USGS-OFR-90-33

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY GEOLOGIC MAP OF THE DELAMAR 3 NE QUADRANGLE, LINCOLN COUNTY, NEVADA

By

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Open-File Report 90-33

DESCRIPTION OF MAP UNITS

[Ages of surficial units are estimates based on field observations of degree of soil development and local surface dissection. The stage of carbonate development reported for soils is a visual estimate using standards defined by Gile and others (1966). Colors of surficial and bedrock units are from the Rock-Color Chart (Rock-Color Chart Committee, 1951). Mineralogical descriptions of volcanic units are based largely upon megascopic identification and estimates of phenocryst abundances, except where noted by reference]

Qahl **Alluvium (late Holocene)**--Grayish-orange to pale-yellowish-brown sand, gravelly sand, and clayey, silty sand; unconsolidated to weakly consolidated, locally compacted, poorly to moderately well sorted, massive to poorly bedded. Gravel is angular to subrounded clasts of ash-flow tuff and lava; clasts are chiefly basalt along washes near the east-central border of quadrangle; minor amounts of gravel are clasts of Paleozoic sedimentary rocks near south-central border. Gravel comprises about 30 percent of the unit near bedrock sources and less than 5 percent near distal edges of fans. Unit forms low-gradient fans, channel deposits of active washes, and small steep fans flanking bedrock ridges; forms thin cover on partly eroded deposits of unit Qap near southeast border of quadrangle. Soil development is limited to a 2-cm-thick sandy vesicular A horizon present in areas characterized by slower deposition and erosion. Surface of unit is smooth on large fans and very irregular in broad shallow washes where bar-and-swale topography occurs. Thickness 0 to more than 2 m

Qahe **Alluvium (early? Holocene)**--Grayish-orange gravelly sand, sandy gravel, and local minor silt; poorly to well sorted, poorly bedded to massive, and unconsolidated to weakly consolidated. Gravel is angular to subangular and locally is very coarse, with clasts as much as 2 m in diameter, that was probably deposited as debris flows. Unit consists of numerous small fan remnants that flank bedrock ridges and terrace remnants inset into older fans along some of the larger washes. Soil includes a 2- to 3-cm-thick sandy vesicular A horizon, a B horizon, and a stage I carbonate horizon. No color change occurs in B horizon above carbonate horizon. Carbonate horizon is typically poorly exposed except in fresh cutbanks. Surface of unit is typically smooth and undissected and locally exhibits a weakly developed pavement with minor rock varnish. Fan surfaces are typically 1-2 m above modern washes. Thickness 0 to more than 4 m

Qap **Alluvium (late and middle Pleistocene)**--Dark-yellowish-orange gravelly sand and sandy gravel; generally poorly sorted, poorly to moderately well bedded, and poorly consolidated. Gravel consists of angular to subrounded clasts, commonly as much as 0.3 m in diameter; clast size increases toward head of fans where boulders are as much as 4 m across. Unit forms a large fan along the east-central border of quadrangle and isolated fan remnants flanking bedrock ridges; fans are 2-5 m above modern washes. Typical soil development includes a 3-5-cm-thick sandy, silty, and clayey vesicular A horizon, a light-brown cambic B horizon, and a stage II to II+ carbonate horizon. A loosely packed stone pavement is typical; surface clasts 15-30 cm in diameter are common and have a moderately developed rock varnish. The surface of large fans is smooth to weakly dissected, but on small remnants at fan heads, it is moderately to strongly dissected. On many fan remnants, the depositional surface is largely intact, but in places the fan surface is eroded to expose abundant boulders and common chips of secondary carbonate. Remnants of the large fan near the east-central border are weakly dissected exposing a coarse lag of abundant basalt cobbles and boulders; downstream from these remnants this fan is more dissected and is covered with thin deposits of unit Qahl. Unit includes both middle and late Pleistocene deposits that were mapped together because of the small topographic separation between the two deposits. Thickness 0 to more than 8 m

Qc **Colluvium (Holocene and Pleistocene)**--Unconsolidated to moderately consolidated talus or slope debris consisting chiefly of angular pebble- to boulder-sized clasts, and minor amounts of silt and sand. Colors are inherited from source rock. Unit is generally nonbedded and locally cemented by secondary carbonate; occurs along base of steep bedrock slopes. Local thicknesses as great as 10 m.

QTa **Alluvium (early Pleistocene and Pliocene?)**--Grayish-brown gravel and sandy gravel; poorly to moderately sorted and moderately to well consolidated; weakly to well cemented with secondary carbonate. Unit forms moderately to deeply dissected fans and isolated fan remnants. Unit is typically exposed as rounded debris-covered ridges that are littered with boulders 2-4 m in diameter and with abundant chips and small plates of secondary carbonate. Clasts consist of a mixture of volcanic units described below. Best exposures are 6.7 km northwest of southeast corner of quadrangle and in the northwest part of the quadrangle. Locally a lower part of the unit is exposed along the major wash in the northwest part of the quadrangle. The lower part consists chiefly of moderately consoliated, moderately well sorted, grayish-orange-pink gravely sand and silt derived from an unexposed(?) nonwelded tuff; also includes a 4-10-cm-thick, light-gray, well-cemented, hornblende-bearing ash that occurs within this lower part of the unit. No soil exposure observed. Thickness 0 to more than 100 m

