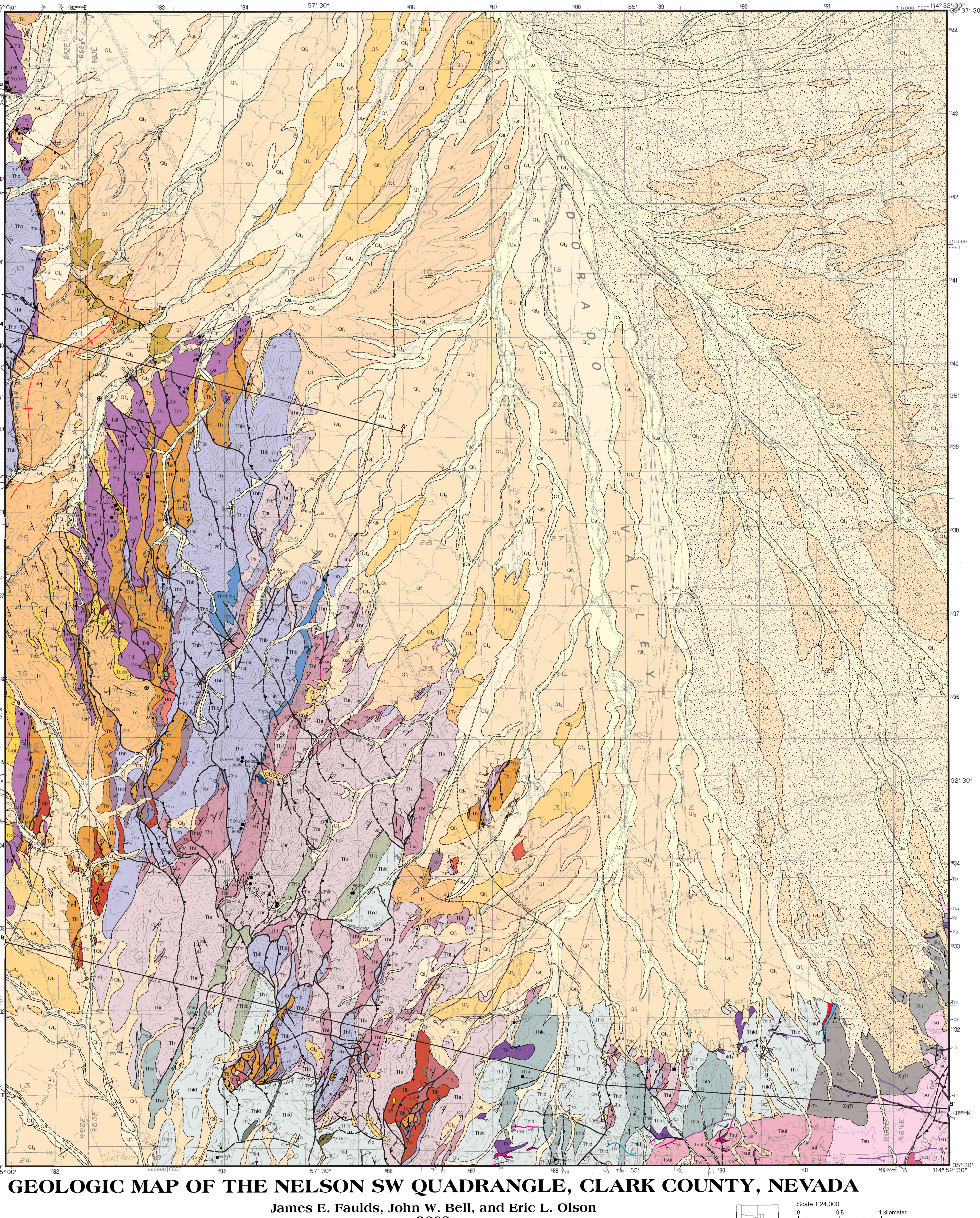
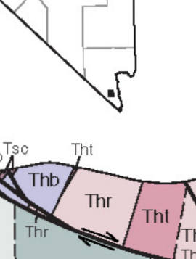


GEOLOGIC MAP OF THE NELSON SW QUADRANGLE, CLARK COUNTY, NEVADA

James E. Faulds, John W. Bell, and Eric L. Olson

2002



Scale 1:24,000

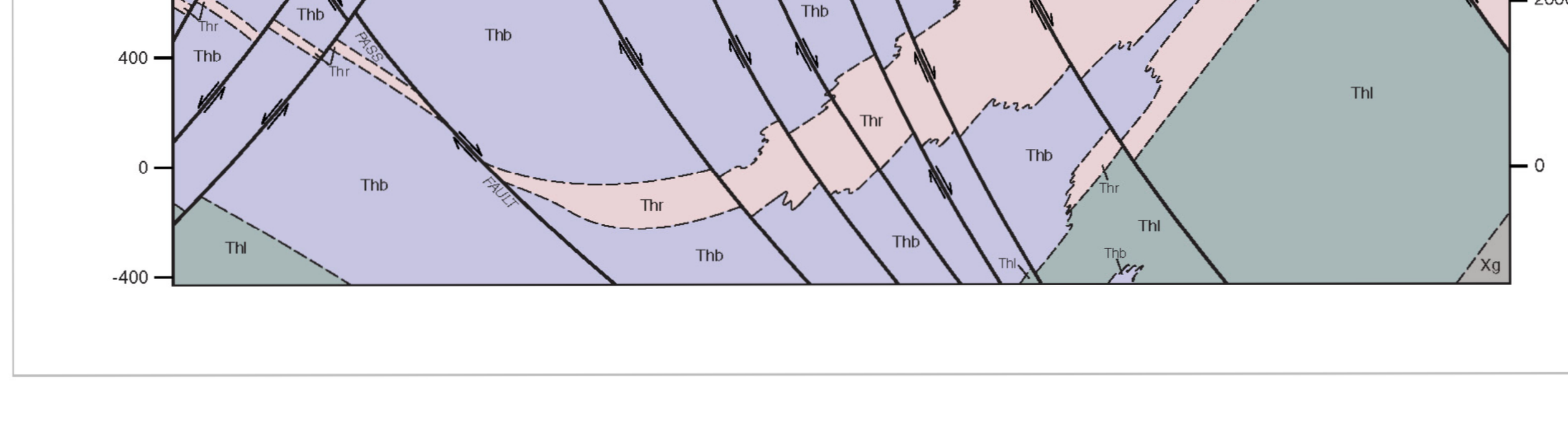
0 0.5 1 kilometer

0 0.5 1 mile

0 1000 2000 3000 4000 5000 feet

CONTOUR INTERVAL 10 METERS

Base map: U.S. Geological Survey Nelson SW 7.5′ Quadrangle, Digital Raster Graphic (DRG) 1984



