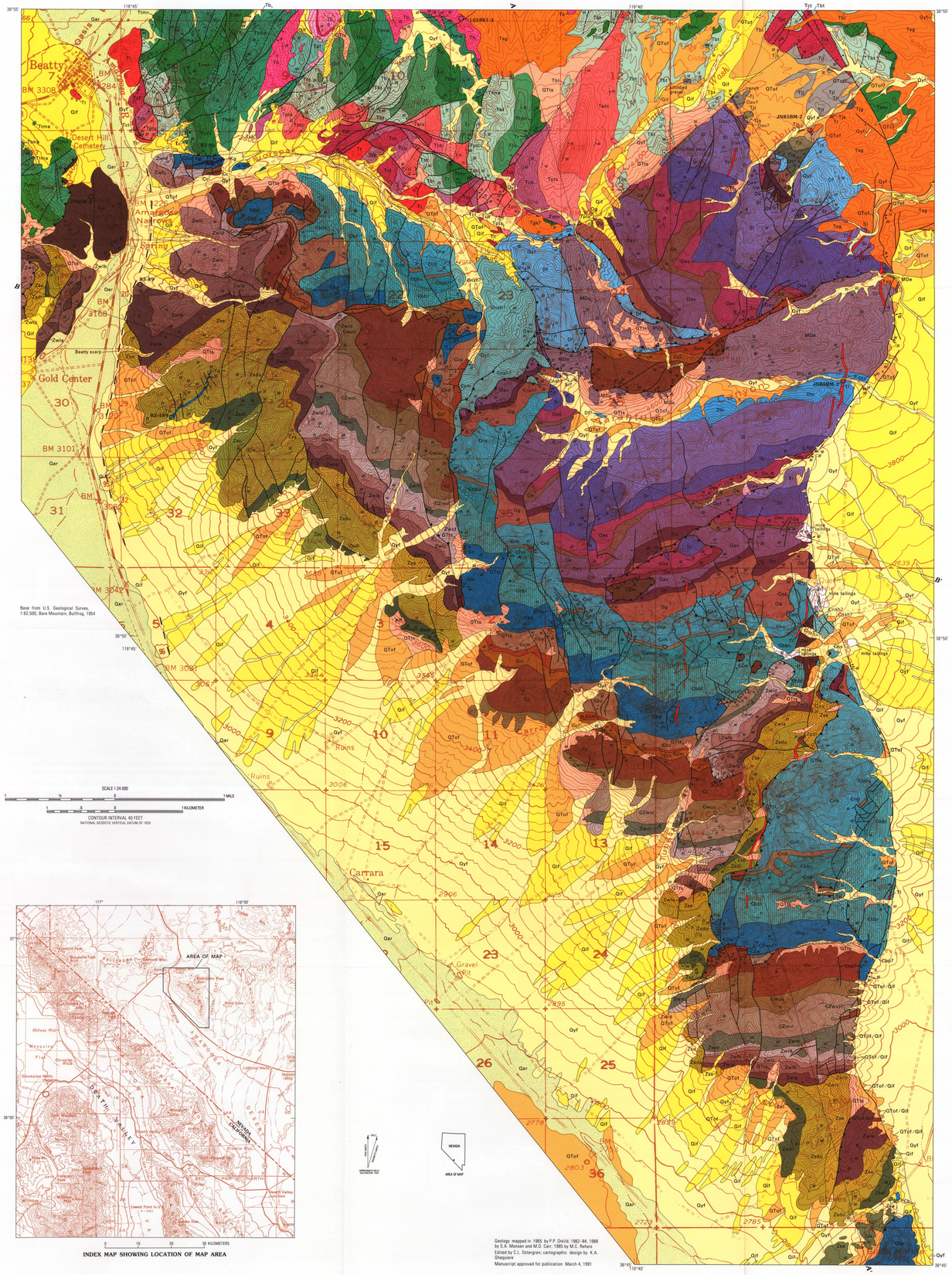
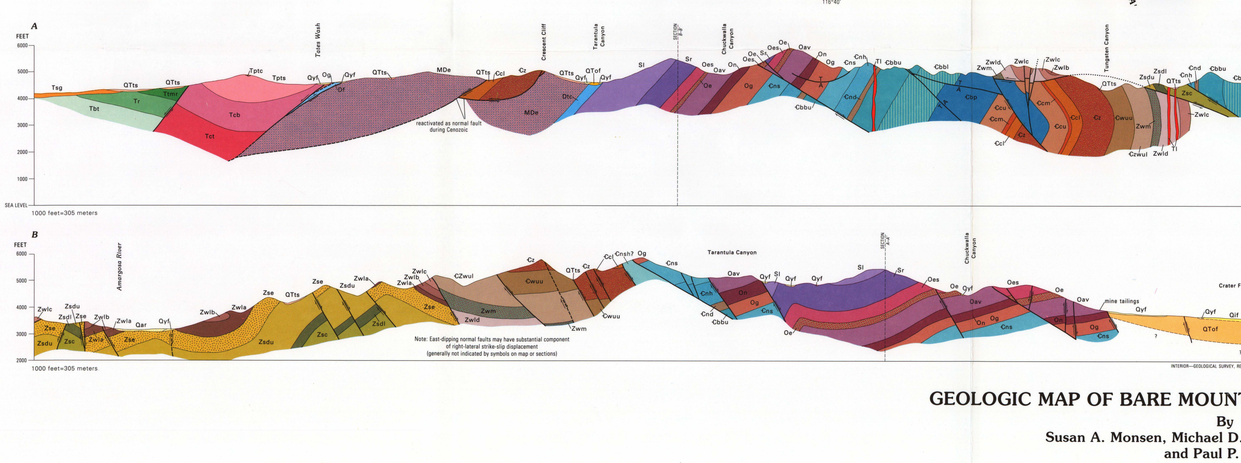
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