QTs **Blocks and debris of gravity-slide complex (Quaternary? to late Miocene?)**--Mixture of coherent blocks and chaotic debris including landslide material; unit generally consists blocks and debris of Tertiary rocks. Debris is unconsolidated to well consolidated. Generally unit grades downward from larger and more coherent blocks at the top, through faulted and rotated blocks, to subrounded chaotic debris at the base; although the top of the unit locally contains relatively undisturbed blocks with stratal attitudes that are nearly consistent with those of areas surrounding unit QTS, attitudes of strata in volcanic blocks are more highly variable toward the base of unit. More coherent parts of the unit are commonly bound laterally by more chaotic parts of the unit. Chaotic parts are commonly cemented by secondary carbonate. Unit occurs near the base of steep slopes and on the flanks of high parts of the range particularly in localities where surrounding strata dip gently down slope. Thicknesses are as great as 100 m. (Where inidividual bedrock units in slide complex are mappable, bedrock units are identified with unit symbols and the symbol QTs is not used; where individual rock units are not mappable, the unit is designated by the symbol QTs

Tcv **Conglomerate, volcanic clasts (Pliocene? or late Miocene?)**--Moderate-pink to grayish-orange, calcite-cemented conglomerate consists of clasts (0.5- 5 cm diameter) of nearby volcanic units. Only exposured 200 m southeast of the caldera wall in central part of quadrangle. Thickness is less than 14 m

INTRACALDERA UNITS

Tbi **Basalt flow, intracaldera (Miocene)**--Medium-dark-gray tholeiitic plagioclase-olivine-phyric basalt lava flow containing of as much as 5 percent plagioclase phenocrysts as large as 1 cm long; locally contains as much as 40 percent gas vesicles partially filled with zeolites or calcite. Forms cap rocks and prominent cliffs within caldera. K-Ar age of flow is 12.1 Ma (Best and others, 1980); late basalt of Novak (1984). Thickness is locally as great as 210 m

Ttr **Rhyolite flow, topaz-bearing (Miocene)**--Pale-red flow-banded rhyolite lava flow containing less than 2 percent phenocrysts of sanidine, plagioclase, biotite, fayalite, and ferroedenite (Novak, 1984). As much as 20 percent of the rock consists of lithophysal cavities that in some cases contain vapor-phase topaz crystals as long as 2 mm. Exposure of unit is limited to one volcanic dome near the western edge of the caldera. K-Ar age of this flow is 13.4 Ma (Novak, 1984). Forms prominent cap rock. Thickness is 170 m

Trv **Rhyolite flow, vitrophyre (Miocene)**--Dark-gray rhyolite vitrophyre forming the base of topaz-bearing rhyolite lava flow (Ttr). Includes thin base-surge ash and ash-fall deposit at base of vitrophyre. Does not contain lithophysae. Thickness is less than 18 m

Trs **Rhyolite stock (Miocene)**--Grayish-pink flow-banded rhyolite forming vent for the topaz-bearing rhyolite (Ttr) and rhyolite vitrophyre (Trv). Contains the same phenocryst mineralogy as topaz-bearing rhyolite (Ttr). Steep foliation forms concentric inward-dipping pattern. Exposure is limited to a knobby prominence 1 km southeast of the volcanic dome of topaz-bearing rhyolite (Ttr)

Tlp **Late pyroclastic rhyolite (Miocene)**--Very light gray, light-gray, to pinkish-gray rhyolitic tuff including ash-fall tuff, nonwelded ash-flow tuff,and sparse reworked fluvial tuff. Phenocrysts of quartz, sanidine, and biotite form less than 5 percent of the tuff. Unit contains locally abundant lithic fragments of basalt and trachyandesite (Tbta) that range from less than 1 mm to greater than 0.5 m in diameter. In the northeast part of the quadrangle, unit is interlayered with intracaldera basalt flows (Tbi). Unit forms slopes between intracaldera basalt (Tbi) and basalt and trachyandesite (Tbta). Tuffaceous beds ranges from 1 cm to 5 m in thickness, and entire unit is as great as 140 m thick

Tbtd **Basalt and trachyandesite dikes (Miocene)**--Medium-dark-gray to olive-gray basalt and trachyandesite dikes ranging from plagioclase-clinopyroxene-olivine(?)-phyric basalts to plagioclase-phyric trachyandesites. Dikes have olive-black chilled margins and intrude early rhyolite pyroclastic tuffs (Tep) and basalt and trachyandesite (Tbta). Dikes probably are feeders for upper flows of basalt and trachyandesite. Dikes have nearly vertical foliation and are 5 to 100 m wide and as much as 400 m long