Alluvial-fan deposits of Eldorado and Piute Valleys

Alluvial-fan deposits are mapped as allostratigraphic units differentiated on the basis of surface morphology, degree of pedogenic soil development, and inset topographic relations. These deposits are dominantly coarse-grained alluvium forming broad fan-piedmont complexes derived from the surrounding bedrock terrain of the Eldorado Mountains and the Highland and McCullough Ranges. Clast lithologies are dominantly volcanic in the western part of Eldorado Valley and in the northern part of Piute Valley. Clasts of granite become dominant to the east in the eastern part of Eldorado Valley, where the alluvium is partially derived from the 16.6 Ma Searchlight pluton in the Eldorado Mountains. Alluvial-fan deposits composed predominantly of granitic clasts are shown by the stippled overprint pattern. Clasts of gneiss become more abundant to the south in Piute Valley, where alluvium is partly derived from Early Proterozoic gneiss of the southern McCullough Range.

Qa — Alluvium of active and recently active washes Pebble-cobble gravel to gravelly sand filling axial washes draining into Eldorado and Piute Valleys. Commonly characterized by anastomosing, fresh to slightly subdued, bar-and-swale microtopography; poorly consolidated; generally poorly sorted, except in areas with granitic provenance where decomposed granite (grus) is moderately well sorted; poorly to locally moderately stratified. Deposits include modern channel alluvium as well as adjacent areas of recently active (late Holocene) alluvium that may be subject to intermittent flooding from active channels.

Qf_4 — Young alluvial-fan deposits Fan-piedmont and interfluvial wash terrace remnants; pebble-cobble to boulder gravel; small pebble sand where dominated by grus. Deposits are commonly thin (<2 m) veneers overlying older alluvial-fan units; in the eastern part of Eldorado Valley, unit consists of broad anastomosing fan-piedmont remnants that may contain numerous small areas of undifferentiated, near-surface Qf_3 deposits. Surfaces are inset slightly below (1-2 m) Qf_3 deposits and are characterized by subdued bar-and-swale microtopography, and incipient to moderately developed desert pavement and rock varnish, except where granitic clasts predominate. Soils contain a 3-5 cm weak to moderately developed Av, 15-30 cm weak to moderately reddened Bw, and 30 cm stage I Bk horizons. Geomorphic character and weak degree of soil development indicate that the unit is early to mid-Holocene in age based on correlation with similar deposits in the Las Vegas Valley area (Bell and others, 1998).

Qf_3 — Late Pleistocene alluvial-fan deposits Fan-piedmont remnants composed predominantly of pebble-cobble to boulder gravel. Deposits are poorly sorted; generally matrix supported; poorly to moderately stratified. Clasts are subangular to subrounded and range up to 35 cm in length. Surfaces are inset several meters below older Qf_1 and Qf_2 deposits, and are flat with no remaining bar-and-swale microtopography; well-developed desert pavement and dark rock varnish. Soils are very distinctive: 5-8 cm platy Av, 40-60 cm strongly reddened (7.5 YR) and prismatic argillic Bt, and 100 cm cemented stage III Bk horizons. The unit is ubiquitous throughout most of Eldorado and Piute Valleys where it lies at generally shallow depths beneath the younger alluvium; the distinctive red Bt soil horizon commonly crops out in shallow cuts and along road exposures. In the southern and eastern parts of Eldorado Valley, numerous dissected remnants occur within and beneath younger Qf_4 deposits forming a complex, anastomosing pediment system on weathered volcanic bedrock. Based on the degree of soil development, this deposit is likely similar in age to deposits dated in the Spring Mountains area at about 129 ka (Sowers, 1985).

Qf_2 — Mid-Pleistocene alluvial-fan deposits Fan-piedmont remnants in the western part of Eldorado Valley and in Piute Valley; mainly cobble to boulder gravel composed predominantly of volcanic clasts and scattered granitic clasts. Deposits are poorly sorted; poorly to moderately stratified. Surfaces are inset 10 m or more below older Qf_1 remnants; they are well dissected but contain relatively well preserved flat interfluvial surfaces containing local patches of well developed desert pavement and dark rock varnish. Soils are characterized by a thick (>2 m) strongly cemented stage III to IV Bqkm horizons directly underlying remnant surfaces; Bt horizons have been stripped. Calcrete horizons form resistant platforms beneath the remnant surfaces and are commonly visible on aerial photographs, forming light-toned alluvial surfaces due to the presence of abundant white to light-gray calcrete fragments. Based on the degree of development of calcrete horizons, the unit is on the order of a few hundred thousands of years in age.

Qf_1 — Early Pleistocene alluvial-fan deposits Deeply dissected fan-piedmont remnants disconformably overlying youngest Tertiary rocks exposed in the quadrangle. No original fan surfaces preserved; remnants consist of rounded, linear digitate surfaces (ballenas) occurring topographically above the younger alluvial fan surfaces by a few to tens of meters. Composed predominantly of sandy cobble-boulder gravel; includes both clast- and matrix-supported beds; dominantly volcanic lithologies with a few scattered gneissic and granitic clasts; subangular clasts dominate and range up to 2 m in length; poorly to moderately stratified, moderate to strong silica- and carbonate-cementation of the matrix results in locally strong induration of the deposit, where in many outcrops it may be characterized as a fanglomerate. Ballena surfaces typically contain stage IV laminar calcrete soils; the calcrete is 1-3 m thick with laminar horizonation conforming to the slope of ballena surfaces indicating that the calcrete developed in the deposits subsequent to deep dissection of the original alluvial-fan surfaces. Occurrence of laminar calcrete fragments on ballena hillslopes produces white to light-gray outcrops visible on aerial photography. In the Yucca Mountain region, similar ballena deposits contain Bishop or Glass Mountain G volcanic ash, indicating that the deposits may be in the range of 0.7-1.1 Ma in age (Peterson and others, 1995). In the Spring Mountains area, Sowers (1985) estimated similar deposits to be >730 ka based on paleomagnetic data.

Qbl — Bouldery lag deposit Lag deposit of undetermined Quaternary age consisting of boulders of the tuff of Bridge Spring; boulders commonly exceed 1 m in length; found only on ridge top in the southernmost part of the quadrangle. Thickness is less than 3 m.