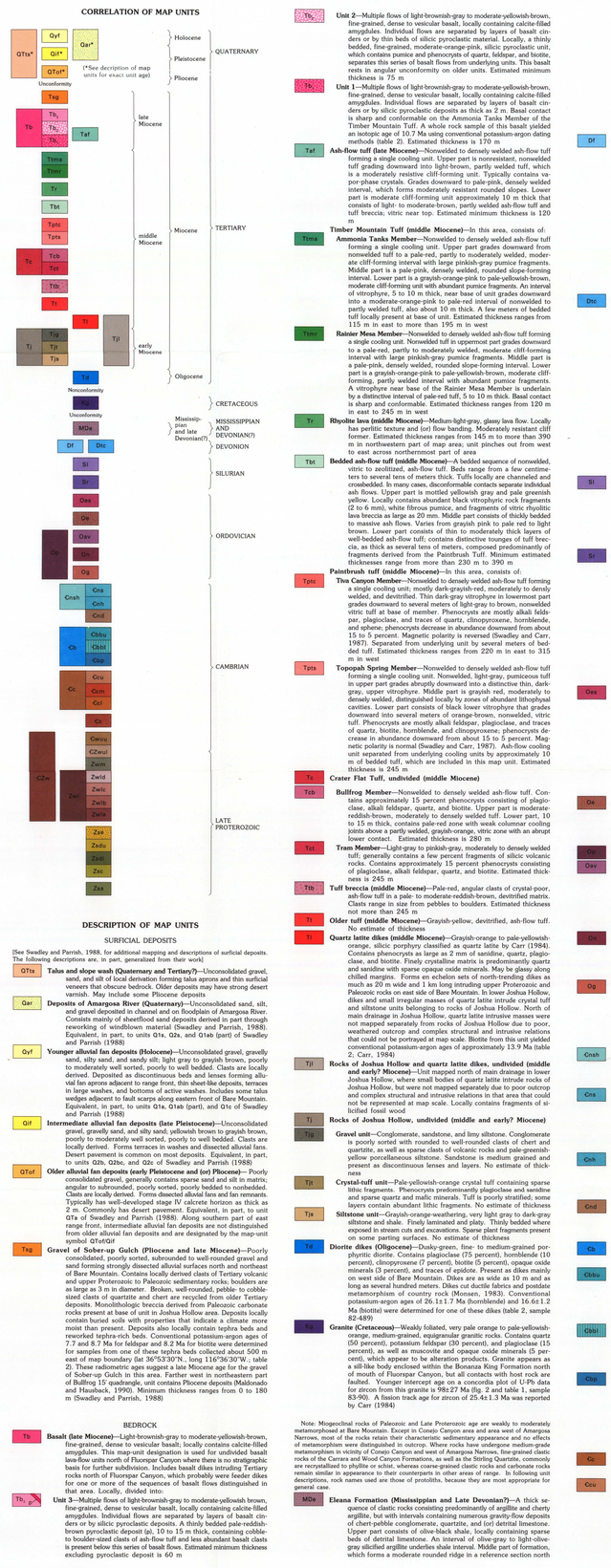
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-2201
*Explanatory pamphlet accompanies map*




INDEX MAP SHOWING LOCATION OF MAP AREA




## CORRELATION OF MAP UNITS




## DESCRIPTION OF MAP UNITS

### SURFICIAL DEPOSITS

[See Swadley and Parrish, 1988, for additional mapping and descriptions of surficial deposits. The following descriptions are, in part, generalized from their work]

**QTa** **Talus and slope wash (Quaternary and Tertiary?)**—Unconsolidated gravel, sand, and silt of local derivation forming talus aprons and thin surficial veneers that obscure bedrock. Older deposits may have strong desert varnish. May include some Pliocene deposits

**Qar** **Deposits of Amargosa River (Quaternary)**—Unconsolidated sand, silt, and gravel deposited in channel and on floodplain of Amargosa River. Consists mainly of sheetflood sand deposits derived in part through reworking of windblown material (Swadley and Parrish, 1988). Equivalent, in part, to units Q1s, Q2s, and Q1ab (part) of Swadley and Parrish (1988)

**Qyf** **Younger alluvial fan deposits (Holocene)**—Unconsolidated gravel, gravelly sand, silty sand, and sandy silt; light gray to grayish brown, poorly to moderately well sorted, poorly to well bedded. Clasts are locally derived. Deposited as discontinuous beds and lenses forming alluvial fan aprons adjacent to range front, thin sheet-like deposits, terraces in large washes, bottoms of active washes. Includes some talus wedges adjacent to fault scarps along eastern front of Bare Mountain. Equivalent, in part, to units Q1a, Q1ab (part), and Q1c of Swadley and Parrish (1988)

**Qif** **Intermediate alluvial fan deposits (late Pleistocene)**—Unconsolidated gravel, gravelly sand, and silty sand, yellowish brown to grayish brown, poorly to moderately well sorted, poorly to well bedded. Clasts are locally derived. Forms terraces in washes and dissected alluvial fans. Desert pavement is common on most deposits. Equivalent, in part, to units Q2b, Q2bc, and Q2c of Swadley and Parrish (1988)

**QTof** **Older alluvial fan deposits (early Pleistocene and (or) Pliocene)**—Poorly consolidated gravel, generally contains sparse sand and silt in matrix; angular to subrounded, poorly sorted, poorly bedded to nonbedded. Clasts are locally derived. Forms dissected alluvial fans and fan remnants. Typically has well-developed stage IV calcrete horizon as thick as 2 m. Commonly has desert pavement. Equivalent, in part, to unit QTa of Swadley and Parrish (1988). Along southern part of east range front, intermediate alluvial fan deposits are not distinguished from older alluvial fan deposits and are designated by the map-unit symbol QTof/Qif