Tbta **Basalt and trachyandesite flow (Miocene)**--Dusky-brown, dark-greenish-gray, and dark-gray basalt and trachyandesite lava flows ranging from plagioclase-clinopyroxene-olivine(?)-phyric basalts to plagioclase-phyric trachyandesites. Although as many as five flows are present, they are not individually mappable; map unit includes thin, discontinuous tuffaceous sediments. K-Ar age of flows is 13.4 Ma (Novak, 1984). Unit forms prominent cliffs and is as thick as 150 m along the west margin of the caldera

Ts **Sandstone (Miocene)**--Grayish-red, pale-red, and grayish-orange-pink, well-indurated sandstone including minor siltstone, and conglomerate. Locally crossbedded, moderately to poorly sorted. Sand grains consists of volcanic rock. Unit forms a slight bench between basalt and trachyandesite flow (Tbta) and icelandite flow (Tif). Unit is discontinuously exposed along the west margin of the caldera and is less than 15 m thick

Tif **Icelandite flow (Miocene)**--Dark-greenish-gray icelandite lava flow (Novak, 1984) containing less than 5 percent phenocrysts of plagioclase and rare pyroxene. Top of flow locally contains 30 percent unfilled gas vesicles; otherwise nonvesicular. Distinctive 0.25- to 2-cm thick partings parallel to base of unit. Forms cliffy ledges above early pyroclastic rhyolite (Tep); unit is less than 20 m thick.

Ter **Early rhyolite flows (Miocene)**--Light-gray, pale-red, and light-red rhyolite lava flows containing less than 10 percent phenocrysts that consist of quartz, sanidine, and ferroedenite (Novak, 1984). Commonly flow-banded but also massive. Intercalated locally with early pyroclastic rhyolite (Tep). K-Ar age of flows is 13.8 Ma (Novak, 1984). Forms cliffs in exposures in north-central part of the quadrangle. Unit is as great as 60 m thick

Tep **Early pyroclastic rhyolite (Miocene)**--Yellowish-gray, pinkish-gray, and light-greenish-gray massively bedded ash-fall tuffs and grayish-pink and pale-red nonwelded to partially welded ash-flow tuffs containing less than 10 percent phenocrysts that consist of quartz, sanidine, and ferroedenite (Novak, 1984). Unit forms slopes along the caldera wall on the west and above the syenite complex units (Tss, Tsx, Ttf, and Ttt) in the north-central part of the quadrangle. Thickness is as great as 140 m

Teb **Exotic blocks (Miocene)**--Exotic blocks of several units overlying the trachyte flow (Ttf) in the northeastern part of the quadrangle; the largest of these consists of Harmony Hills Tuff (Thh) that covers nearly 0.1 km^2 and is 25 m thick; other smaller exotic blocks include Kane Wash Tuff (units Tkb and Tkw), and the Hiko Tuff (Th)

Syenite complex (Miocene)--Complex of extrusive and intrusive chemically related units including from top to bottom a trachytic ash-flow tuff (Ttt), a trachytic lava flow (Ttf), a subvolcanic xenolithic syenite (Txs), and a seriate syenite (Tss). K-Ar age of the complex is 14.1 to 13.9 Ma (Novak, 1984). Although the trachytic ash-flow tuff and lava flow appear to be the skin of the nearly coeval subvolcanic xenolithic syenite, the seriate syenite appears to be a distinctively younger intrusive phase that has both ductilely domed and brittlely faulted the overlying parts of the syenite complex in different localities during intrusion

Tss **Seriate syenite**--Grayish-pink, pinkish-gray to grayish-red massive syenite consisting of seriate alkali feldspar crystals between 0.25 and 7.5 mm in diameter. Rock contains a trace of interstitial quartz, about 95 percent alkali feldspar, and 2-3 percent clinopyroxene (Novak, 1984). Unit forms exfoliation domes 0.25-1 km in diameter and intrudes and deforms the overlying xenolithic syenite (Txs)

Txs **Xenolithic syenite**--Grayish-pink to pale-red fine-grained porphyritic syenite containing xenoliths of pale-red trachyte. Xenoliths form between a trace and 75 percent of the rock; locally xenoliths (1 cm to greater than 2 m diameter) or alkali feldspar laths define a crude foliation. The rock contains about 25 percent phenocrysts that include a trace of interstitial quartz, about 80 percent anorthoclase (with common sieve texture), and about 15 percent clinopyroxene; a finer groundmass of alkali feldspar make up 75 percent of the rock (Novak, 1984). Miarolitic cavities are present locally near the top of the xenolithic syenite. Unit locally intrudes overlying trachyte lava flows (Ttf) in several localities along the northeast part of the quadrangle but appears to be gradational with the overlying trachyte elsewhere

Ttt **Trachytic ash-flow tuff**--Mottled moderate-orange-pink and grayish-red to mottled grayish-pink and pale-red trachytic ash-flow tuff exhibiting flattened pumice fragments as great as 2 cm in diameter in plane of foliation without discernable flow lineation. Phenocrysts and groundmass mineralogy same as underlying trachytic lava flow (Ttf) and is probably coeval with the lava flow. Unit is discontinuous on top of syenite complex. Thickness of unit is less than 40 m