Middle to late Miocene volcanic and sedimentary rocks

The middle to late Miocene stratigraphy of the Nelson SW Quadrangle consists, in ascending order, of sandstone and conglomerate (Tsc), megabreccia of probable rock avalanche origin (e.g., Tlu), two regionally extensive ash-flow tuffs (15.2 Ma tuff of Bridge Spring [Tb] and 15.0 Ma tuff of Mount Davis [Tdt]) with a thin interval of megabreccia and conglomerate commonly between the tuffs (Tbc), and a capping sequence of conglomerate, sandstone, and tuffaceous sedimentary rocks (Tc and Tct). The middle to upper parts of this section (above Tb) are temporally correlative with the Mount Davis Volcanics to the east and northeast of the Nelson SW Quadrangle. The Mount Davis Volcanics of Anderson (1971) primarily consist of synextensional basalt and basaltic andesite lavas but also include sequences of conglomerate and monolithologic megabreccia, as well as the 15.0 Ma tuff of Mount Davis (Faulds, 1995, 1996). The most complete sections crop out near the western margin of the Mount Davis Quadrangle (Faulds, 1995) and in the northern Eldorado Mountains northeast of Nelson, Nevada (Anderson, 1971, 1977). The Mount Davis Volcanics were deposited during Tertiary extension, as evidenced by well-developed growth-fault relations (i.e., tilt fanning) within the section.

Mafic lavas temporally correlative with the Mount Davis Volcanics, which are prevalent in the Eldorado and Black Mountains to the northeast and east, are not exposed within the Nelson SW Quadrangle. Such lavas do crop out, however, to the north of the quadrangle on the east flank of the northern Highland Range. A basalt flow from that area has yielded an $^{40}Ar/^{39}Ar$ whole-rock age of 12.79±0.22 Ma (Faulds and others, 2002). Tilts within the middle to late Miocene section range from ~35-40° in the tuff of Bridge Spring (Tb) to ~15° in capping basalt flows directly north of the quadrangle. This tilt fanning suggests that the middle to late Miocene section within the Nelson SW Quadrangle is synextensional.

Tct — Tuffaceous sedimentary rocks (late Miocene) Medium-grained, weakly indurated, noncalcareous tuffaceous sandstone and subordinate reworked nonwelded tuff and pebble conglomerate; confined to the northwestern part of the quadrangle, where it caps Tc; conglomerate is matrix supported and moderately sorted; sand grains are subrounded and consist of feldspar, clinopyroxene, and lithic fragments; more tuffaceous layers include pumice fragments; pebbles are subangular and consist of rhyolite (Thr), welded tuff (Tb and Tdt), and lesser basaltic andesite (Thb). Thickness is as much as 40 m.

Tc — Conglomerate and sandstone of the Highland Range (middle to late Miocene) Pale brown to grayish-brown, pebble-cobble conglomerate and lesser medium- to coarse-grained sandstone. Conglomerate is matrix and clast supported, moderately well stratified, and poorly to moderately sorted with subangular to locally subrounded clasts; clasts of Thr dominate in south-central part of the quadrangle, whereas clasts of Thb and Tha prevail in the northwest; clasts of Proterozoic gneiss are relatively sparse (<5%) in the central part of the quadrangle but increase in size and abundance toward the west, suggesting a source in the crystalline terrane of the southern McCullough Range. Average clast size is less than 3 cm but ranges to 35 cm; locally derived boulders of volcanic rock to 1.5 m occur near bedrock exposures; 2 m long boulders of Proterozoic gneiss occur near the western margin of the quadrangle more than 10 km from probable source areas in the southern McCullough Range; weakly to moderately indurated; silica cement dominates; minor calcite cement found locally; conglomerate supported by a coarse-grained sandy matrix with subangular to lesser subrounded grains; sand grains largely composed of lithic fragments and feldspar; bedding thickness typically ranges from 2.5 to 25 cm, but 1.5-m-thick beds were locally observed; thicker beds are generally matrix supported and probably represent debris flows. Sandstone is pale-brown to light-gray, medium- to coarse-grained, and weakly to moderately indurated with silica cement; contains sparse subangular volcanic pebbles; grains are subrounded to subangular and composed primarily of lithic fragments, lesser feldspar, and minor quartz and mafic minerals. Tc locally includes 2- to 3-cm-thick beds of very fine-grained sandstone and nonwelded, generally reworked tuff to 4 m thick. In the western part of the quadrangle, Tc generally rests disconformably on Tdt and locally fills paleochannels cut into Tdt and Tb; rests in angular unconformity on Thr in the south-central part of the quadrangle; accumulated in a west-tilted half graben in the west-central part of the quadrangle. Tc may locally include thin deposits of Tct, Tcbb, and Tcbt. Thickness in the west-tilted half graben exceeds 400 m.

Tcbt — Nonwelded tuff breccia (middle Miocene) Isolated deposit of brecciated, white nonwelded tuff intercalated in Tcbb; found only in the northwest corner of section 31 T27S R63E; interpreted as a rock avalanche deposit primarily because of its association with Tcbb; contains ~15% phenocrysts of sanidine, lesser biotite and quartz, and accessory plagioclase and clinopyroxene. Thickness is as much as 15 m.

Tcbb — Basaltic andesite breccia (middle Miocene) Lens-shaped bodies of massive monolithologic breccia of basaltic andesite intercalated in Tc; contains ~5% phenocrysts of plagioclase, aegirine-augite and augite, and apatite; generally poorly exposed except in steep cutbanks of washes; probably originated as rock avalanche deposits (cf., Yarnold and Lombard, 1989) derived from the higher terrain of the central Highland Range directly west of the quadrangle; may represent seismically induced ancient landslides; confined to the west-central part of the quadrangle; generally intercalated within conglomerate and sandstone in the lower part of Tc; one large body rests directly on Tdt at the base of Tc. Thickness of individual sheets is as much as 60 m; cumulative thickness is as much as 100 m.