**Tsg** **Gravel of Sober-up Gulch (Pliocene and late Miocene)**—Poorly consolidated, poorly sorted, subrounded to well-rounded gravel and sand forming strongly dissected alluvial surfaces north and northeast of Bare Mountain. Contains locally derived clasts of Tertiary volcanic and upper Proterozoic to Paleozoic sedimentary rocks; boulders are as large as 1 m in diameter. Broken, well-rounded, pebble- to cobble-sized clasts of quartzite and chert are recycled from older Tertiary deposits. Monolithologic breccia derived from Paleozoic carbonate rocks present at base of unit in Joshua Hollow area. Deposits locally contain buried soils with properties that indicate a climate more moist than present. Deposits also locally contain tephra beds and reworked tephra-rich beds. Conventional potassium-argon ages of 7.7 and 8.7 Ma for feldspar and 8.2 Ma for biotite were determined for samples from one of these tephra beds collected about 500 m east of map boundary (lat 36°53'30"N., long 116°36'30"W.; table 2). These radiometric ages suggest a late Miocene age for the gravel of Sober-up Gulch in this area. Farther west in northeastern part of Bullfrog 15' quadrangle, unit contains Pliocene deposits (Maldonado and Hausback, 1990). Minimum thickness ranges from 0 to 180 m (Swadley and Parrish, 1988)

### BEDROCK

**Tb** **Basalt (late Miocene)**—Light-brownish-gray to moderate-yellowish-brown, fine-grained, dense to vesicular basalt; locally contains calcite-filled amygdules. This map-unit designation is used for undivided basalt lava-flow units north of Fluorspar Canyon where there is no stratigraphic basis for further subdivision. Includes basalt dikes intruding Tertiary rocks north of Fluorspar Canyon, which probably were feeder dikes for one or more of the sequences of basalt flows distinguished in that area. Locally, divided into:

**Tb$_3$, p$_{Cb}$** **Unit 3**—Multiple flows of light-brownish-gray to moderate-yellowish brown, fine-grained, dense to vesicular basalt, locally containing calcite-filled amygdules. Individual flows are separated by layers of basalt cinders or by silicic pyroclastic deposits. A thinly bedded pale-reddish-brown pyroclastic deposit (p), 10 to 15 m thick, containing cobble- to boulder-sized clasts of ash-flow tuff and less abundant basalt clasts is present below this series of basalt flows. Estimated minimum thickness excluding pyroclastic deposit is 60 m

**Tb$_2$** **Unit 2**—Multiple flows of light-brownish-gray to moderate-yellowish-brown, fine-grained, dense to vesicular basalt, locally containing calcite-filled amygdules. Individual flows are separated by layers of basalt cinders or by thin beds of silicic pyroclastic material. Locally, a thinly bedded, fine-grained, moderate-orange-pink, silicic pyroclastic unit, which contains pumice and phenocrysts of quartz, feldspar, and biotite, separates this series of basalt flows from underlying units. This basalt rests in angular unconformity on older units. Estimated minimum thickness is 75 m

**Tb$_1$** **Unit 1**—Multiple flows of light-brownish-gray to moderate-yellowish-brown, fine-grained, dense to vesicular basalt, locally containing calcite-filled amygdules. Individual flows are separated by layers of basalt cinders or by silicic pyroclastic deposits as thick as 2 m. Basal contact is sharp and conformable on the Ammonia Tanks Member of the Timber Mountain Tuff. A whole rock sample of this basalt yielded an isotopic age of 10.7 Ma using conventional potassium-argon dating methods (table 2). Estimated thickness is 170 m

**Taf** **Ash-flow tuff (late Miocene)**—Nonwelded to densely welded ash-flow tuff forming a single cooling unit. Upper part is moderately resistant, nonwelded tuff grading downward into light-brown, partly welded tuff, which is a moderately resistive cliff-forming unit. Typically contains vapor-phase crystals. Grades downward to pale-pink, densely welded interval, which forms moderately resistant rounded slopes. Lower part is moderate cliff-forming unit approximately 10 m thick that consists of light- to moderate-brown, partly welded ash-flow tuff and tuffaceous sandstone near top. Estimated minimum thickness is 120 m

**Ttmx** **Timber Mountain Tuff (middle Miocene)**—In this area, consists of:
**Ammonia Tanks Member**—Nonwelded to densely welded ash-flow tuff forming a single cooling unit. Upper part grades downward from nonwelded tuff to a pale-red, partly to moderately welded, moderate cliff-forming interval with large pinkish-gray pumice fragments. Middle part is a pale-pink, densely welded, rounded slope-forming interval. Lower part is a grayish-orange-pink to pale-yellowish-brown, moderate cliff-forming unit with abundant pumice fragments. An interval of vitrophyre, 5 to 10 m thick, near base of unit grades downward into a moderate-orange-pink to pale-red interval of nonwelded to partly welded tuff, also about 10 m thick. A few meters of bedded tuff locally present at base of unit. Estimated thickness ranges from 115 m in east to more than 195 m in west

**Ttmr** **Rainier Mesa Member**—Nonwelded to densely welded ash-flow tuff forming a single cooling unit. Nonwelded tuff in uppermost part grades downward to a pale-red, partly to moderately welded, moderate cliff-forming interval with large pinkish-gray pumice fragments. Middle part is a pale-pink, densely welded, rounded slope-forming interval. Lower part is a grayish-orange-pink to pale-yellowish-brown, moderate cliff-forming, partly welded interval with abundant pumice fragments. A vitrophyre near base of the Rainier Mesa Member is underlain by a distinctive interval of pale-red tuff, 5 to 10 m thick. Basal contact is sharp and conformable. Estimated thickness ranges from 120 m in east to 245 m in west