Ttf **Trachytic flow**--Grayish-red to pale-red flow-lineated trachyte lava flow containing coarse (2.5-10 mm diameter) seived anorthoclase phencocrysts that form as much as 40 percent of the rock. Groundmass ranges from cryptocrystalline to very fine grained growths of alkali feldspar and minor amounts of clinopyroxene (Novak, 1984). Trachyte flow locally forms envelopes around syenitic parts of complex (Tss and Txs); foliation dips viariably. Locally unit is vesicular near the top. Upper parts of flows are overlain by exoitic blocks (Teb), early pyroclastic rhyolite (Tep), early rhyolite flows (Ter), or trachytic ash-flow tuff (Ttt). Map unit as great as 250 m thick on west flank of the syenite complex

Tbe **Early basalt flow (Miocene)**--Brownish-gray, vesicular, olivine(?)-phyric basalt flow containing less than 5 percent altered olivine(?) phenocrysts (2 mm diameter). Vesicles form about 5-10 percent of the rock and most are less than 1 mm in diameter but some are as large as 1 cm. Unit is less than 15 m thick in two exposures near southwest caldera wall

Tt **Trachyte flow, postcaldera (Miocene)**--Brownish-gray coarsely porphyritic trachyte lava flow consisting of about 70 percent sieved anorthoclase phenocrysts (as great as 2 cm diameter); a disequilibrium assemblage of xenocrystic quartz, olivine, and clinopyroxene occurs (Novak, 1984). K-Ar age of flow is 14.1 Ma (Novak, 1984). Unit postdates caldera collapse and overlies intracaldera exposures of the Gregerson Basin unit of the Kane Wash Tuff (Tkb) near southwest margin of the caldera. Thickness of unit as great as 85 m

Twb **Caldera wall breccia (Miocene)**--Extremely coarse and angular breccia deposited as a wedge of debris along the caldera wall containing clasts that consist mostly of Kane Wash Tuff and ranging from sand-sized fragments to 8 m in diameter; older tuffs are conspicuously absent. Common ash-fall deposits (a) and rare thin unmapped ash-flow tuffs are intercalated between layers of breccia. Attitude of layers of breccia and ash are near the angle of reposed, dipping into the caldera. Breccia is discontinuously exposed on wall of caldera. Unit including ash is as great as 200 m thick

a **Ash**--Yellowish-gray to very light gray unconsolidated vitric ash-fall deposits containing sparse phenocrysts of quartz, sanidine, and biotite, and pumice fragments less than 0.5 cm in diameter. Layers of ash intercalated between layers of wall breccia (Twb) are discontinuous and less than 5 m thick

EXTRACALDERA UNITS

[An angular unconformity occurs between younger alluvial units and older extacaldera units]

Tbt **Bedded tuff (Pliocene? to Miocene?)**--Pinkish-gray ash-fall tuff consisting of slightly to moderately consolidated, nonwelded tuff and containing about 2 percent quartz, 2 percent sandine, and 1 percent biotite phenocrysts, 15 percent pumice fragments (less than 0.5 cm diameter), and no lithic fragments. Bedding is crude, and beds are between 0.1 and 2 m thick. Bedded tuff is the youngest tilted volcanic rock. Exposures at the base of washes in the central western part of the quadrangle suggest that thickness of at least 100 m is probable

Tbd **Basalt dike (Miocene)**--Medium-dark-gray basalt feeder dike for extracaldera basalt flows (Tbe), containing about 2 percent plagioclase and 5 percent olivine phenocrysts. Dike is 1.5-2 m wide, is greater than 80 m long, and has nearly vertical dips

Tbe **Basalt flow, extracaldera (Miocene)**--Medium-dark-gray plagioclase-olivine-phyric basalt flow containing megacrysts of plagioclase commonly greater than 1 cm in diameter. Locally contains as much as 30 percent vesicles. Forms cap rocks at exposures along west-central border of the quadrangle. K-Ar age of basalt flow is.7 Ma (Novak, 1984). Thickness is as great as 25 m

Kane Wash Tuff (Miocene)--Peralkaline ash-flow tuff sequence divisible into four informally named tuffs

Tkb **Gregerson Basin unit**--Informally named comenditic to trachytic ash-flow tuffs consisting of at least three nearly identical cooling units. Map unit includes units V2 and V3 of Novak (1984). Individual cooling units are not mapped separately because lithologic similarities make them indistinguishable and the cooling breaks are not traceable at all localities. Variations in degree of welding indicate that the lowest cooling unit is a compound cooling unit; where the cooling breaks are traceable, they are shown as dashed contacts within the Gregerson Basin unit. Each cooling unit generally contains a trachytic cap above upper, middle, and basal comenditic zones. Trachytic caps are partly vitric, partially welded, and pale brown; they commonly contain abundant cognate inclusions of scoriaceous trachyte in matrices that are noticeably darker and browner than the lower parts of the upper zones. Trachytic caps range from 1 to more than 10 m thick and are commonly absent. Upper zones are devitrified, moderately to densely welded, and yellowish gray to light brownish gray in most places. The upper zones contain few recognizable pumice fragments and have 0-20 percent lithophysal cavities that contain abundant vapor-phase crystals of amethyst and blocky mafic minerals (riebeckite and unidentified phases). The upper zones contain as much as 25 percent phenocrysts that consist of 25 percent quartz, 60 percent sanidine, and 15 percent hedenbergite, fayalite, and ilmenite (Novak, 1984). Upper zones range from 10 to 65 m thick. Middle zones are densely welded, pale blue, medium bluish gray, grayish green, pale yellowish brown where devitrified, and black where vitrophyres are locally developed. Middle zones commonly are mottled, have partings between layers

