **Intrusive porphyry member**--Light-pink, very light gray, and light-green, crystal-rich intrusive rock similar in composition to lava-flows member of intermediate rocks of Serviceberry Canyon. Dikes near Gold Bug Mountain contain phenocrysts of plagioclase, alkali feldspar, quartz, 2-3 percent biotite and minor disseminated pyrite. Large intrusion at head of Serviceberry Canyon appears to be the root of an eroded dome that fed compositionally similar lava flows to west; this intrusion contains only sparse phenocrysts of quartz and no augite. Biotite from this intrusion collected at lat 37°59'19" N. and long 114°03'43" W. has a K-Ar age of 21.0 ± 1.3 Ma (Keith, 1980)

Th **Harmony Hills Tuff (Miocene)**--Light-gray, light-brown, and light-pink crystal-rich, densely to moderately welded, simple cooling unit of andesite to trachyandesite ash-flow tuff (Williams, 1967). About one half of rock consists of phenocrysts, mostly plagioclase and lesser amounts of biotite, clinopyroxene, hornblende, quartz, and Fe-Ti oxides. Rowley and others (1991) suggest the age of unit is about 22 Ma and the source lies to the south in the Caliente caldera complex, or to southeast in the Bull Valley Mountains of Utah. About 20 m thick in northern and western parts of mapped area but possibly as much as 120 m in the southern part near Flatnose Wash

Trt **Rhyolite lava flow of Tobe Spring**--Similar to the rhyolite lava-flows member of Blawn Formation but has more abundant phenocrysts of quartz. Present only along northern edge of map area where thickness is as much as 100 m

Tc **Condor Canyon Formation (Miocene)**--Consists of Bauers Tuff Member and underlying Swett Tuff Member. These members were not distinguished in map area because in most places they are exposed in nearly vertical cliffs. Each is a simple cooling unit of densely welded rhyolite ash-flow tuff that contains less than about 20 percent phenocrysts. Upper light-gray, very light pink, and reddish-brown devitrified part of each contains lapilli and small blocks of white pumice; about 2 m of black vitrophyre lies just above base of each sheet. Bauers (see below) contains phenocrysts of plagioclase, sanidine, minor biotite, and a trace of augite in contrast to Swett which contains only plagioclase and minor biotite. Formation is about 40 m thick on the east side of Rose Valley where in places the thinner Swett Tuff Member pinches out; in the northern part of map area the Swett is absent

Tcb **Bauers Tuff Member**--Contains phenocrysts of plagioclase, lesser sanidine, minor biotite, and a trace of augite and Fe-Ti oxides. Source of Bauers is the Clover Creek caldera (Rowley and others, 1991) and age is 22.78 $\pm$ 0.03 Ma (Best and others, 1989b, Table R3). In the northern part of map area the Bauers is less than 10 m thick but on the east side of Rose Valley may be as much as 40 m

Tlf **Latite lava flows (Miocene)**--Sequence of generally reddish-brown lava flows that contains sparse to abundant phenocrysts of plagioclase, biotite, and clinopyroxene; proportions of these phenocrysts are variable. To south of map area (Best and others, 1991) Bauers Tuff Member of Condor Canyon Formation lies within sequence of lava flows making up unit. To east of map area, Best (1987) reports K-Ar ages determined by H.H. Mehnert on biotite of 22.8 $\pm$ 0.9 and 21.9 $\pm$ 0.8 Ma and notes that flows contain 60-65 weight percent silica and about 8 weight percent total alkali oxides; unit is thus latite and trachydacite according to IUGS classification (Le Maitre, 1989). Locally, unit includes a nearly aphyric, dark-brown lava flow containing sparse crystals of plagioclase, pyroxene, and embayed quartz. Probably as much as several hundred meters thick in upper Deer Lodge Canyon. In adjacent Rice Mountain quadrangle (Keith and others, 1992) to north of map area unit was clearly deposited on Ripgut Formation (Tg) although such a relation is equivocal in the Ofer Basin part of map area. The absence of regional ash-flow tuff sheets of the Leach Canyon and Isom Formations between the unit and the Ripgut is problematic but their deposition may have been precluded because of resurgently uplifted Ripgut within the Mount Wilson caldera that was the source of the Ripgut ash flows (Best and others, 1989a)