**Tr** **Rhyolite lava (middle Miocene)**—Medium-light-gray, glassy lava flow. Locally has perlitic texture and (or) flow banding. Moderately resistant cliff former. Estimated thickness ranges from 145 m to more than 390 m in northwestern part of map area; unit pinches out from west to east across northernmost part of area

**Tbt** **Bedded ash-flow tuff (middle Miocene)**—A bedded sequence of nonwelded, vitric to zeolitized, ash-flow tuff. Beds range from a few centimeters to several tens of meters thick. Tuffs locally are channeled and crossbedded. In many cases, disconformable contacts separate individual ash flows. Upper part is mottled yellowish gray and pale greenish yellow. Locally contains abundant black vitrophyric rock fragments (2 to 6 mm), white fibrous pumice, and fragments of vitric rhyolite lava breccia as large as 20 mm. Middle part consists of thickly bedded to massive ash flows. Varies from grayish pink to pale red to light brown. Lower part consists of thin to moderately thick layers of well-bedded ash-flow tuff, contains distinctive tounges of tuff breccia, as thick as several tens of meters, composed predominantly of fragments derived from the Paintbrush Tuff. Minimum estimated thicknesses range from more than 230 m to 390 m

**Paintbrush tuff (middle Miocene)**—In this area, consists of:

**Tptc** **Tiva Canyon Member**—Nonwelded to densely welded ash-flow tuff forming a single cooling unit; mostly dark-grayish-red, moderately to densely welded, and devitrified. Thin dark-gray vitrophyre in lowermost part grades downward to several meters of light-gray to brown, nonwelded vitric tuff at base of member. Phenocrysts are mostly alkali feldspar, plagioclase, and traces of quartz, clinopyroxene, hornblende, and sphene; phenocrysts decrease in abundance downward from about 15 to 5 percent. Magnetic polarity is reversed (Swadley and Carr, 1987). Separated from underlying unit by several meters of bedded tuff. Estimated thickness ranges from 220 m in east to 315 m in west

**Tpts** **Topopah Spring Member**—Nonwelded to densely welded ash-flow tuff forming a single cooling unit. Nonwelded, light-gray, pumiceous tuff in upper part grades abruptly downward into a distinctive thin, dark-gray, vapor-phase vitrophyre. Middle part is grayish red, moderately to densely welded, distinguished locally by zones of abundant lithophysal cavities. Lower part consists of black lower vitrophyre that grades downward into several meters of orange-brown, nonwelded, vitric tuff. Phenocrysts are mostly alkali feldspar, plagioclase, and traces of quartz, biotite, hornblende, and clinopyroxene; phenocrysts decrease in abundance downward from about 15 to 5 percent. Magnetic polarity is reversed (Swadley and Carr, 1987). Ash-flow cooling unit separated from underlying cooling units by approximately 10 m of bedded tuff, which are included in this map unit. Estimated thickness is 245 m

**Tc** **Crater Flat Tuff, undivided (middle Miocene)**

**Tcb** **Bullfrog Member**—Nonwelded to densely welded ash-flow tuff. Contains approximately 15 percent phenocrysts consisting of plagioclase, alkali feldspar, quartz, and biotite. Upper part is moderate-reddish-brown, moderately to densely welded tuff. Lower part, 10 to 15 m thick, contains pale-red zone with weak columnar cooling joints above a partly welded, grayish-orange, vitric zone with an abrupt lower contact. Estimated thickness is 280 m

**Tct** **Tram Member**—Light-gray to pinkish-gray, moderately to densely welded tuff, generally contains a few percent fragments of silicic volcanic rocks. Contains approximately 15 percent phenocrysts consisting of plagioclase, alkali feldspar, quartz, and biotite. Estimated thickness is 245 m

**Ttb** **Tuff breccia (middle Miocene)**—Pale-red, angular clasts of crystal-poor, ash-flow tuff in a pale- to moderate-reddish-brown, densified matrix. Clasts range in size from pebbles to boulders. Estimated thickness not more than 245 m

**Tt** **Older tuff (middle Miocene)**—Grayish-yellow, devitrified, ash-flow tuff. No estimate of thickness

**Tl** **Quartz latite dikes (middle Miocene)**—Grayish-orange to pale-yellowish-orange, silicic porphyry classified as quartz latite by Carr (1984). Contains phenocrysts as large as 2 mm of sanidine, quartz, plagioclase, and biotite. Finely crystalline matrix is predominantly quartz and sanidine with sparse opaque oxide minerals. May be glassy along chilled margins. Forms en echelon sets of north-trending dikes as much as 20 m wide and 1 km long intruding upper Proterozoic and Paleozoic rocks on east side of Bare Mountain. In lower Joshua Hollow, dikes and small irregular masses of quartz latite intrude crystal tuff and siltstone units belonging to rocks of Joshua Hollow. North of main drainage in Joshua Hollow, quartz latite intrusive masses were not mapped separately from rocks of Joshua Hollow due to poor, weathered outcrop and complex structural and intrusive relations that could not be portrayed at map scale. Biotite from this unit yielded conventional potassium-argon ages of approximately 13.9 Ma (table 2; Carr, 1984)

**Tjl** **Rocks of Joshua Hollow and quartz latite dikes, undivided (middle and early? Miocene)**—Unit mapped north of main drainage in lower Joshua Hollow, where small bodies of quartz latite intrude rocks of Joshua Hollow, but were not mapped separately due to poor outcrop and complex structural and intrusive relations in that area that could not be represented at map scale. Locally contains fragments of silicified fossil wood

**Tj** **Rocks of Joshua Hollow, undivided (middle and early? Miocene)**

**Tjg** **Gravel unit**—Conglomerate, sandstone, and limy siltstone. Conglomerate is poorly sorted with rounded to well-rounded clasts of chert and quartzite, as well as sparse clasts of volcanic rocks and pale-greenish-yellow porcellaneous siltstone. Sandstone is medium grained and present as discontinuous lenses and layers. No estimate of thickness