Tdt — Tuff of Mount Davis (middle Miocene, 15.0 Ma) Pale-reddish-brown, weathering dark-brown, generally moderately welded, rhyolitic ash-flow tuff; contains 15-35% subhedral to anhedral phenocrysts of sanidine and significantly lesser amounts of plagioclase (mainly oligoclase), biotite, and augite; of the total rock volume, sanidine phenocrysts constitute 10-25%, biotite 1% to 3%, augite <1% to 2%, and plagioclase <1% to 3%; ~1% titanomagnetite is ubiquitous; sphene is very rare (e.g., one grain per 10 thin sections); by volume, sanidine consistently makes up >62% of the total assemblage of phenocrysts; sanidine phenocrysts range up to 5 mm in length, whereas the maximum size of other phenocrysts is typically 2 mm; lower poorly welded part generally has fewer phenocrysts (~15%) than moderately welded zone (25-35%); lithic fragments of basaltic andesite are common; thickness of white to pinkish-white basal nonwelded zone increases from 1 to 10 m to the north; basal nonwelded zone is thickest in the southeast 1/4 of section 19 T27S R63E; locally includes a thin (<1m thick) vitrophyre above the basal nonwelded zone. In contrast to the tuff of Bridge Spring, Tdt essentially lacks sphene, contains more phenocrysts in welded parts, has slightly more plagioclase and biotite phenocrysts, locally contains coarser-grained sanidine, and is darker colored. Tdt thickens northwestward in the quadrangle and appears to have accumulated in structural-topographic lows, including the west-tilted half graben in the hanging wall of the Highland fault and northeast-trending syncline in the northwestern part of the quadrangle; also locally filled small paleochannels cut into Tb. Sanidine from two samples in the quadrangle yielded $^{40}Ar/^{39}Ar$ dates of 15.00±0.04 and 15.01±0.03 Ma. The age, composition, and stratigraphic position strongly suggest a correlation with the 14.97±0.02 Ma tuff of Mount Davis to the east in the Lake Mohave area (Faulds, 1995; Faulds and others, 1995); reverse polarity. Thickness is as much as 70-100 m in west-central part of the quadrangle.

Tbc — Volcanic megabreccia and conglomerate (middle Miocene) Pale-brown to reddish-brown or light-gray monolithologic megabreccia, pebble to bouldery conglomerate, and minor volcaniclastic sandstone and nonwelded tuff; poorly to moderately well stratified; poorly to moderately indurated typically with calcite cement. Megabreccia is primarily composed of basaltic andesite but includes isolated lenses of Proterozoic gneiss; mainly crackle and jigsaw breccia facies (cf., Yarnold and Lombard, 1989); probable rock avalanche origin; gneiss in megabreccia resembles Proterozoic bedrock in the southern McCullough Range rather than that in the northern Newberry Mountains (Ruppert and Faulds, 1998) or southeastern part of the quadrangle. Sandstone and matrix of conglomerate consist of subangular, coarse-grained sand; conglomerate is generally matrix supported and poorly sorted with subangular clasts; commonly includes matrix supported boulder-size blocks of basaltic andesite (derived from Thb), which probably originated as debris flows. Tbc pinches out to north as lower nonwelded part of Tdt thickens; bracketed between 15.2 and 15.0 Ma. Thickness is as much as 80 m.

Tb — Tuff of Bridge Spring (middle Miocene, 15.2 Ma) Purplish-gray to light-gray, weathering pale-brown, moderately to densely welded rhyolitic ash-flow tuff; contains 5-15% anhedral to subhedral phenocrysts of sanidine and significantly lesser amounts of biotite, augite, plagioclase (mainly oligoclase), and sphene (in typical order of decreasing abundance); of the total rock volume, sanidine phenocrysts typically constitute 5-15%, biotite <1% to 3%, augite 0-1%, and plagioclase <1 to 2%; traces of sphene and titanomagnetite are ubiquitous; by volume, sanidine consistently makes up >80% of the total assemblage of phenocrysts; sanidine phenocrysts range up to 3.5 mm in length, whereas the maximum size of other phenocrysts is typically less than 1 mm; lithic fragments of basaltic andesite are common; generally includes 0.5- to 4-m thick vitrophyre at or near (within 2 m) base of densely welded section below which lies 1 to 6 m of basal, nonwelded tuff. In contrast to the tuff of Mount Davis (Tdt), Tb has a lighter color, ubiquitous sphene, generally fewer phenocrysts, generally finer-grained sanidine, and slightly less abundant biotite and plagioclase. Sanidine from three samples in the quadrangle yielded $^{40}Ar/^{39}Ar$ dates of 15.21±0.04, 15.22±0.04, and 15.26±0.04 Ma. The age, composition, and stratigraphic position strongly suggest a correlation with the tuff of Bridge Spring (Anderson, 1971; Darvall, 1991) in the northern Eldorado Mountains; found throughout most of the map area, where appropriate part of the section is exposed; possibly erupted from a caldera in the northern Eldorado Mountains (Gans and others, 1994); reverse polarity; thickness is as much as 125 to 200 m in the west-central part of the quadrangle.

Tl — Megabreccia deposits (middle Miocene) The section directly beneath the tuff of Bridge Spring and above the basaltic andesite lavas of Thb is largely composed of monolithologic megabreccia deposits. Breccia lithologies include basaltic andesite (Tlb), dacite-rhyodacite (Tld), and Proterozoic gneiss (Tlx). Individual megabreccia sheets are monolithologic, but a single section of Tl may contain multiple sheets of different lithologies. Megabreccia of Proterozoic gneiss dominates in the south-central part of the quadrangle on the east flank of the southern Highland Range, whereas megabreccia of volcanic rock prevails in the southern and western parts of the quadrangle. The megabreccia generally consists of crackle and jigsaw breccia facies (cf., Yarnold and Lombard, 1989). These deposits probably originated as rock avalanches (essentially landslides) induced perhaps by ground shaking associated with earthquakes. Their 15.7 to 15.2 Ma age indicates deposition during the major episode of Tertiary extension.

Tlu — Megabreccia undifferentiated (middle Miocene) Undifferentiated lens of breccia containing several monolithologic sheets; breccia lithologies include basaltic andesite, dacite-rhyodacite, and Proterozoic gneiss; includes both crackle and jigsaw breccia facies; dacite clasts contain ~25% phenocrysts of plagioclase (17% of rock), oxyhornblende (5%), and biotite (3%); found only in the west-central part of the quadrangle. Thickness is as much as 115 m.

Tlx — Gneiss megabreccia (middle Miocene) Sheets of pale-reddish-brown to light-gray monolithologic breccia of orthogneiss that resembles Early Proterozoic gneiss exposed in the southeastern part of the quadrangle; generally poorly exposed; best exposures occur in cutbanks of washes (e.g., on north side of wash in west-central part of section 3 T28S R63E); a common lithology in Tlx consists of 60-65% quartz, 25-30% potassium feldspar, 10% hornblende (altered to chlorite), and traces of garnet and zircon; includes both crackle and jigsaw breccia facies; also includes blocks and thin megabreccia sheets of rhyolite, andesite, and porphyritic dacite; bracketed between 15.7 and 15.2 Ma. Thickness is as much as 125 m.