Tlc **Leach Canyon Formation (Miocene or Oligocene)**--Partially welded, very light brown to light-gray rhyolitic ash-flow tuff that contains about 20 percent phenocrysts of quartz, plagioclase, sanidine, biotite, and more sparse hornblende, pyroxene, Fe-Ti oxides, and titanite (Williams, 1967). Consists of two simple cooling units. Upper Table Butte Member contains abundant lapilli and small blocks of pumice and dark-colored volcanic rock whereas thinner, underlying Narrows Member has almost no volcanic rock fragments; these two members were not distinguished in the map area. Isotopic age determinations range widely (22.9 to 26.7 Ma) but average about 24 Ma. Source probably lies in the Caliente caldera complex (Rowley and others, 1991). Unit is more than 60 m thick in map area but a complete section on the west side of Rose Valley just west of the map area is about 400 m thick

Ti **Isom Formation (Oligocene)**--As many as three moderately to densely welded simple cooling units of trachytic ash-flow tuff that have been designated as the Hole-in-the-Wall and the underlying Bald Hills Members (Rowley and others, 1991). Isom units contain generally fewer than 20 percent phenocrysts, chiefly plagioclase and lesser augite, hypersthene, and magnetite and are trachydacite in bulk composition (Best and others, 1989a; Christiansen and others, 1988). Upper unit in map area has a black vitrophyre about a meter thick near the base overlain by a pale-purple to reddish-brown devitrified zone 6-15 m thick that contains abundant compacted light-gray pumice clasts as much as 30 cm long; phenocrysts include about 2 percent of commonly altered pyroxene and magnetite and 10 percent plagioclase. Outcrop area just north of Rose Valley exposes less than 1 m of an overlying brown tuff that is probably the lower unit of the Shingle Pass Tuff whose age is 26.68 Ma (Best and others, 1989b, Table R2). If this correlation is correct then Isom units in map area may belong to Bald Hills Member of the Isom Formation. Lower two cooling units of Isom are red, contain fewer pumice clasts and fewer phenocrysts of plagioclase than upper; these two units together are about 20 m thick

Ta **Andesitic lava flows (Oligocene)**--Mostly dark-colored lava and minor debris flows containing phenocrysts of plagioclase and pyroxene. Petrographically similar lava flows in the same stratigraphic position to the northeast are mostly andesite but locally transitional into dacite (Best and others, 1989a). Incomplete sections in map area are as much as 100 m thick

Tg **Ripgut Formation (Oligocene)**--Crystal-poor, pumice-rich partially to densely welded rhyolite tuff that contains small phenocrysts of feldspar and quartz (Best and others, 1989a). Along north edge of map area unit includes local overlying lava flows of same composition as tuff. Thickness of about 200 m exposed in map area but in Rice Mountain quadrangle to north (Keith and others, 1992) unit is at least 650 m thick

Lund Formation (Oligocene)--Breccia and dacite ash-flow tuff lying within the southwestern part of the White Rock caldera (see Discussion of Geology) that collapsed about 27.9 Ma as the Lund ash flows were erupted (Best and others, 1989a). Thickness of unit is at least several hundred meters

Tlt **Tuff member**--Light-brown, red-brown, light-pink, light-gray, partially to densely welded, compound cooling unit of dacitic lapilli ash-flow tuff. Locally contains a black vitrophyre. Phenocrysts of plagioclase make up about one-fourth of rock; lesser phenocrysts include quartz, biotite, minor hornblende, and a trace of titanite (Best and others, 1989a)

Tlb **Breccia member**--Red-brown angular blocks as much as 3 m in diameter in fine reddish matrix of comminuted clast material. Clasts are chiefly of tuff of older Wah Wah Springs Formation and Cottonwood Wash Tuff (Best and others, 1989a) as well as andesite lava flow rock. Interpreted to be a wall breccia formed during caving and landsliding off the caldera wall as the Lund ash-flows were erupted

Cu **Upper Cambrian limestone and dolomite, undifferentiated(?) of Tschanz and Pampeyan (1970)**--Light- to dark-gray limestone and dolomite including Mendha Formation. About 200 m section exposed in map area

