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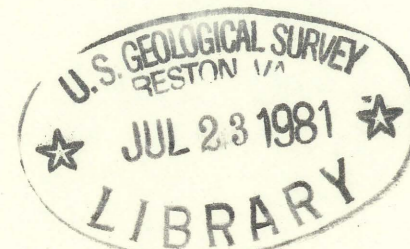
GEOLOGICAL SURVEY

Preliminary geologic map including argillic and advanced
argillic alteration and principal hydrothermal quartz
and alunite veins in the Tushar Mountains and adjoining areas,
Marysvale volcanic field, Utah

By

Charles G. Cunningham, Thomas A. Steven, Peter D. Rowley,

Lori B. Glassgold, and John J. Anderson



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DESCRIPTION OF MAP UNITS

- Qa ALLUVIAL DEPOSITS (QUATERNARY)--Silt, sand, and gravel in alluvial fans, alluvial slope wash, stream alluvium, and lacustrine deposits. Includes older deposits as well as deposits graded to present drainage
- Ql LANDSLIDE DEBRIS (QUATERNARY)--Poorly sorted rock debris that moved downslope by gravity. Locally contains significant glacial drift, rock glaciers, talus, and other deposits
- Qt TRAVERTINE (QUATERNARY)--Calcareous spring deposits
- Qg GLACIAL DEPOSITS (PLEISTOCENE)--Till deposited by glaciers (unsorted sand and gravel), probably Pinedale in age. Locally includes glacial outwash deposits. Mapped separately only in northern Sevier Plateau
- Qcf BASALTIC ANDESITE OF COVE FORT (PLEISTOCENE)--Dark-gray to black, vesicular to dense lava flows containing phenocrysts and microphenocrysts of plagioclase, pyroxene, magnetite, olivine, and sparse corroded quartz in a felted matrix of microlites and glass. Petrographic description modified from Clark (1977). Forms shield volcano. Source of most flows is marked by a cinder cone on the crest of the shield volcano. K-Ar age is 0.5 m.y. (Best and others, 1980)
- QTa OLDER ALLUVIUM (PLEISTOCENE TO MIOCENE?)--Poorly to moderately consolidated fluvialite and lacustrine conglomerate, sandstone, and siltstone, containing local interlayered airfall tuff beds. Includes fanglomerate and pediment gravel. Probably equivalent in part to Sevier River Formation (Ts)
- Ts SEVIER RIVER FORMATION (PLIOCENE AND MIOCENE)--Tan or gray, poorly to moderately consolidated fluvialite and lacustrine conglomerate, sandstone, and siltstone, containing local interlayered white airfall tuff beds. Locally contains interlayered basalt lava flows (Tbas). A tuff bed near the base of the unit has been dated by fission tracks at about 15 m.y. old, and another near the top at about 7 m.y. old (Steven and others, 1979)
- Tc CONGLOMERATE (MIOCENE)--Brown and locally red, conglomerate and sandstone containing rounded clasts of Bullion Canyon volcanics. Accumulated in the lower parts of a basin marking the eroded Big John caldera
- BIMODAL BASALT-RHYOLITE ASSEMBLAGE
- Tbas BASALT LAVA FLOWS (MIOCENE)--Black to dark-gray, vesicular or amygdaloidal olivine basalt. Includes some scoria. K-Ar ages range from 14 to 5 m.y. (Best and others, 1980)
- Trf RHYOLITE OF FORBES MOUNTAIN (MIOCENE)--Resistant, light-gray, white, or black, flow-layered, spherulitic, locally vesicular alkalic rhyolite lava flows and volcanic domes. Contains sparse small phenocrysts of plagioclase and minor sanidine and quartz. K-Ar age is about 8 m.y. (Rowley and others, 1981)