Tlb — Basaltic andesite megabreccia (middle Miocene) Sheets of light-grayish-brown to reddish-brown monolithologic volcanic breccia composed primarily of basaltic andesite (Thb), but rhyolite (Thr) and dacite (Thld) locally dominate the lower part of the section; includes crackle and jigsaw breccia facies with negligible matrix; also includes matrix-supported breccia; matrix consists primarily of subangular sand-size grains of volcanic rock, feldspar, and biotite. Most of Tlb originated as rock avalanches, but matrix-supported deposits probably represent debris flows; bracketed between 15.7 and 15.2 Ma; thickness ranges up to ~95 m.

Tld — Dacite megabreccia (middle Miocene) Pale-reddish- or pinkish-gray dacite or rhyodacite monolithologic breccia and lesser pale brown, matrix and clast-supported pebble to cobble dacite conglomerate; dacite clasts contain 15-20% phenocrysts of plagioclase (andesine; 12-15% or rock), biotite (3-4%), oxyhornblende (1-2%), and traces of zircon; possibly derived from Thld or Thlr; breccia probably originated as rock avalanche deposits. The dacite conglomerate is found only in section 16 T28S R63E; it is weakly indurated with calcite cement and has 2- to 15-cm-thick beds, subangular clasts to 35 cm composed almost entirely of dacite with sparse andesite and basaltic andesite, and a coarse-grained sandy matrix. Tld is bracketed between 15.7 and 15.2 Ma. Thickness may locally approach 100 m.

Tsc — Sandstone and conglomerate (middle Miocene) Mainly pale-brown to purplish-brown or light-gray volcaniclastic, matrix- to locally clast-supported, poorly to locally moderately sorted pebble-cobble conglomerate and sandstone; clasts are subangular and generally consist of rhyolite, dacite, and basaltic andesite in varying proportions, but commonly includes minor amounts of Proterozoic gneiss; volcanic clasts range up to 20 cm in length, Proterozoic clasts to 30 cm; matrix of conglomerate and sandstone is medium to coarse grained and consists of subangular to subrounded grains of lithic fragments, feldspar, quartz, and biotite; weakly to moderately indurated; noncalcareous to weakly calcareous; locally includes beds of fine-grained sandstone or siltstone. Tsc locally consists of cross-bedded white tuffaceous surge deposits, nonwelded ash-flow and air-fall tuffs to 2 m thick, reworked tuff, tuffaceous fine- to medium-grained sandstone, and tuffaceous matrix-supported conglomerate; nonwelded tuff contains 2-4% phenocrysts of sanidine and lesser quartz, biotite, augite, and plagioclase, as well as lithic fragments of basaltic andesite (Thb) and abundant pumice fragments; tuffaceous sandstone and matrix of tuffaceous conglomerate consist of glass shards and subrounded to subangular grains of feldspar, volcanic lithic fragments, and biotite. In the west-central part of the quadrangle, Tsc locally contains thin poorly exposed monolithologic megabreccia of basaltic andesite and dacite (which probably represent rock avalanche deposits and massive debris flows) and thin andesite and basaltic andesite lavas. Thickness is as much as 80 m.

Th — Volcanics of the Highland Range (early to middle Miocene) The volcanics of the Highland Range (Th) consist of a thick lower sequence of intermediate composition lavas (e.g., trachydacite and trachyandesite lavas of Thld and Thla, respectively), a middle interval of rhyolite lavas (Thr) intercalated with nonwelded tuffs and tuffaceous sedimentary rocks (Tht), and an upper northward thickening sequence of basaltic andesite lavas (Thb). Thin sequences of rhyodacite (Thrd) and andesite (Tha) lavas locally occur between the middle siliceous interval and upper sequence of mafic lavas. Within the quadrangle, Th is bracketed between ~18.5 and 15.7 Ma. The overall thickness of the volcanics of the Highland Range locally exceeds 2,800 m.

Upper mafic sequence, volcanics of the Highland Range (middle Miocene) The upper unit of basaltic andesite lavas (Thb) is relatively thin (<200 m) in the south but thickens appreciably northwestward, exceeding 1,200 m in thickness near the northwest margin of the quadrangle. Although a few basaltic andesite dikes crop out within the quadrangle, most of the basaltic andesite lavas were probably derived from a large volcanic center just to the northwest in the central Highland Range, as evidenced by an apparent preponderance of basaltic andesite intrusions in that area (Faulds, 1999, p. 31; Feuerbach and others, 1999). The thin sequences of rhyodacite and andesite lavas (Thrd and Tha) at the base of the mafic sequence are confined to the west-central part of the quadrangle. The rhyodacite lavas may have been derived from a rhyodacite plug (Trdi) in the northwest part of section 5 T28S R63E.

Thb — Basaltic andesite lavas (middle Miocene) Light- to dark-gray basaltic trachyandesite and trachyandesite lavas, flow breccias, and agglomerate containing 15-35% phenocrysts of plagioclase (9-20% of rock; mainly andesine but includes some labradorite) to 3 mm, augite (7-17%) to 3 mm, 0-3% iddingsitized olivine, 0-1% hypersthene, 0-1% apatite, and accessory titanomagnetite; plagioclase usually constitutes ~2/3 of the phenocrysts, but some flows contain subequal amounts of plagioclase and augite; a few flows also contain traces of quartz, which may be xenocrystic; includes a conspicuous layer of scoria in the NW 1/4 of section 17 and SW 1/4 of section 8, T28S R63E; lower part locally includes as much as 30 m of more andesitic or dacitic lavas that contain 20-25% phenocrysts mainly of plagioclase (andesine to 4.5 mm in length) and augite (to 2 mm) with lesser quartz (to 3 mm) and sparse biotite, hypersthene, ±sanidine (to 3 mm), and ±sphene; bracketed between 15.98±0.05 Ma and 15.66±0.08 Ma by $^{40}Ar/^{39}Ar$ whole-rock ages on lower and upper flows, respectively, in the west-central part of the quadrangle, whereas the upper part of Thb directly north of the quadrangle has yielded $^{40}Ar/^{39}Ar$ whole-rock ages ranging from 16.5±0.06 to 16.03±0.07 Ma (Faulds and others, 2002); temporally correlative and lithologically similar to the lower part of the Patsy Mine Volcanics of Anderson (1971, 1977) and Fire Mountain volcanics of Faulds (1996). Thickness ranges from 35 m in the southern part of the quadrangle to greater than 1,200 m in the northwestern part.