of different degrees of devitification, range in abundances of phenocrysts from 5 to 25 percent, and are generally 5 to 30 m thick. Basal zones are most commonly nonwelded to partially welded, are moderate orange pink to pale yellowish orange, contain less than 5 percent phenocrysts, and are 1-5 m thick. The K-Ar age of the Gregerson Basin unit is 14.1 Ma (Novak, 1984). Ash-flow tuff units form cliffs, and the cooling breaks between them have little or no geomorphic expression. The Gregerson Basin unit ranges from about 50 m to about 120 m thick

Tkg **Grapevine Spring unit**--Informally named rhyolitic to trachytic ash-flow tuff consisting of one compound cooling unit. Grapevine Spring unit correlates with unit V1 of Novak (1984). Slight variations in the degree of welding suggest that map unit is a compound cooling unit; a thin, very indistinct simple cooling unit of Grapevine Spring unit lithology found in the adjacent Elgin SW quadrangle may also be present at the base of the compound cooling unit but limited exposures do not confirm its presence in this quadrangle. Map unit grades downward through four zones that includes a poorly, and locally, developed trachytic cap above upper, middle, and lower rhyolitic zones. Cap rock contains sparse dark scoriaceous trachytic cognate inclusions in a matrix that is slightly darker brown than lower zones. Cap rock is generally less than a few meters thick. Upper zone is devitrified, moderately to densely welded, and yellowish gray to light brownish gray in most areas. The upper zone contains few recognizable pumice fragments and contains 0-10 percent lithophysal cavities, which have minor vapor-phase crystals of quartz and sparse garnet. The upper zone contains as much as 30 percent phenocrysts that consist of 25 percent quartz, 60 percent sanidine, and 15 percent hedenbergite, fayalite, titano-magnetite, and ilmenite (Novak, 1984). In several localites, the upper part of the upper zone contains less than 10 percent phenocrysts and forms a smooth weathered surface in contrast to the crumbly weathered surface of the more phenocryst-rich parts. The upper zone has less than 1 percent lithic fragments of volcanic rocks, ranges from 2 to 70 m thick. Middle zone is densely welded, grayish brown, brownish gray, to moderate brown where devitrified and black where sparse vitrophyre occurs. Vitrophyres are commonly mottled with grayish-orange-pink devitrification centers in the black vitric matrix. Highly lenticular local lithophysae are 2-4 cm in diameter in the plane of foliation. The middle zone contains less than 5 percent phenocrysts and is 1-3 m thick. Basal zone is generally nonwelded to partially welded, is pale brown to dark yellowish brown, contains less than 2 percent phenocrysts, and is 1-1.5 m thick. The map unit forms cliffs, and the contact between it and the Gregerson Basin unit (Tkb) forms a slight notch or bench in the cliffs. The K-Ar age of the unit is 14.1 Ma (Novak, 1984). Thickness of the Grapevine Spring unit is 130 m near the caldera margin but thins to about 25 m near the southwest part of the quadrangle

Sunflower Mountain unit--Informally named rhyolitic ash-flow tuff consisting of a compound cooling unit and containing two mappable zones. The Sunflower Mountain unit correlates with unit W of Novak (1984). The K-Ar age of the unit is 14.7 Ma (Novak, 1984). The Sunflower Mountain unit ranges from 140 to 170 m thick

Tksu **Upper zone**--The more welded part of the Sunflower Mountain unit grades downward from partially welded, through moderately welded, to moderately to densely welded tuff. The upper zone is devitrified, pale red and mottled. Mottling consists of distinctive moderate-orange to very pale orange altered blotches in a pale-red matrix. Upper zone contains as much as 20 percent pumice fiamme as large as 15 cm in diameter in the plane of foliation and has indistinct lithophysae. Upper zone contains as much as 25 percent phenocrysts that consist of subequal quartz and sanidine and sparse hedenbergite and fayalite (Novak, 1984). Lithic fragments of volcanic rocks form less than 1 percent of the rock. Map unit forms bold cliffs; a small notch or bench in the cliff above the upper zone marks the base of the Grapevine Spring unit (Tkg) in most areas. The map unit is about 75 m thick in the central part but thins to 30 m in the southwest part of the quadrangle

Tksl **Lower zone**--Less welded part of the Sunflower Mountain unit grading downward from partially welded, through a slightly more welded, to a nonwelded tuff. The lower zone is very pale orange to grayish orange. Pumice fragments form about 20 percent of the rock and range between 0.25 and 2 cm in diameter. The lower zone contains less than 15 percent phenocrysts that consist of subequal amounts of quartz and sanidine and sparse altered mafic minerals (Novak, 1984). Volcanic lithic fragments are commonly as large as 0.5-1 cm in diameter and form as much as 10 percent of the rock at some localities. Lower zone forms distinct slopes. Map unit is as thick as 140 m in the southwest part but thins to about 65 m thick in central part of the quadrangle