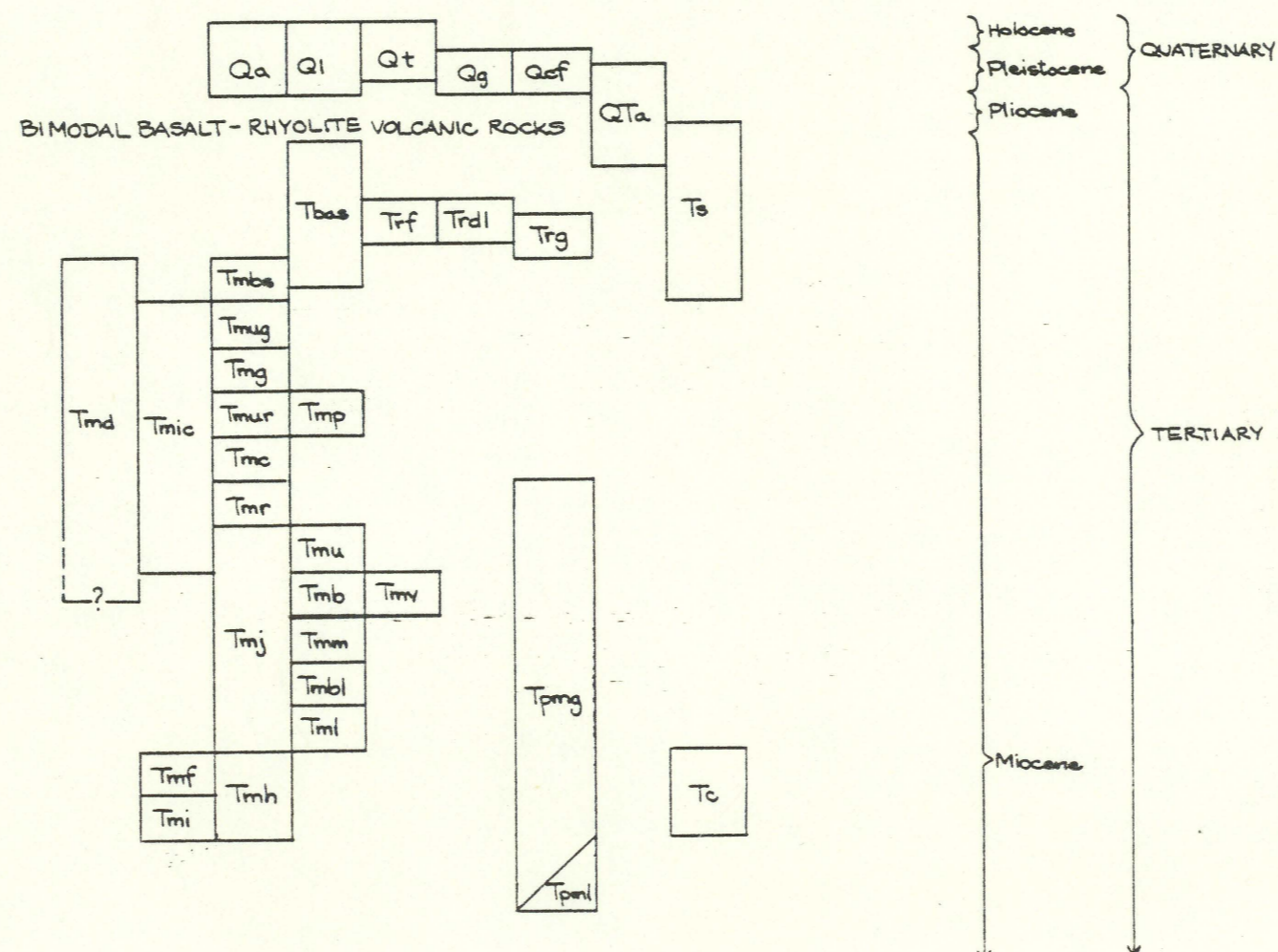


Figure 1.-- CORRELATION OF HOLOCENE TO MIOCENE MAP UNITS

- Trd1 RHYODACITE OF DRY LAKE (MIOCENE)--Resistant, light-gray, pink, tan, or black, flow-layered, devitrified, locally spherulitic rhyodacite volcanic domes and stubby lava flows. Phenocrysts of plagioclase, subordinate hornblende, and minor biotite, quartz, and Fe-Ti oxides comprise 10-30 percent of the rock
- Trg RHYOLITE OF GILLIES HILL (MIOCENE)--Light-gray to white, flow-layered rhyolite lava flows and volcanic domes containing phenocrysts of sanidine and partly resorbed quartz in a vuggy, devitrified groundmass. Formed only on west side of Tushar Mountains and at north end of Beaver Valley. K-Ar age is about 9 m.y. (Evans, 1980)
- MOUNT BELKNAP VOLCANICS (MIOCENE)
- Intrusive rocks
- Tmd Dikes and small stocks--Several small, glassy to aphanitic, rhyolitic dikes, stocks, and lava flows. Most are younger than Red Hills Tuff Member (Tmr)
- Tmc Intracaldera intrusive rocks--Several small porphyritic quartz latite to rhyolitic stocks within the Mount Belknap caldera. Contain sparse phenocrysts of quartz, plagioclase, and sanidine in a finely granular mosaic of alkali feldspar and quartz
- Tmf Fine-grained granite--Forms a small stock and related dikes that host the uranium-bearing veins in the Central Mining Area. Contains phenocrysts of quartz, orthoclase, plagioclase, and minor biotite in a groundmass characterized by graphic intergrowths. K-Ar age is about 20 m.y. (Steven and others, 1979)
- Tmi Porphyritic rhyolitic stocks and volcanic domes--Several small bodies northeast of Marysvale. Contain phenocrysts of sanidine, plagioclase, biotite, hornblende, quartz, and minor apatite, sphene, and magnetite in a devitrified or glassy matrix. K-Ar age is about 21 m.y. (Steven and others, 1979)
- Tmbs Outflow facies volcanic rocks
- Tmgs Rhyolite of Big Star--Light-gray, flow-layered rhyolite lava flows with sparse sanidine phenocrysts and, locally, black basal glass. K-Ar age is about 14 m.y. (Bassett and others, 1963)
- Tmug Upper gray tuff member--Light-gray, partially welded, ash-flow tuff containing sparse sanidine phenocrysts. Derived from the Mount Belknap caldera source area. K-Ar age is 18 m.y. (Steven and others, 1979)
- Tmg Gray Hills Rhyolite Member--Light-gray, spherulitically devitrified rhyolite lava flows. Contains sparse sanidine phenocrysts and is characterized by contorted flow layers
- Tmur Upper red tuff member--Red, crystal-poor, densely welded, ash-flow tuff characterized by black flame as much as 3 cm long. Derived from the Mount Belknap caldera source area
- Tmp Porphyritic lava flows--Dark-gray, pyroxene latite lava flows located west of the Sevier River. Contain phenocrysts of andesine, diopside augite, and oxidized hornblende in a felted groundmass of microlites and hematite
- Tmc Crystal-rich member--Dark-reddish-brown, moderately welded, alkali rhyolite ash-flow tuff containing 30 percent phenocrysts of anorthoclase, quartz, sodic plagioclase, and biotite. Derived from the Mount Belknap caldera source area. K-Ar age is about 19 m.y. (Steven and others, 1979)