Tha — Andesite lavas (middle Miocene) Medium- to light-gray and reddish-gray porphyritic andesite lavas; contain phenocryst assemblages of either plagioclase (andesine), oxyhornblende, aegirine-augite, and biotite (central part of section 6 T28S R63E) or plagioclase (andesine), augite, subordinate quartz, and sparse biotite and sphene (eastern part of section 6 T28S R63E); confined to the west-central part of the quadrangle. Age is bracketed between ~16.0 Ma and 15.2 Ma. Thickness is as much as 55 m.

Thrd — Rhyodacite-rhyolite lavas (middle Miocene) Purplish-gray to medium-gray porphyritic trachyrhyodacite and rhyolite lavas. Thrd contains 30-35% phenocrysts mainly of plagioclase (probably oligoclase); subordinate sanidine, aegirine-augite or augite, quartz, minor biotite, and sparse sphene and apatite; greatly resembles the Trdi plug exposed in the northwest part of section 5 T28S R63E; largely confined to sections 29, 30, 31, and 32 T27S R63 but isolated unmapped flows of Thrd are found elsewhere within Thb. Age is bracketed between ~16.0 Ma and 15.2 Ma. Thickness is as much as 65 m.

Middle felsic sequence, volcanics of the Highland Range (middle Miocene) The intercalated rhyolite lavas and tuffaceous rocks (Thr and Tht) are thickest in the southwestern part of the quadrangle and appear to pinch out to the northwest and west. They are virtually absent from the central Highland Range directly west and northwest of the quadrangle. Although no rhyolite domes were identified, the thickness (>900 m) of the rhyolite lavas and tuffaceous rocks suggests a nearby source, perhaps a rhyolite dome complex now buried beneath the southern part of Eldorado Valley. The quartz-bearing rhyolite dikes and plugs (Tri) mapped in the southernmost part of the quadrangle may have been the source for some of the rhyolite lavas.

Thta — Welded ash-flow tuff (middle Miocene, ~16 Ma) Pale-brownish-gray, lithic-rich, poorly to moderately welded ash-flow tuff; contains 10-15% subhedral phenocrysts of sanidine (to 3 mm long), quartz (to 2 mm), plagioclase, and sparse biotite. Of the total rock volume, sanidine phenocrysts generally constitute ~5-8%, quartz 2-4%, plagioclase 1-2%, and biotite <1%. Lithic fragments of basaltic andesite and andesite are common and contain phenocrysts of clinopyroxene and/or hornblende; Thta was mapped only in section 6 T28S R63E directly beneath Thb, but it may be more extensive, locally comprising perhaps a nonwelded ash-flow tuff in the upper part of Tht elsewhere in the quadrangle. Probably about 16 Ma on the basis of the 15.98 Ma age of the base of Thb. Thickness is as much as ~60 m.

Tht — Tuffaceous sedimentary rocks and non-welded tuffs (middle Miocene) White to pale-yellowish-brown air-fall and nonwelded ash-flow tuffs, surge deposits, and tuffaceous conglomerate and sandstone commonly interfingering with Thr; locally includes a few thin rhyolite lavas; beds are generally 2 to 3 cm thick but commonly range from 1 to 30 cm thick; at least one nonwelded ash-flow tuff is as thick as 10 m; in order of decreasing abundance, nonwelded tuff contains 3-15% phenocrysts of sanidine and quartz with lesser plagioclase (mainly oligoclase), biotite, and clinopyroxene; sparse sphene and hornblende were also observed in a few tuffs; nonwelded tuff also contains abundant pumice fragments and lithic fragments of basaltic andesite; feldspar and biotite phenocrysts are commonly altered to sericite and chlorite-iron oxides, respectively. Tuffaceous sandstone and conglomerate typically represent reworked tuffs; conglomerate contains varying amounts of subangular to locally angular clasts that usually range from 1 to 20 cm in length; Tht locally pinches out abruptly against rhyolite lavas and possibly eroded domes (e.g., peak at 1,319 m elevation along boundary of sections 7 and 8, T28S R63E); boulders of rhyolite in such areas range up to 6 m in length (e.g., northwest corner of section 8 T28S R63E); clasts in conglomerate are primarily of flow-banded rhyolite and lesser dacite; locally includes a few thin layers (~2 m thick) of plagioclase-hornblende-biotite rhyodacite breccia that may represent rock avalanche deposits. In the southeastern part of section 6 T28S R63E, Tht progressively thickens northeastward across several northeast-dipping normal faults suggesting that Tht is synextensional and accumulated in growth-fault basins. Some sections of Tht display tilt fanning (e.g., western part of section 5 T28S R63E). Biotite from a nonwelded tuff near the base of the section yielded an $^{40}Ar/^{39}Ar$ date of 16.21±0.17 Ma. Age is bracketed between ~16.2 and 16.0 Ma; may correlate with the volcanics of Red Gap Mine (Faulds, 1995; Faulds and others, 1995) in the central Black Mountains to the east. Thickness is as much as 310 m.

Thr — Rhyolite lavas (middle Miocene) Pale brownish-gray, light-grayish-white, and pinkish- to reddish-gray commonly flow-banded rhyolite and lesser trachydacite lavas; locally interfingers with the tuffaceous rocks of Tht; includes spherulitic and vitrophyric flows; contains 5-35% phenocrysts. Phenocryst assemblages in individual flows include (1) sanidine (to 6 mm) and lesser quartz (to 3 mm), plagioclase (oligoclase), and biotite; some with sparse sphene, augite, and/or oxyhornblende; (2) sanidine (to 3 mm) and lesser biotite, plagioclase, augite, and sphene; (3) plagioclase (oligoclase; to 5 mm) and lesser biotite, sanidine (to 4 mm), and aegirine-augite or augite; and (4) plagioclase (oligoclase and some andesine), biotite, and lesser sanidine and augite. Assemblage #1 is most common; #4 is least common. Frothy rhyolite (phenocryst type #2) crops out in the western part of section 3 and southeast part of section 4 T28S R63E. Plagioclase-rich, quartz-free varieties (# 3 and 4) appear to be more common in the southwesternmost part of the quadrangle (e.g., sections 7 and 18, T28S R63E). Conspicuous 2- to 6-m-thick vitrophyre occurs at the base of the section directly above Thlb in southern part of sections 4 and 5 and northern part of section 8 T28S R63E. Lower part of Thr locally includes thin rhyodacite or dacite flows containing phenocrysts of plagioclase, biotite, and clinopyroxene. Biotite from the vitrophyre at the base of the section yielded an $^{40}Ar/^{39}Ar$ date of 16.26±0.15 Ma. The bulk of the section is bracketed between 16.26 and 16.21 Ma, but flows intercalated in the lower part of the Thb section may be as young as ~15.9 Ma; may correlate with the volcanics of Red Gap Mine in the central Black Mountains to the east (Faulds, 1995; Faulds and others, 1995). Thickness is as much as 620 m.