Tkd **Delamar Lake unit**--Informally named rhyolitic ash-flow tuff consisting of two simple cooling units. The Delamar Lake unit correlates with unit O of Novak (1984). The upper cooling unit is devitrified, nonwelded to moderately welded, and grayish pink to pale red. Pumice fragments as large as 4 cm in diameter in the plane of foliation form as much as 25 percent of tuff. As much as 25 percent of the rock consists of phenocrysts that consist of 20 percent quartz, 75 percent sanidine, and 5 percent fayalite and other mafic minerals (Novak, 1984). The tuff contains less than 2 percent volcanic lithic fragments. The lower cooling unit is devitrified, nonwelded to moderately welded, and grayish orange pink to pale red to light brownish gray. Pumice fragments as large as 6 cm in diameter in the plane of the foliation form as much as 30 percent of the tuff. As much as 20 percent of the rock consists of phenocrysts that consist of 35 percent quartz, 60 percent sanidine, and 5 percent fayalite and other mafic minerals (Novak, 1984). The tuff contains less than 3 percent volcanic lithic fragments. The less welded zones of the cooling units form slopes and more welded zone form small cliffs. The K-Ar age of the Delamar Lake unit is 15.6 Ma (Novak, 1984) The thickness of the map unit ranges from 50 m in the central part of the quadrangle to 20 m in the southwest part

Th **Hiko Tuff (Miocene)**--Rhyolitic ash-flow tuff consists of one cooling unit grading dwonward from a moderately to densely welded devitrified zone, through a local vitrophyre, to a glassy nonwelded to partially welded basal zone. Devitrified zone is eutaxitic, devitrified, moderately to densely welded, and mottled very light gray to light gray; pumice fragments are lighter in color than matrix.. Lenticular pumice fragments are as large as 6 cm in diameter in the plane of foliation and form 15 percent of the rock. Lithophysae are commonly 4 cm in diameter parallel to foliation. Rock contains 35 percent phenocrysts that consist of 25 percent very pale purple quartz, 25 percent sanidine, 35 percent plagioclase, 10 percent biotite, and less than 5 percent hornblende and pyroxene. The tuff contains less than 2 percent lithic fragments largely of argillite. Vitrophyre is partly glassy, eutaxitic, moderately to densely welded, and mottled medium gray to grayish black; pumice is darker in color than matrix. Basal zone is nonwelded to partially welded, and very light gray; pumice is white. The Hiko Tuff forms crumbly but rugged cliffs and has a very distinctive rounded knobby exfoliated surface in the devitrified zone; these knobs are 1-4 m wide and 1-3 m high. The $^{40}Ar/^{39}Ar$ age of the Hiko Tuff is 18.6 Ma (Taylor and others, 1989). The tuff thins from 110 m near the central part of the quadrangle to about 50 m at the south

Thh **Harmony Hills Tuff (Miocene)**--Andesitic ash-flow tuff consisting of one cooling unit grading downward from a partially welded upper zone, through a densely welded zone, to a nonwelded basal zone. The map unit is devitrified, phenocryst-rich, and massive with crudely developed foliation. The moderately to densely welded tuff ranges from pale red where more weathered to light olive gray to pinkish gray where fresher. Pumice fragments are sparse. The rock contains 50 percent phenocrysts that consist of 5 percent quartz, 65 percent plagioclase, 15 percent biotite, 10 percent hornblende, and less than 5 percent clinopyroxene. Lithic fragments are sparse. The unit forms cliffs, and the lower part of the unit is commonly covered with colluvial debris from both overlying the Hiko Tuff (Th) and the Harmony Hills Tuff. A small bench marks the base of the Hiko Tuff. Five K-Ar ages by Armstrong (1970) and one by Noble and McKee (1972) average 21.6 Ma for the map unit; however, isotopic ages of 22.5-22 Ma for plutons and an ash-flow tuff that postdate the Harmony Hills Tuff in the Iron Springs District may provide a better age constraint (Rowley and others, 1989). Although the Harmonly Hills Tuff, Bauers Memberof the Condor Canyon Formation (Tcb), and the Leach Canyon Tuff (Tlc) were included in the Quichapa Group (Cook, 1957; Williams, 1967; Anderson and Rowley, 1975), the group name will not be used here because the source(s?) of all these ash-flow tuffs have not been determined. The Harmony Hills Tuff is about 95 m thick