**Tjt** **Crystal-tuff unit**—Pale-yellowish-orange crystal tuff containing sparse lithic fragments. Phenocrysts predominantly plagioclase and sanidine and sparse quartz and mafic minerals. Tuff is poorly stratified; some layers contain abundant lithic fragments. No estimate of thickness

**Tjs** **Siltstone unit**—Grayish-orange-weathering, very light gray to dark-gray siltstone and shale. Finely laminated and platy. Thinly bedded where exposed in stream cuts and excavations. Sparse plant fragments present on some parting surfaces. No estimate of thickness

**Td** **Diorite dikes (Oligocene)**—Dusky-green, fine- to medium-grained porphyritic diorite. Contains plagioclase (75 percent), hornblende (10 percent), clinopyroxene (7 percent), biotite (5 percent), opaque oxide minerals (3 percent), and traces of epidote. Present as dikes mainly on west side of Bare Mountain. Dikes are as wide as 10 m and as long as several hundred meters. Dikes cut ductile fabrics and postdate metamorphism of country rock (Monsen, 1983). Conventional potassium-argon ages of 26.1±1.7 Ma (hornblende) and 16.6±1.2 Ma (biotite) were determined for one of these dikes (table 2, sample 82-489)

**Kg** **Granite (Cretaceous)**—Weakly foliated, very pale orange to pale-yellowish-orange, medium-grained, equigranular granitic rocks. Contains quartz (50 percent), potassium feldspar (30 percent), and plagioclase (15 percent), as well as muscovite and opaque oxide minerals (5 percent), which appear to be alteration products. Granite appears as a sill-like body enclosed within the Bonanza King Formation north of mouth of Fluorspar Canyon, but all contacts with host rock are faulted. Younger intercept age on a concordia plot of U-Pb data for zircon from this granite is 98±27 Ma (fig. 2 and table 1, sample 83-90). A fission track age for zircon of 25.4±1.3 Ma was reported by Carr (1984)

Note: Miogeoclinal rocks of Paleozoic and Late Proterozoic age are weakly to moderately metamorphosed at Bare Mountain. Except in Conejo Canyon area and area west of Amargosa Narrows, most of the rocks retain their characteristic sedimentary appearance and no effects of metamorphism were distinguished in outcrop. Where rocks have undergone medium-grade metamorphism in vicinity of Conejo Canyon and west of Amargosa Narrows, fine-grained clastic rocks of the Carrara and Wood Canyon Formations, as well as the Stirling Quartzite, commonly are recrystallized to phyllite or schist, whereas coarse-grained clastic rocks and carbonate rocks remain similar in appearance to their counterparts in other areas of range. In following unit descriptions, rock names used are those of protoliths, because they are most appropriate for general case.

**MDe** **Eleana Formation (Mississippian and Late Devonian?)**—A thick sequence of clastic rocks consisting predominantly of argillite and cherty argillite, but with intervals containing numerous gravity-flow deposits of chert-pebble conglomerate, quartzite, and (or) detrital limestone. Upper part consists of olive-black shale, locally containing sparse beds of detrital limestone. An interval of olive-gray to light-olive-gray silicified argillite underlies shale interval. Middle part of formation, which forms a moderate rounded ridge in a reference section north of Tarantula Canyon, consists of olive-gray argillite with numerous interbeds of medium-bedded, chert-pebble conglomerate, quartzite, and grayish-orange or medium-gray, fine- to medium-grained detrital limestone. Middle part is underlain by an interval of thinly bedded, platy, olive-gray to olive-black silicified or cherty argillite. Lower part consists of light-brownish-gray siltstone that is slightly calcareous near base. In Tarantula Canyon, basal contact of siltstone interval grades abruptly into concordant beds of underlying Middle Devonian carbonate rocks, allowing possibility that lower part (siltstone) of the Eleana may be Late Devonian in age here. Elsewhere both upper and lower contacts of the Eleana Formation are faults. Fossils indicating a Late Mississippian age for at least part of formation were reported from Bare Mountain by Cornwall and Kleinhampl (1964). Total thickness more than 976 m (3,200 ft; Cornwall and Kleinhampl, 1961). Equivalent to the Mesklajoche Formation of former usage (Cornwall and Kleinhampl, 1961, 1964; Cornwall, 1972)

**Df** **Fluorspar Canyon Formation of former usage (Devonian)**—Steep slope and cliff-forming unit consisting predominantly of medium to thick layers of light- to dark-gray, fine- to medium-grained dolomite and limy dolomite containing limestone and quartzite beds in some intervals. Generally divisible into four subunits. Uppermost subunit is medium- to light-gray, moderately well-bedded dolomite and limestone with conspicuous beds, as much as 2 m thick, of medium- to light-brown-weathering quartzite, limy quartzite, and sandy limestone. Next lower subunit is medium-dark-gray, poorly to well-bedded dolomite with laminated beds and beds containing abundant stromatoporoids (*Amphipora*). Next lower subunit is poorly to moderately well bedded, medium-grained, light-gray dolomite forming medium to thick beds. Contains sparse layers of intraformational pebble conglomerate. Lowermost subunit consists of medium-dark-gray to medium-light-gray, poorly bedded, medium-crystalline dolomite containing sparse light-brown chert nodules; some distinct layers contain moderately abundant chert nodules. Grades downward into the Lone Mountain Dolomite; basal contact is indistinct. Thickness of incomplete section at Razorback Ridge more than 256.2 m (840 ft; Cornwall and Kleinhampl, 1961)