Thl — Lower intermediate sequence, volcanics of the Highland Range (early to middle Miocene) The lower intermediate composition sequence of the volcanics of the Highland Range consist primarily of trachydacite, trachyandesite, and rhyodacite lavas. This sequence may correlate with the volcanics of Dixie Queen Mine in the Mount Perkins area of the central Black Mountains in northwestern Arizona (Faulds and others, 1995), ~31 km east of the Nelson SW Quadrangle, as evidenced by similarities in stratigraphic position, composition, and age. The volcanics of Dixie Queen Mine are generally preextensional in the region. In the Nelson SW Quadrangle, the magnitude of tilting within Thl differs only slightly (~10°) between the lower and upper parts of the section, suggesting deposition prior to any appreciable extension. Thl is probably widely distributed throughout the area but is only exposed in the southern part of the quadrangle. The age of Thl is bracketed between 18.5 and ~16.2 Ma by the underlying 18.5 Ma Peach Springs Tuff (Tp) and $^{40}Ar/^{39}Ar$ dates on overlying rhyolite lavas in Thr. Biotite from a dacite lava within the volcanics of Dixie Queen Mine directly south of the quadrangle has yielded an $^{40}Ar/^{39}Ar$ date of 17.59±0.06 Ma. Trachydacite and trachyandesite lavas in the northern Newberry Mountains ~8 km to the southeast of the quadrangle have yielded $^{40}Ar/^{39}Ar$ dates ranging from 18.58±0.05 to 16.75±0.26 Ma (Ruppert and Faulds, 1998). Thl locally interfingers with the lower part of the felsic sequence in the volcanics of the Highland Range and is temporally correlative with the lower part of the Patsy Mine volcanics of Anderson (1971). Within the Nelson SW Quadrangle, Thl is divided into (1) an upper unit of biotite-rich trachydacite and trachyandesite lavas (Thlb), (2) sequences of trachyandesite lavas (Thla), (3) sparse rhyodacite lavas (Thlr), (4) an isolated exposure of dacitic tuffaceous rock (Thldt), and (5) thick sections of mainly trachydacite lavas (Thld). In cross section A-A′, the sequence is shown as undifferentiated (Thl). The overall thickness of Thl approaches and possibly exceeds 1,500 m.

Thlb — Biotite-rich trachydacite-trachyandesite lavas (early to middle Miocene) Medium-gray to reddish-brown trachydacite and/or trachyandesite lavas containing 15-20% phenocrysts of andesine plagioclase, augite, and biotite (in order of decreasing abundance), as well as accessory apatite, titanomagnetite, and possibly hypersthene; in contrast to Thld or Thla, biotite and augite phenocrysts are typically nearly as common as plagioclase and are locally more abundant; pilotaxitic to hyalopilitic textures. Thickness is as much as 165 m.

Thla — Trachyandesite-trachydacite lavas (early to middle Miocene) Light- to dark-gray trachyandesite and trachydacite lavas containing 20-30% phenocrysts of plagioclase (generally andesine), oxyhornblende, augite or aegirine-augite, biotite, and trace hypersthene and apatite (in typical order of decreasing abundance); the relative abundance of oxyhornblende, clinopyroxene, and biotite varies, but oxyhornblende or clinopyroxene are generally more abundant than biotite; pilotaxitic to trachytic textures prevail; plagioclase phenocrysts range up to 6.5 mm in length, clinopyroxene to 3 mm, and biotite to 2.5 mm; plagioclase and the mafic constituents are commonly partly to largely altered to sericite and chlorite-iron oxides, respectively; degree of alteration increases southward and southeastward toward the Searchlight pluton; commonly interfingers with Thld; distinguished from Thld by darker color, greater abundance of hornblende or clinopyroxene, less biotite, and presence of both hornblende and clinopyroxene in most lavas; interfingers with the lower part of Thr in the southwestern part of the quadrangle. Overall thickness is as much as 415 m.

Thlr — Rhyodacite lavas (early to middle Miocene) White porphyritic rhyodacite or rhyolite lavas intercalated in Thld; contain ~35% phenocrysts of andesine plagioclase (to 5 mm), biotite (to 2 mm), and hornblende (to 2 mm); accessory minerals include titanomagnetite and apatite. Thickness is as much as 70 m.

Thldt — Dacitic tuffaceous rocks (early to middle Miocene) Reddish-brown to purplish-white bedded dacitic air-fall tuff; beds are 2-10 cm thick and consist of clasts and lapilli of Thld; found only in the south-central part of the quadrangle (southeast part of section 17 T28S R63E). Thickness ranges up to 100 m.

Thld — Dacite lavas (early to middle Miocene) Purplish- to reddish-gray, light-gray, reddish-brown, or greenish-gray trachydacite lavas containing 15-35% phenocrysts of plagioclase (andesine and lesser oligoclase), biotite, augite or aegirine-augite, oxyhornblende, and traces of hypersthene and apatite (in typical order of decreasing abundance); relative abundance of clinopyroxene and hornblende varies; some lavas lack either clinopyroxene or hornblende; pilotaxitic to hyalopilitic textures dominate; plagioclase phenocrysts range up to 9 mm in length, whereas phenocrysts of mafic minerals rarely exceed 2.5 mm; a few flows, however, contain hornblende up to 6.5 mm long; plagioclase and mafic constituents are commonly partly to largely altered to sericite and chlorite-iron oxides, respectively, with degree of alteration increasing southward and southeastward toward the Searchlight pluton; alteration is especially prevalent near the poorly exposed base of the section in the western part of section 13 and eastern part of section 14 T28S R63E, where abundant generally unmapped intermediate to felsic dikes cut Thld—small zones of silicification occur in this area; commonly interfingers with Thla; locally includes minor trachyandesite lavas (Thla), biotite-rich trachydacite-trachyandesite lavas (Thlb), and rhyodacite lavas (Thlr); distinguished from Thla by lighter color, greater abundance of biotite, less hornblende and clinopyroxene, and lack of either hornblende or clinopyroxene in some lavas; also includes isolated lenses of dark purplish-brown volcaniclastic sandstone that contains subangular to subrounded grains of largely sericitized feldspar (mainly plagioclase) and lesser biotite (altered to iron oxides and lesser chlorite), quartz, and lithic fragments within a hematite-rich matrix (e.g., overturned beds in northeast part of section 14 T28S R63E). Overall thickness of Thld is as much as 810 m.