- Tmr Red Hills Tuff Member--Reddish-brown, crystal-poor, densely welded, alkali rhyolite ash-flow tuff. Contains about 7 percent phenocrysts of anorthoclase, quartz, plagioclase, and minor biotite. Derived from the Red Hills caldera source area (Cunningham and Steven, 1979)
- Tmj Joe Lott Tuff Member--Partially welded, crystal-poor, light-gray or tan, alkali rhyolite ash-flow tuff containing 1-2 percent phenocrysts of quartz, sodic plagioclase, sanidine, and traces of biotite. Comprises most of the outflow facies derived from the Mount Belknap caldera source area (Cunningham and Steven, 1979). Stratigraphic position relative to radiometrically dated units indicates an age of about 19 m.y. (Steven and others, 1979)
- Tmh Lower heterogeneous member--A sequence of rhyolitic volcanic domes, lava flows, and subordinate ash-flow tuff and volcanic sedimentary rocks that lie on or intrude older, intermediate-composition volcanic rocks and are, in part, overlain by the Joe Lott Tuff Member
- Tmu Intracaldera facies volcanic rocks (Mount Belknap caldera)
- Tmb Upper tuff member--Red to black, crystal-poor, rhyolitic, partially welded, ash-flow tuff. Lithologically similar to that of the outflow Joe Lott Tuff Member (Tmj)
- Tmb Mount Baldy Rhyolite Member--Light-gray, crystal-poor, rhyolite lava flows and dikes consisting largely of a fine granular mosaic of quartz and alkali feldspar, and minor plagioclase, biotite, and hematite. Contorted flow layers are common. Mostly intracaldera facies, but locally extends out across the margin of the Mount Belknap caldera
- Tmv Volcaniclastic rocks--Dominantly light gray to white volcanic mudflow breccia derived from nearby lava flows of the Mount Baldy Rhyolite Member (Tmb). Some landslide debris and fluvialite sand and gravel are included in the unit
- Tmm Middle tuff member--Light-gray to buff, partially welded, crystal-poor, rhyolite ash-flow tuff. Lithologically similar to, and locally continuous across the caldera margin into, the upper part of the Joe Lott Tuff Member (Tmj)
- Tmbi Blue Lake Rhyolite Member--Crystal-poor, rhyolite lava flows lithologically similar to those in the Mount Baldy Rhyolite Member (Tmb). Contorted flow layers are characteristic
- Tml Lower tuff member--Moderately welded, crystal-poor, rhyolite ash-flow tuff lithologically similar to the Joe Lott Tuff Member (Tmj)
- POTASSIUM-RICH MAFIC VOLCANIC ROCKS IN THE SOUTHERN TUSHAR MOUNTAINS
- Tpmg Gravels from potassium-rich mafic lava flows--Poorly consolidated fanglomerate and conglomerate composed largely of fragments of the potassium-rich mafic lavas
- Tpml Potassium-rich mafic lava flows--Black to dark-gray, vesicular mafic lava flows containing olivine, augite, plagioclase laths, and Fe-Ti oxides. Includes some scoria and amygdaloidal flows. K-Ar age is about 22 m.y. (Best and others, 1980)