**Dtc** **Rocks of Tarantula Canyon (Devonian)**—Moderately resistant, light- to dark-gray, dolomite, limestone, silty dolomite, and silty limestone unit. Predominantly consists of moderately well bedded, laminated limestone, dolomite, silty limestone, and silty dolomite. Contains debris flows of detrital carbonate rock as thick as 10 m. Laminated intervals commonly contain intraformational breccia beds. Debris flows contain sand-, cobble-, and boulder-sized clasts of limestone or dolomite, quartzite and limy quartzite, and coral heads. Upper one-fourth of unit is mostly limestone, whereas remainder is predominantly dolomite. Upper contact is abruptly gradational with overlying light-brownish-gray limy siltstone assigned to lower part of the Eleana Formation. Conodont fauna from uppermost part of unit indicates a Middle to Late Devonian age. A conodont fauna from 15 m below top of unit is considered early Middle Devonian in age. Basal contact is gradational and defined by change from light- to dark-gray, moderately well stratified dolomite and cherty dolomite to light-gray, poorly stratified, craggy-weathering dolomite. A moderately distinct break in slope coincides with basal contact. Thickness is 91.5 m (300 ft) near mouth of Tarantula Canyon (Cornwall and Kleinhampl, 1961). Crops out only at mouth and along south side of Tarantula Canyon, and formerly was included within the now-abandoned Fluorspar Canyon Formation by Cornwall and Kleinhampl (1961)

**Dtmx** **Timber Mountain Dolomite (Silurian)**—Very light gray, craggy dolomite containing a distinct medium-gray interval approximately 60 m thick near middle of unit. Total thickness is approximately 488 m (1600 ft; Cornwall and Kleinhampl, 1961). Dolomite ranges from fine to medium grained, is indistinctly bedded, and commonly is brecciated. It is sparsely fossiliferous with poorly preserved crinoid debris being moderately common. Basal contact is gradational and distinguished from a distance by a distinct darkening of gray dolomite downward into the Roberts Mountains Formation

**Sr** **Roberts Mountains Formation (Silurian)**—Slope-forming, light-brownish-gray to medium-gray dolomite and limestone containing interbedded silty and sandy dolomite and sparse beds of dolomite-pebble conglomerate. Thin to thickly bedded, commonly flaggy. In a measured section in Chuckwalla Canyon (Carr and others, 1986a), upper part is predominately thin- to medium-bedded, light- to medium-gray dolomite with sparse silty partings and dolomite-cobble conglomerate layers. Middle and lower parts contain platy to medium-bedded dolomite, limestone, dolomitic mudstone, and calcarenite. Dark-gray chert layers and nodules and dolomite-pebble conglomerate present locally. Fossils including silicified brachiopods and corals are common locally throughout unit. Conodonts from measured section indicate an age range from very latest Early Silurian to very early Middle Silurian at base to Late Silurian or Early Devonian at top (Carr and others, 1986a). Basal contact is disconformable and mapped at base of a persistent 0.3-m-thick dolomite pebble-and-cobble conglomerate. Thickness is 198 m

**Oes** **Ely Springs Dolomite (Ordovician)**—Ledge-forming, medium- to dark-gray dolomite and limy dolomite containing abundant dark-gray chert layers and nodules 5 to 20 cm thick. Bedding varies from thin to medium. In measured section in Chuckwalla Canyon (Carr and others, 1986a), uppermost 5 m consist of medium- to dark-gray cherty dolomite. Chert decreases in abundance downward as rock color becomes lighter forming a distinct light-gray band approximately 40 m thick. Lower part is thin- to medium-bedded, medium- to dark-gray dolomite containing chert layers and nodules as thick as 4 cm. Conodonts from measured section indicate an age range from late Middle through Late Ordovician at base to Late Ordovician at top. Basal contact marked by an abrupt gradation from dolomite to quartzite and is recognized from a distance by a distinct change from dark-gray to reddish-brown rocks. Thickness is 127 m

**Oe** **Eureka Quartzite (Ordovician)**—Ledge-forming, light-gray to pale-red quartzite and sandstone. Predominantly medium- to thick-bedded, fine-grained, well-sorted quartzite containing thin intervals of limy sandstone at base and top. Basal contact is placed at first appearance of limestone and limy sandstone downward in section. Thickness is approximately 109.8 m (360 ft; Cornwall and Kleinhampl, 1961)

**Ogp** **Pogonip Group, undivided**

**Oav** **Antelope Valley Formation (Ordovician)**—Ledge- and cliff-forming unit of medium-gray limestone and silty limestone. Predominantly nodular, finely to coarsely crystalline limestone forming medium to thick beds of massive to laminated and platy-splitting rock. Pale-orange-weathering silty partings are common in lower and upper parts of formation. Middle part is predominately massive medium-bedded limestone. Unit is fossiliferous. Basal contact is abruptly gradational from limestone into siltstone and silty carbonate rocks of the Nimemile Formation. Estimated thickness is 205 m

**Onm** **Nimemile Formation (Ordovician)**—Light- to moderate-brown siltstone and olive-black to dark-medium-gray silty limestone or dolomite. Irregular, thin, platy layers of siltstone alternate with nodular interbeds of carbonate rocks. Unit distinguished from a distance as a moderate-brown slope. Abruptly gradational basal contact. Estimated thickness 85 m

**Og** **Goodwin Limestone (Ordovician)**—Ledge-forming unit consists predominantly of medium- to dark-gray limestone containing some silty limestone. Limestone is thin to thick bedded and commonly platy splitting. Contains pale-orange silty laminae and partings and brown-weathering chert lenses. Basal contact is placed arbitrarily at base of lowermost, ledge-forming limestone bed above dolomite and silty dolomite of the Nopah Formation. Estimated thickness 135 m

**Nopah Formation (Cambrian)**

**Cnsh** **Smokey and Halfpint Members, undivided**—Poorly bedded, light- and medium-gray, saccharoidal dolomite. Forms distinctive cliffs that appear from a distance as a prominent white to very light gray band approximately 70 m thick sandwiched between two medium-gray bands. Consists of:

**Cns** **Smoky Member**—Cliff-forming unit of very light gray to medium-gray dolomite in indistinct medium to thick beds. Dolomite is medium to coarsely crystalline and has a saccharoidal texture. Upper part of unit is alternating dark- to medium-gray dolomite containing sparse very light gray beds; lowermost 70 m is white to very light gray dolomite. Lower contact of white to very light gray dolomite, which forms prominent color band from a distance, is mapped as base of member. Estimated thickness is 305 m

**Cnh** **Halfpint Member**—Predominantly medium- to dark-gray, thin- to thick-bedded, finely to coarsely crystalline dolomite, which locally contains abundant black chert nodules and layers; bedding generally indistinct. Forms steep slopes and cliffs. Cliff-forming dark-gray limestone present locally in lowermost part. Basal contact is abrupt. Estimated thickness is 185 m

**Cnd** **Dunderberg Shale Member**—Greenish-brown, platy-splitting shale containing subordinate medium-gray to pale-brown, thinly bedded limestone. Slope former; commonly forms a distinctive dark-brown recessed band on hillsides and forms notches where it crosses ridges. Contacts are sharp. Thickness is 30 m

**Bonanza King Formation, undivided (Cambrian)**

**Cb** **Banded Mountain Member**—Light- to dark-gray, medium- to thick-bedded dolomite and limestone. Divided into:

**Cbbu** **Upper part**—Cliff-forming dolomite; fine to medium crystalline, thickly bedded, varying in color from light to dark gray. From a distance, upper part of member appears as three prominent color bands of approximately equal thicknesses; these are from top to bottom: medium gray, very light gray, and dark gray. Basal contact was mapped at base of dark-gray band. Thickness is approximately 183 m (600 ft; Cornwall and Kleinhampl, 1961)

**Cbbl** **Lower part**—Cliff-forming dolomite and limestone. Distinctively striped in alternating light- to dark-gray bands ranging from 0.5 to 6 m thick. Basal contact mapped at top of a prominent silty and sandy dolomite and limestone interval that forms uppermost part of the Papoose Lake Member and appears from a distance as a pale-orange band. Estimated thickness is 395 m

**Cbp** **Papoose Lake Member**—Cliff-forming, white to dark-gray dolomite and limestone intercalated with sparse but distinctive yellowish-orange silty and sandy intervals. Uppermost 20 m is silty and sandy dolomite and limestone. Uppermost part grades downward into an interval consisting mainly of medium- to thick-bedded dolomite and limestone with interspersed silty and sandy beds. Basal part is typically white dolomite and limestone with yellowish-orange, silty laminae and layers. Basal contact is gradational and mapped at a contact between white, silty limestone and dolomite above and dark-gray limestone below. Estimated thickness is 580 m

**Cc** **Carrara Formation, undivided (Cambrian)**—A heterogeneous unit of phyllite or schist and fine-grained micaceous quartzite; contains prominent intervals of limestone and silty limestone

**Ccu** **Upper part**—Slope-forming succession of intercalated thin- to medium-bedded, dark-greenish-gray phyllite or schist, micaceous quartzite, and medium-dark-gray limestone. Intervals of medium-gray, medium-bedded algal limestone form resistant ribs at top and near middle of upper part of formation. Proportion of pelitic rocks increases downward in section, and phyllite or schist predominate throughout rest of upper part of formation. Basal contact of upper part of the Carrara Formation is sharply defined at upper contact of a resistant, dark-gray limestone unit that constitutes middle part of formation. Thickness 200 m (Palmer and Halley, 1979)

**Ccm** **Middle part**—Cliff-forming, thickly bedded, dark-gray limestone. *Groenella* characteristically are present. Forms a distinctive gray rib between nonresistant brown pelite slopes. Basal contact is sharp. Thickness 62 m (Palmer and Halley, 1979). Equivalent to the Gold Ace Limestone Member of the Carrara Formation (Palmer and Halley, 1979)

**Ccl** **Lower part**—Nonresistant lower part of formation is similar to upper part and also consists of greenish-gray, thinly interbedded phyllite or schist, fine-grained micaceous quartzite, and dark-gray limestone. Limestone predominates near top, grading downward to thinly interbedded phyllite or schist, fine-grained quartzite, and sandstone lenstone. Lower part abruptly grades into orthoquartzite; contact mapped where quartzite becomes dominant rock type. Thickness 87 m (Palmer and Halley, 1979)

**Cz** **Zabriskie Quartzite (Cambrian)**—Cliff-forming unit of pale-red to dusky-red, fine- to medium-grained orthoquartzite; thick-bedded and commonly laminated or cross-stratified. Trace fossils, particularly *Scolithus*, are common in lower part. Basal contact is gradational from quartzite to pelitic rocks of the Wood Canyon Formation and is marked by a sharp break in slope. Thickness is 347.7 m (1,140 ft; Stewart, 1970)

**CZwc** **Wood Canyon Formation (Cambrian and Late Proterozoic)**

**Cwcu** **Upper member (Cambrian and Late Proterozoic)**—Divided into:
**Upper part (Cambrian)**—Steep-slope-forming sequence of interbedded quartzite and siltstone with sparse dolomite or limestone beds. Thick beds of pale-red, fine-grained quartzite predominate near top of this upper part of member; these quartzite beds commonly contain abundant trace fossils including *Scolithus*. Proportion of grayish-green, thin- to medium-bedded siltstone and micaceous quartzite increases relative to quartzite downward in section. Basal contact is sharp and defined as upper contact of a conspicuous yellowish-brown carbonate submit that forms top of underlying unit. Thickness is 254.1 m (833 ft; Monsen, 1983)