Tpl **Tuff of Pahranagat Lake (Miocene)**--Rhyolitic ash-flow tuff consisting of one simple cooling unit grading downward from nonwelded, through partially welded, to nonwelded. This informally named tuff is the Pahranagat Lake tuff of Williams (1967). The tuff is devitrified and ranges from grayish pink, to very light gray, and to grayish orange pink. Pumice fragments as large as 5 cm in diameter forms as much as 20 percent of tuff. The rock contains 15 percent phenocrysts that consist of 45 percent quartz, 25 percent sanidine, 25 percent plagioclase, and less than 5 percent biotite. Less than 1 percent lithic fragments occur in the tuff. The tuff forms gentle slopes commonly covered by talus from the Harmony Hills Tuff (Thh). The $^{40}Ar/^{39}Ar$ age of the tuff is 22.65 Ma (Deino and Best, 1988). The tuff of Pahranagat Lake is as thick as 25 m in the southwest part of the quadrangle but appears to pinch out to the southeast

Tcb **Bauers Tuff Member of the Condor Canyon Formation (Miocene)**--Rhyolitic ash-flow tuff consisting of one simple cooling unit grading downward from a moderately to densely welded light-brownish-gray to pale-red devitrified zone, through a brownish-gray vitrophyre, to a grayish-pink partially to nonwelded basal zone. Pumice fragments are generally less than 0.5 cm diameter in the plane of foliation and make up less than 5 percent of the rock. Rock contains 10 percent phenocrysts that consist of 35 percent sanidine, 65 percent plagioclase, and 5 percent biotite and a trace of hornblende. About 2 percent volcanic lithic fragments are generally less than 1 cm in diameter. Unit forms a resistant ledge. The $^{40}Ar/^{39}Ar$ age of the tuff is 22.8 Ma (Best and others, 1989). The Bauers Tuff Member ranges from 5 to 12 m thick

Tba **Basaltic andesite lava flow (Miocene or upper Oligocene?)**--Basaltic andesite occurs as several small pale-brown weathered exposures in the northwest part of the quadrangle. The rock contains about 50 percent groundmass, 25 percent plagioclase, 15 percent clinopyroxene, and 10 percent altered olivine(?). Locally rock contains 20 percent calcite amygdules. Map unit thickness is unknown

Tlc **Leach Canyon Formation, undifferentiated (Oligocene)**--Rhyolitic ash-flow tuff conisting of one compound cooling unit. Grades upward from pinkish-gray nonwelded to partially welded base through a locally developed grayish-black vitrophyre and zones of grayish-orange-pink moderately welded devitrified tuff to a grayish-pink partially welded top. Pumice fragments are less than 0.5 cm in diameter and form less than 5 percent of the rock. The rock contains about 15 percent phenocrysts that consist of 35 percent quartz, 25 percent sanidine, 35 percent plagioclase, 5 percent biotite, and a trace of hornblende. Lithic fragments are sparce. Unit forms gentle, undulating slopes and poorly developed cliffs. The average K-Ar age of the Leach Canyon Formation is about 24.7 Ma (Armstrong, 1970). In the south central-part of the map area, formation is subdivided into upper (Tlcu) and lower (Tlcl) parts. Leach Canyon Formation ranges from 75 to 100 m thick

Tlcu **Upper part**--Rhyolitic ash-flow tuff grading downward from a grayish-pink partially welded top to grayish-orange-pink moderately welded tuff. The exposures have distinctive partings with spacings of 0.5-2 m that are subparallel to the foliation. The upper part of the Leach Canyon Formation is about 75 m thick

Tlcl **Lower part**--Rhyolitic ash-flow tuff grading downward from a zone of grayish-orange-pink moderately welded devitrified tuff, through a locally developed grayish-black vitrophyre, to a pinkish-gray nonwelded to partially welded base. The exposures above the vitrophyre have a distinctive knobby or bulbous shape that is similar to that of the Hiko Tuff (Th). The lower part of the Leach Canyon Formation is about 25 m thick

Tl **Limestone (Oligocene)**--Lacustrine limestone containing disrupted algal plates. Limestone is very light gray to pinkish-gray and recrystallized to medium grain size. Beds range are 0.2-1.5 m thick. Limestone ranges from 0 to 10 m thick

Shingle Pass Tuff (Oligocene)--Two members of rhyolitic ash-flow tuff

Tspu **Upper member**--Rhyolitic ash-flow tuff consisting of a simple cooling unit grading downward from a grayish-orange-pink to very pale pink moderately to partially welded devitrified tuff, through a locally developed dark-gray to brownish-gray vitrophyre, to a pinkish-gray nonwelded to partially welded base. Distinctive grayish-yellow to moderate-greenish-yellow partings, formed by altered layers (1 mm thick), are common in the vitrophyre. Pumice fiamme are as large as 3 cm in diameter in the plane of foliation and form about 15 percent of the rock. The rock contains about 5 percent phenocrysts that consist of a trace of quartz, 35 percent sanidine, and 50 percent plagioclase. Lithic fragments are as great as 3.5 cm in diameter and form 10 percent of the rock. Unit forms gentle slopes except for ledge where vitrophyre is present. The $^{40}Ar/^{39}Ar$ age of the upper member is 26.0 Ma (Best and others, 1989, table 2). Upper member of the Shingle Pass Tuff is about 20 m thick