FUNDAMENTALLY INTERMEDIATE-COMPOSITION VOLCANIC ROCKS

NORTHERN ASSEMBLAGE CENTRAL AND SOUTHERN ASSEMBLAGE EASTERN ASSEMBLAGE

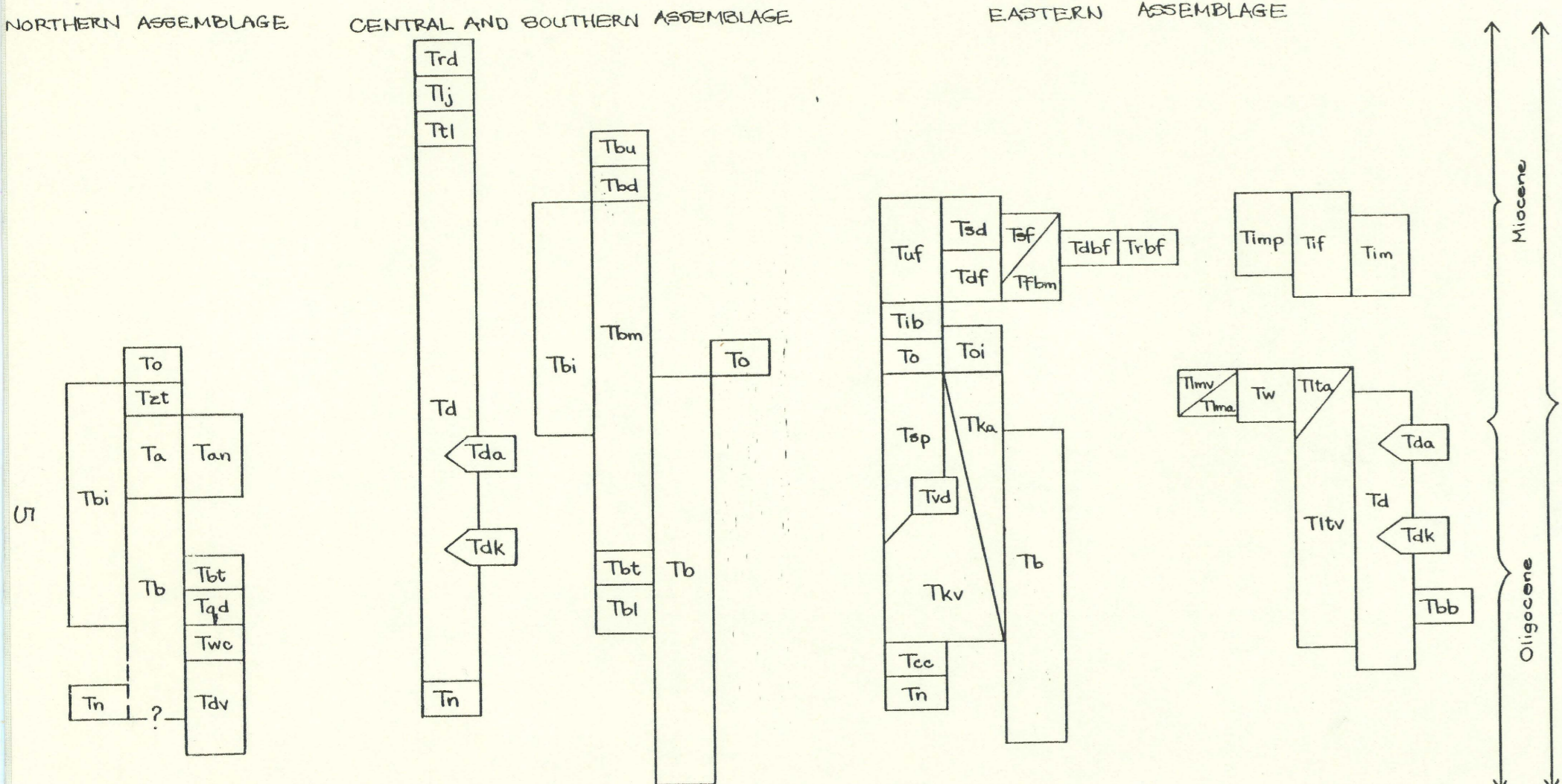


Figure 2.-- CORRELATION OF FUNDAMENTALLY INTERMEDIATE-COMPOSITION TERTIARY VOLCANIC ROCKS

NORTHERN ASSEMBLAGE OF FUNDAMENTALLY INTERMEDIATE-COMPOSITION VOLCANIC ROCKS

- To OSIRIS TUFF (MIOCENE)--White, partially welded ash-flow tuff containing about 10 percent lithic fragments and phenocrysts of sanidine and plagioclase with sparse quartz and biotite. Matrix has been almost completely converted to the zeolite mineral clinoptilolite. May correlate with the Leach Canyon Formation of southwestern Utah (24 m.y.; Anderson and Rowley, 1975)
- Ta TUFF OF ALBINUS CANYON (MIOCENE OR OLIGOCENE)--Red to gray, vesicular, densely welded ash-flow tuff (tufflava) containing a few percent phenocrysts of calcic labradorite, augite, and biotite in a glassy to devitrified matrix. Prominent fluidal textures from secondary flow and very abundant lineate vesicles are characteristic
- Tan BASALTIC ANDESITE (MIOCENE OR OLIGOCENE)--Vesicular, black to dark-gray lava flows containing phenocrysts of calcic labradorite, pyroxene, magnetite, and olivine (altered to iddingsite) in a glassy to microgranular matrix
- Tb BULLION CANYON VOLCANICS (MIOCENE AND OLIGOCENE)²
- Tbi Heterogeneous lava flows and volcanic breccias
- Tbt Intermediate-composition intrusive rock (OLIGOCENE AND MIOCENE)²