DISCUSSION OF GEOLOGY

Late Cenozoic Basin-Fill Deposits

During late Miocene time, Basin and Range block faulting disrupted the drainage pattern and produced many basins of internal drainage that began to fill with alluvial and, locally, lacustrine deposits. A small basin of this type occupied the central part of the Ursine Quadrangle. A lake of perhaps 10 km^2 formed in the western part of the quadrangle near the present location of Eagle Valley. The lake was bounded on the west by a ridge of volcanic rock and on the east by alluvial fans (QTf) growing out from the mountain front about 7 km to the east. As the lake was filling with fine silt and sand (unit Te), at least five silicic eruptions, probably from sources to the west, caused fine tephra and pumice fragments to rain into the lake. Through time, the alluvial fans grew larger and their coarse deposits began to episodically encroach on the lake basin. During the final stages of deposition, the Eagle Valley basin was filled to the level of the threshold separating it from the basin to the west, and ceased to be a closed basin. The lake deposits (Te) were overtopped by coarse fan alluvium (QTf), and the depositional surface of the alluvial fans became graded to fill in the adjacent Lake Valley basin to the west, which had also been the site of lake deposition. The highest and oldest alluvial fan depositional surface in the Ursine quadrangle, which is probably of early Pleistocene age, is extensively preserved because of the buried bedrock ridges that protected the upper parts of the fan surfaces from erosion.

Headward erosion of Colorado River tributaries up through the Panaca, Lake Valley, and Eagle Valley basins during the Pliocene (Rowley and Shroba, 1991) and early Pleistocene created a new pattern of drainage that ended the aggradational cycle and began exhumation of buried topography and deposits in the Eagle Basin. As Meadow Valley Wash incised the high fan surface, it did not follow the pre-lake valley filled with soft sediment but instead became superposed on a buried bedrock ridge. Cutting of a narrow 125-m-deep canyon down through the buried ridge was slowed by the resistant bedrock, whereas the less resistant lake beds (Te) immediately upstream were easily eroded, so that a wide valley developed upstream from the canyon. During at least two pauses in downcutting, hard gravel clasts eroded from alluvial fan deposits washed down over the soft lake deposits and mantled two pediment surfaces that were graded to former levels of Meadow Valley Wash. These pauses occurred when Meadow Valley Wash was about 6 and 15 m above the modern level. The pedimentation process is acting today as in the past to erode broad, alluvium-mantled surfaces in tributary valleys that are graded to the modern level of Meadow Valley Wash.

Ash beds in fine basin fill deposits of Eagle Valley (Te) are offset as much as a meter by steep, northeast-striking faults in the southwest corner of Sec. 12 and in the east central part of Sec. 14, R. 69 E., T. 1 N. These faults dip steeply northwest and are down to the southeast, indicating apparent reverse dip-slip motion. Alternatively, a significant component of the motion may be strike slip.

Calderas

The map area encompasses a small volcanic depression and probably includes parts of two larger calderas.

The small, elliptical Gold Springs depression between Gold Springs and Deer Lodge in the eastern part of the map area was created during eruption of the ash flows that formed the tuff of Gold Springs member of the Blawn Formation (Tbg). Outflow portions of this unit thin away from the depression whereas within it the unit is much thicker and includes beds of reworked and epiclastic deposits. The perimeter of depression is marked by an abrupt change in the thickness of the tuff of Gold Springs and, on the west, by dike-shaped lenses of the breccia member of the Blawn Formation (unit Tbrb) that we believe to have been emplaced along the wall of the depression. A larger intrusion of Blawn magma (Tbri) was also subsequently emplaced in the western part. The moderately dipping layers of tuff and sedimentary deposits (Tbg) in the structure suggest it has a sloping wall and funnel shape. Whether the floor of the depression subsided as a consequence of eruptive activity, in which case it would be a caldera, or not, in which case it would be a crater, is unknown. In either case, the elliptical structure is the vent source of the tuff of Gold Springs.

The northern margin of the Mount Wilson caldera (Willis and others, 1987; Best and others, 1989a), which was the source of ash flows forming the Ripgut Formation, is exposed north and east of Mount Wilson about 35 km northwest of the map area. Reconnaissance mapping in the intervening area has disclosed an extensive thick cover of Blawn Formation that conceals other parts of the caldera. However, in the southern part of the adjacent Rice Mountain quadrangle (Keith and others, 1992) just north of the map area, tuff and lava flows of the Ripgut Formation are at least 650 m thick and the tuff contains clasts of the older Lund Formation as much as 10 cm in diameter. These relations we believe indicate that the Mount Wilson caldera probably extends into the Rice Mountain quadrangle; field relations are furthermore compatible with resurgence in the caldera. Continuity of the Ripgut exposures for about 3 km into the northern part of map area indicate that the caldera likewise extends at least that far.