Tspl **Lower member**--Rhyodacitic ash-flow tuff consisting of a simple cooling unit grading downward from a relatively thin moderate-orange-pink moderately welded devitrified tuff, through a nearly ubiquitous very dark red to brownish-black to grayish-red vitrophyre, to a pinkish-gray nonwelded to partially welded base. Flattened pumice fragments are as large as 4 cm in diameter in the plane of foliation and form about 5 percent of the rock. The rock contains about 15 percent phenocrysts that consist of 5 percent quartz, 55 percent sanidine, 40 percent plagioclase, and a trace of hornblende. Lithic fragments, as large as 2 cm in diameter, form less than 5 percent of the rock. Flattened lithophysal cavities are as great as 6 cm in diameter and form about 10 percent of the rock. Flow lineations are common where member is draped on buried topography. Unit forms a sharp cliffy ledge above the gentle slopes of the Monotony Tuff (Tm). The $^{40}Ar/^{39}Ar$ age of the lower member is 26.7 Ma (Best and others, 1989, table 2). The lower member of the Shingle Pass Tuff is as thick as 20 m but pinches out in the southeast part of the quadrangle

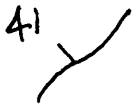
Tm **Monotony Tuff (Oligocene)**--Rhyodacitic ash-flow tuff consisting of a simple cooling unit. Tuff is nonwelded to partially welded and very light gray to pinkish gray. Layers of bedded ash-fall tuff overlie ash-flow tuff. Pumice fragments are sparse in unit. Rock contains about 15 percent phenocrysts that consist of 15 percent quartz, 10 percent sanidine, 50 percent plagioclase, 10 percent biotite, 5 percent hornblende, and 5 percent pyroxene. Lithic fragments are sparse. Unit forms gentle slopes. The $^{40}Ar/^{39}Ar$ age of the Monotony Tuff is 27.3 Ma (Best and others, 1989, table 2). Monotony Tuff is at least 30 m thick at south margin of quadrangle and pinches out to the east

Tcp **Conglomerate, Paleozoic clasts (early Tertiary ?)**--Clasts of Paleozoic limestone and chert boulders derived from the underlying Bird Springs Formation. Pale-red color is imparted by calcareous cement. Unit exposed along south margin of the quadrangle where it is less than 10 m thick in low areas on buried topography

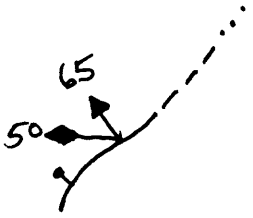
Bird Springs Formation (Lower Permian and Upper Pennsylvanian?)--An upper part correlated with unit D of Langenheim and others (1962) and a lower part (PIPb) are mapped. Tertiary rocks rest on an angular unconformity above the Bird Springs Formation. The base of the lower part is not exposed

PIPbd **Unit D**--Interbedded limestone, siltstone, and shale characterized by downward increases in shale from 5 to 60 percent and decrease in chert from 30 to 0 percent. Limestone is olive gray (fresh) and light-brown, grayish yellow, and very pale orange (weathered) mostly aphanitic, and regularly bedded with abundant bedding-parallel laminations. Average bed thickness about 0.1 m. Grayish-orange, pale-red, and light-brown shale partings are common and are repeated at a spacing of 0.3-0.6 m. Chert occurs as discontinuous layers and isolated nodules. Basal 12 m of unit D is slightly calcareous, laminated to fissile pale-red and grayish-orange siltstone and subordinate shale containing abundant elaongate limestone pods (as great as 5 cm in diameter). With the exception of a thin zone containing abundant fusilinids in the middle, unit D is relatively unfossiliferous. Unit is as great as 50 m thick

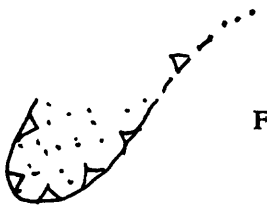
PIPb **Lower part**--Medium-gray, light-brown, and pale-red-purple limestone characterized by common discontinuous beds and nodules of chert and micritic to finely crystalline and arenaceous limestone. Limestone beds range in thickness from 0.2 to 2 m. Rock has abundant reddish-weathering, thinly bedded, shaley limestone and shale partings, and less common interbeds of light-gray silty dolomite, light-brown-weathering sandstone, siltstone, and shale. Locally, rock is highly fossiliferous (chain and rugose corals, pelmatazoan stems, brachiopods, fusulinids, and gastropods). Unit forms ledgey slopes and is as much as 85 m thick



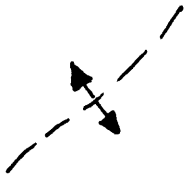
Contact--showing direction and amount of dip, where known



Fault--showing dip (barbed arrow) and trend and plunge of lineation (diamond-shaped arrow). Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

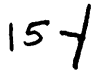


Fault--Sawteeth on upper plate of slide block. Dashed where approximately located; dotted where concealed. Stippled pattern on upper plate



Anticline

Strike and dip of sedimentary beds and of compaction foliation of ash-flow tuffs



Inclined

Horizontal

Strike and dip of foliation in lava flows and ash-flow tuffs that show evidence of flow in addition to flattening

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Correlation of Map Units