- Tbd Three Creeks Tuff Member²
- Tqd QUARTZ LATITE AND RHYODACITE VOLCANIC DOME AND FLOW (OLIGOCENE)--A single large volcanic dome of porphyritic quartz latite containing 30 percent phenocrysts of andesine and biotite, and trace amounts of quartz, sanidine, and augite. Overlain by a dark-gray rhyodacite flow containing sparse phenocrysts of plagioclase, pyroxenes, and Fe-Ti oxides
- Twc VOLCANIC ROCKS OF WALES CANYON (OLIGOCENE)--Red, porphyritic, intermediate-composition lava flows and densely welded ash-flow tuff containing phenocrysts of plagioclase, clinopyroxene, and biotite in a microgranular matrix
- Tn NEEDLES RANGE FORMATION (OLIGOCENE)--Gray, tan, or pink moderately welded quartz latite ash-flow tuff consisting of 40-50 percent phenocrysts of andesine, hornblende (10-15 percent), biotite, and minor sanidine, quartz, pyroxene, and Fe-Ti oxides. The high hornblende to biotite ratio is a distinguishing characteristic. Probably the Wah Wah Springs Member (Shuey and others, 1976). The K-Ar age is 30 m.y. (Fleck and others, 1975)
- Tdv VOLCANIC ROCKS OF DOG VALLEY (OLIGOCENE)--Heterogeneous assemblage of intermediate-composition lava flows, flow breccia, volcanic mudflow breccia, and minor, moderately welded ash-flow tuff. Rock typically is a dark- to light-gray porphyry containing phenocrysts of plagioclase, hornblende, and biotite, and Fe-Ti oxides. Clinopyroxene is locally present, particularly in the ash-flow tuff units