Burial under extensive younger deposits has obscured the southern margin of the White Rock caldera that was the source of ash flows forming the Lund Formation, However, the regional gravity pattern indicates the caldera probably lies in the northern part of the map area (Best and others, 1989a). In Condor Canyon (G.J. Axen, unpublished mapping, 1989) 12 km southwest of the southwest corner of the map area, the stratigraphic sequence is extracaldera.

The presence of Cambrian rocks within the caldera in the northwestern part of the map area is problematic but open to two possible interpretations. First, the rocks could be large landslide masses which caved off the nearby caldera wall, similar to masses of Paleozoic rock in the older Indian Peak caldera in the southern Needle Range to the east (Best and others, 1987a); however, their large areal extent (4 km long by as much as 1 km wide) and general absence of internal fracturing and brecciation suggest the masses are not allochthonous into the White Rock caldera. Second, the Cambrian exposures could represent part of the uplifted resurgent core of the White Rock caldera, which is also likely the case for the exposures of Cambrian rock in the adjacent Rice Mountain quadrangle to the northeast (Keith and others, 1992); in this interpretation, the absence of ash-flow units lying beneath the Lund, as in the nearby Condor Canyon outflow area, is puzzling, but may be a consequence of erosion or uplift in the caldera complex prior to Lund time.

Economic Geology

Gold and silver were first discovered in the vicinity of State Line in the northeast corner of the map area about 1896 and intermittent mining continued until 1943. Current exploration in the Ofer and Snowflake mine areas could lead to possible production. The State Line, Gold Springs, Fay, and Deer Lodge districts were established solely in quartz-carbonate veins, but mining in each district was relatively brief due to decreasing ore grade beneath the surface (Butler and others, 1920). Incomplete records show production of about $0.5 million in gold, silver, and minor lead and copper from these districts during the first half of the twentieth century (Perry, 1976; Thomson and Perry, 1976). Concentrations just above background of Te, Hg, Mo, and U have also been reported (Butler and others, 1920; Tschanz and Pampeyan, 1970; Perry, 1976; Thomson and Perry, 1976, Keith, 1980). Although Butler and others (1920) noted that vein deposits in each of these districts are generally similar, significant variations occur in the relative amounts of quartz, calcite, and adularia gangue minerals. Higher grades of ore occur in adularia-rich material. Less abundant gangue minerals include fluorite, pyrite, carbonate minerals other than calcite, and Fe-Mn oxides. Most of the mining took place in secondarily enriched oxidized parts of the veins. Smith (1908) noted that the gold/silver ratio in the veins increase from west to east across the State Line district. Veins which surround the vent of the tuff of Gold Springs member of the Blawn Formation (Tbg), from the Homestake mine on the northwest to the Etna mine on the southeast, were dominantly gold producing. In contrast, veins to the northwest of Deer Lodge (Tempa mine and unnamed prospects and shafts) produced mainly silver; specimens of chlorargyrite-rich vein material (as much as 170 oz/ton Ag; Keith, 1980) can be found locally on dumps and in ore bins at these mines. An unnamed shaft about 380 m east of hill 7668 in the large Blawn rhyolite intrusion in the vent area of the Gold Springs tuff marks the position of a fluorite pipe that contains gold-bearing hematitic clay (Perry, 1976). Alluvium near Big Summit was purportedly prospected for cobbles of Au-bearing quartz rock that had been eroded from veins to the east (Dee Burgess, 1979, oral commun.).

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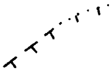
Contact

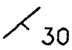
High-angle fault--Ball and bar on downthrown side of predominantly dip-slip fault. Arrows indicate relative movement on predominantly strike-slip fault. Dashed where approximately located or inferred; dotted where concealed



Approximately located topographic margin of Gold Springs depression--Dotted where concealed

Subvertical vein--Chiefly quartz and carbonate; locally contains minor amounts of sulfides and adularia

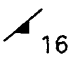
Strike and dip of beds



Inclined

Horizontal

Strike and dip of compaction foliation in welded tuff



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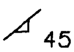

Strike and dip of flow layering in lava flows and flow breccia

CORRELATION OF MAP UNITS
URSINE AND DEER LODGE CANYON QUADRANGLES