**CZwcl** **Lower part (Cambrian and Late Proterozoic)**—Interbedded micaceous quartzite, siltstone, quartzite, and carbonate rocks. Uppermost 60 m is dark-yellowish-gray, thickly bedded limestone and dolomite. Carbonate rocks are medium to coarsely crystalline, laminated, and commonly contain abundant fossil fragments, as well as oolitic beds. Remainder of unit mostly medium to thick interbeds of moderate-brown to pale-gray, very fine grained micaceous quartzite and siltstone containing subordinate quartzite. Forms steep slopes. Basal contact is gradational from interbedded, fine-grained quartzite and siltstone into coarse-grained orthoquartzite and quartz-pebble conglomerate of middle member. Thickness is 350.1 m (1,148 ft; Monsen, 1983)

**Zwm** **Middle member (Late Proterozoic)**—Pale-green, very coarse grained, poorly sorted, gritty quartzite containing beds of very light gray, quartz-pebble conglomerate and sparse beds of pale-green siltstone. Thin to thickly bedded. Moderate slope-forming unit. Abundance of quartz-pebble conglomerate increases downward in section. Basal contact defined as base of lowermost quartz-pebble conglomerate bed in section. Thickness is 210.1 m (689 ft; Monsen, 1983)

**Zw** **Lower member, undivided (Late Proterozoic)**

**Zwld** **Unit D**—Thickly bedded, brownish-black to moderate-brown, very fine grained micaceous quartzite and quartzite containing sparse interbeds of light-green siltstone. Forms steep slopes and ledges. Basal contact is sharp and is mapped at top of upper of three pale-orange dolomite marker beds in lower member. Thickness is 49.1 m (161 ft; Monsen, 1983)

**Zwlc** **Unit C**—Uppermost 25 m consists of pale-orange dolomite and limestone. Carbonate rocks grade abruptly downward into thin to medium interbeds of greenish-gray, very fine grained micaceous quartzite and siltstone. Slope forming unit. Basal contact is abrupt and is mapped at top of middle of three pale-orange dolomite marker beds in lower member. Thickness 79.9 m (262 ft; Monsen, 1983)

**Zwlb** **Unit B**—Uppermost 20 m consists of pale-orange, medium- to thick-bedded dolomite and limestone. Carbonate rocks grade abruptly downward into thin to medium interbeds of greenish-gray, very fine grained, quartzite, micaceous quartzite, and siltstone. Slope-forming unit. Basal contact is abrupt and is mapped at top of lower of three pale-orange dolomite marker beds in lower member. Thickness is 108 m (354 ft; Monsen, 1983)

**Zwla** **Unit A**—Uppermost 10 m consist of pale-orange, medium- to thick-bedded dolomite and limestone containing intercalated beds of sandy dolomite and quartzite. Lower part is very fine grained, thin- to medium-bedded, greenish-gray micaceous quartzite and siltstone. Quartzite beds become abundant in lowermost part. Basal contact is gradational into the E member of the Stirling Quartzite and is mapped where quartzite becomes predominant rock type. Thickness is 97.9 m (321 ft; Monsen, 1983)

**Zs** **Stirling Quartzite (Late Proterozoic)**—Consists of:

**Zse** **E member**—White to pale-yellowish-brown, medium- to thick-bedded, fine-grained orthoquartzite. Lamination and crossalamination are common. Moderate ridge-forming unit. Basal contact gradational into interbedded quartzite, micaceous quartzite, siltstone, and dolomite of the D member and is defined as horizon at which orthoquartzite beds comprise less than 50 percent of rock unit. Thickness is 90 m (295 ft; Monsen, 1983)

**Zsdu** **D member—Divided into:**
**Upper part**—Medium to thick interbeds of light-brownish-gray, fine-grained quartzite and micaceous quartzite, yellowish-brown dolomite and sandy dolomite, and pale-green siltstone. Relative abundance of dolomite beds increases downward at expense of quartzite beds. Moderate slope-forming unit. Basal contact gradational into pale-orange dolomite, and is defined where dolomite becomes predominant rock type. Thickness is 414.2 m (1,358 ft; Monsen, 1983)

**Zsdl** **Lower part**—Pale-gray to pale-orange, coarsely crystalline limestone and dolomite; medium to thick bedded and commonly is laminated. Ledge-forming unit. Basal contact sharp. Thickness is 66.2 m (217 ft; Monsen, 1983)

**Zsc** **C member**—Pale-green siltstone, phyllite, or schist containing sparse thin beds of micaceous quartzite, limestone, and dolomite. Siltstone is thinly bedded and platy-splitting where metamorphism is slight. Basal contact not exposed. Thickness of partial section is 17.4 m (57 ft; Stewart, 1970)

**Zsa** **A member**—Pale-red to purplish-red, thin- to medium-bedded, fine- to coarse-grained quartzite. Contains some beds of quartz-pebble conglomerate with sparse jasperoid pebbles. Pale-orange dolomite present in southwestern part of outcrop area. Crops out south of Steve's Pass. Member is stratigraphically lower than all other units at Bare Mountain, but upper and lower contacts are faulted. Tentatively correlated with the A member of the Stirling Quartzite as defined by Stewart (1970). No estimate of thickness

**Contact**—Dashed where inferred on geologic sections

**Faults**—Dashed where inferred; dotted where inferred beneath surficial deposits; short arrow, dip direction and degree of dip; long arrow, trend and plunge of slickensides. In geologic sections: A, movement away from observer; T, movement toward observer. Where sufficient geometric and (or) kinematic information is available, classified as:

**Moderately to steeply dipping normal, oblique-, or strike-slip**—Bar and ball on downthrown side; arrows show relative direction of horizontal movement

**Thrust**—Sawteeth on upper plate

**Gently dipping normal**—Boxes on upper plate

**Reactivated thrust**—Interpreted as thrust fault later reactivated as gently dipping normal fault. Sawteeth and boxes on upper plate

**Gently dipping**—Classification uncertain; upper plate inferred to have moved southward relative to lower plate. Formed during Cenozo