CENTRAL AND SOUTHERN ASSEMBLAGE OF FUNDAMENTALLY INTERMEDIATE-COMPOSITION VOLCANIC ROCKS

- Trd RHYODACITE TO RHYOLITE DIKES (MIOCENE)--Light-gray rhyodacite to white rhyolite containing phenocrysts of sanidine, andesine, quartz, and chloritized hornblende in a matrix of altered feldspar, quartz, and minor accessory zircon and apatite. Fission-track ages on dikes from Bullion Canyon are 21.9 m.y. for a rhyolite (Cunningham and others, 1978) and 21.5 m.y. for a rhyodacite (C. W. Nassert, written commun., 1978)
- Tlj FORMATION OF LOUSY JIM (SIGMUND, 1979) (MIOCENE)--Light- to dark-gray, quartz latite porphyry lava flows and flow breccia. Contains 23 percent phenocrysts of plagioclase, amphibole, clinopyroxene, magnetite, biotite, quartz, and accessory minerals in a glassy groundmass (Sigmund, 1979). Contorted flow layering is common
- Ttl TUFF OF LION FLAT (MIOCENE)--Light-gray to grayish-pink, ash-flow tuff consisting of glass shards, pumice fragments, and volcanic dust, and about 5 to 15 percent phenocrysts of plagioclase, quartz, sanidine, biotite, and amphibole. Locally reworked and zeolitized
- Td MOUNT DUTTON FORMATION (MIOCENE AND OLIGOCENE)¹
- Tda Antimony Tuff Member (Oligocene)
- Tdk Kingston Canyon Tuff Member (Oligocene)¹
- Tn NEEDLES RANGE FORMATION (OLIGOCENE)
- Tbi BULLION CANYON VOLCANICS (MIOCENE AND OLIGOCENE)
- Intermediate-composition intrusive rock (Miocene)--Dark- to light-gray and brown, strongly porphyritic quartz latite and latite and porphyritic to equigranular, fine- to medium-grained quartz monzonite, monzonite, and granodiorite. The more crystalline rocks commonly contain approximately equal proportions of plagioclase and orthoclase, 0-20 percent quartz, plus augite, hornblende, and biotite. Accessory minerals are apatite, zircon, and Fe-Ti oxides. Radiometric ages cluster near 23 m.y. (Steven and others, 1979; Cunningham and others, 1981) but differ slightly in the various assemblages
- Tbu Upper member (Miocene)--Mostly dark-gray to black, fine-grained rhyodacite to andesite lava flows and local densely welded ash-flow tuff, some of which show prominent lineate texture due to secondary flowage. Overlies Delano Peak Tuff Member in central Tushar Mountains
- Tbd Delano Peak Tuff Member (Miocene)--Dark-reddish-brown densely welded, crystal-rich quartz latite ash-flow tuff containing 40-50 percent phenocrysts of andesine, hornblende, biotite, and minor quartz, zircon, and apatite. Source area marked by Big John caldera in central Tushar Mountains. K-Ar age is about 22 m.y. (Steven and others, 1979)
- Tbn Middle member (Miocene and Oligocene)--Mostly light gray and brown rhyodacite lava flows, flow breccia, and volcanic mudflow breccia that lie between the overlying Delano Peak Tuff Member (Tbd) and underlying Three Creeks Tuff Member (Tbt) in the central Tushar Mountains

- Tbt Three Creeks Tuff Member (Oligocene)--Light-gray and brown, densely welded, crystal-rich quartz latite ash-flow tuff containing 45-50 percent phenocrysts of plagioclase, hornblende, biotite, and quartz, with trace amounts of Fe-Ti oxide minerals, sanidine, and other accessory minerals. K-Ar age is 27 m.y. (Steven and others, 1979). Contains local masses of diverse breccias adjacent to scarps formed by penconemporaneous volcano-tectonic subsidence
- Tbl Lower member (Oligocene)--Heterogeneous lava flows, flow breccia, and volcanic mudflow breccia, and minor tuffaceous sedimentary rocks. Rocks range from porphyritic rhyodacite, containing phenocrysts of plagioclase, biotite, hornblende, and lesser pyroxene, to fine-grained, dark-gray rocks containing small phenocrysts of plagioclase and pyroxene. Underlies Three Creeks Tuff Member in the central Tushar Mountains
- Tb Heterogeneous lava flows and volcanic breccia (Miocene and Oligocene)--Porphyritic andesite, rhyodacite, and quartz latite. Contains phenocrysts of plagioclase, biotite, and clinopyroxene. In part consists of fine-grained dark lava flows and breccia of intermediate composition, containing small phenocrysts of plagioclase and clinopyroxene. Age range differs slightly in the various assemblages
- To OSIRIS TUFF (MIOCENE)
- EASTERN ASSEMBLAGE OF FUNDAMENTALLY INTERMEDIATE-COMPOSITION VOLCANIC ROCKS
- Tuf POST-CALDERA VOLCANIC ROCKS FILLING UPPER PART OF MONROE PEAK CALDERA (MIOCENE)
- Undivided post-Monroe Peak caldera volcanic rocks--Includes one or more of the sanidine-bearing dacitic lava flows (Tsd) or dacitic lava flows (Tdf)
- Tsd Sanidine-bearing dacitic lava flows--Resistant to moderately resistant, generally light to dark gray and dark brown, locally vesicular or amygdaloidal, locally flow layered, dacitic lava flows. Locally includes volcanic mudflow breccia and ash-flow tuff. Contains moderately abundant phenocrysts of plagioclase, sanidine, pyroxene, and biotite, and minor Fe-Ti oxides and olivine; sanidine phenocrysts may be as long as 2 cm. Considered to be the extrusive equivalent of the resurgent intrusive rocks (Tim) that invaded the volcanic rocks filling the Monroe Peak caldera. K-Ar age is 21.1 m.y. (H. H. Mehnert, written commun., 1980)
- Tdf Dacitic lava flows--Moderately resistant to soft, brownish-red, tan, and light- to dark-gray, locally vesicular or amygdaloidal, locally flow layered dacitic lava flows. Contain abundant to sparse small phenocrysts of plagioclase, sanidine, pyroxene, and minor biotite, Fe-Ti oxides, and olivine. Unit locally contains light-gray crystal-poor rhyodacitic lava flows. Considered to be an extrusive equivalent of the resurgent pluton (Tim)
- Tsf Lava flows of Sage Flat--Resistant, medium- to dark-gray or black andesitic lava flows. Contain mostly large phenocrysts of plagioclase, pyroxene, olivine, and minor Fe-Ti oxides. Upper part generally scoriaceous and amygdaloidal



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