Tp — Peach Springs Tuff (early Miocene, 18.5 Ma) Poorly exposed, purplish-gray, moderately welded rhyolite tuff containing ~10-15% phenocrysts primarily of sanidine and plagioclase, with lesser biotite and sparse quartz and sphene; feldspars are largely altered to sericite; biotite is altered to iron oxides; intruded by several unmapped intermediate to felsic dikes; probably correlates with the 18.5 Ma Peach Springs Tuff (cf., Glazner and others, 1986; Nielson and others, 1990), as evidenced by stratigraphic position, lithology, and phenocryst assemblage; exposed only in the southeastern part of the quadrangle. Thickness is as much as ~30 m.

Tca — Arkosic conglomerate (early Miocene) Poorly exposed, pale-brown to reddish-brown, poorly to moderately sorted, generally matrix supported arkosic pebble conglomerate at base of Miocene section; predates onset of widespread volcanism; clasts are subangular and consist of Proterozoic gneiss and small pebble size potassium feldspar grains; matrix consists of subangular coarse-grained sandstone composed of feldspar, quartz, and lithic fragments; noncalcareous; weakly indurated; intruded by several unmapped intermediate to felsic dikes; correlative with the conglomerate of Cottonwood Pass of Faulds (1995); exposed only in the southeastern part of the quadrangle. Tca is locally intercalated with ~19 Ma alkaline basalt flows elsewhere in the region (Faulds and others, 1995). Thickness ranges up to ~30 m.

Miocene intrusions

Tbai — Basaltic andesite dikes (middle Miocene) North- to northwest-striking dikes of basaltic andesite, which contain 20-30% phenocrysts of plagioclase (12-15% of rock), augite (~10%), and subordinate iddingsitized olivine (0-3%). Groundmass consists of intergrown plagioclase and pyroxene laths. Confined to section 32 T27S R63E, where intruded along east-dipping normal faults that cut Tht; lithologically identical to typical Thb lavas; may have fed some Thb lavas; probably 16.0 to 15.7 Ma.

Trdi — Rhyodacite plug (middle Miocene) Isolated plug of light-gray porphyritic rhyodacite containing ~25% phenocrysts of plagioclase; lesser sanidine, quartz, augite, and biotite; and sparse oxyhornblende. Trdi has large sanidine phenocrysts to 1.1 cm in length; plagioclase phenocrysts range up to 3 mm in length; pilotaxitic texture; margin marked by 30-cm-thick rind of vitrophyre; intrudes Tht in northwest corner of section 5 T28S R63E; probably fed nearby Thrd lavas; probably also related to 2 m thick layer of unmapped rhyodacite breccia within the uppermost part of Tht directly south of the plug; probable age is ~16 Ma.

Tri — Rhyolite intrusions (middle Miocene) Grayish-white to pinkish-white rhyolite dikes and plugs; flow-banding and/or spherulites characterize some intrusions; generally contain 2-10% phenocrysts of sanidine, quartz, and sparse biotite and plagioclase; sanidine and quartz commonly occur in subequal amounts, but sanidine dominates in some intrusions; some bodies lack quartz, biotite, or plagioclase; accessory minerals include titanomagnetite and hematite; in some dikes feldspars and biotite are largely altered to sericite and chlorite, respectively.

Tcv — Calcite veins (early to middle Miocene) Generally easterly striking grayish-white veins composed primarily of coarse-grained calcite and lesser quartz; quartz typically constitutes ~5-10% of the veins but locally approaches or exceeds 50%; quartz-rich veins contain long prismatic crystals of calcite that clearly grew after quartz; some veins also include minor amounts of barite; veins are typically 2 to 4 m thick and commonly exhibit margin-parallel layering; some veins were clearly emplaced along faults; also includes one sizable travertine deposit along a northerly striking fault in the western part of section 29 T27S R63E.

Tsv — Quartz veins (early to middle Miocene) Veins of fine-grained quartz ranging from 30 cm to 1 m in width; locally vuggy; mainly chalcedony; abundant thin veinlets are locally found proximal to major veins; thin (5-30 cm thick) discontinuous and unmapped quartz veins locally occur along fault zones throughout the quadrangle.

Searchlight pluton (early to middle Miocene, 16.6±0.5 Ma) The Searchlight pluton is a 10 km thick quartz monzonite to granite pluton exposed in a large, steeply west-tilted fault block in the southern Eldorado Mountains (Miller and others, 1995, 1998a; Bachl, 1997; Bachl and others, 2001). The uppermost part of this fault block extends into the southern part of the Nelson SW Quadrangle. Paleomagnetic data indicate that the pluton is tilted at least 55° to the west (Faulds and others, 1998). The pluton is compositionally stratified with quartz monzonite (61-70 weight % SiO_2) in the shallow western part, granite (69-75 weight % SiO_2) in the middle unit, and more mafic quartz monzonite (59-64 weight % SiO_2) in the deeper eastern part (Bachl and others, 2001). U/Pb and $^{40}Ar/^{39}Ar$ data indicate that the age of the pluton is 16.6±0.5 Ma (J.S. Miller, unpublished data). Part of the northern margin and roof of the upper quartz monzonite unit crops out in the southeastern part of the Nelson SW Quadrangle and is here referred to as the upper Searchlight pluton. Here, the upper Searchlight pluton invades Early Proterozoic gneiss and the lower part of the Miocene volcanic section (up through the upper part of Thl). The average grain size in the pluton generally coarsens eastward within the quadrangle from locally fine-grained phaneritic and more dominant porphyritic phases near the roof (Tsuf) in westernmost exposures to medium-grained (~3 mm) equigranular in the east (Tsu). The pluton further coarsens east of the quadrangle, where grain size commonly exceeds 5 mm (Bachl, 1997). An early Miocene brittle-ductile transition is nicely exposed in the pluton to the east of the quadrangle. The floor of the pluton is exposed in the Copper Mountain area, ~10 km east of the eastern margin of the Nelson SW Quadrangle, where it was mapped as the granitic pluton of Copper Mountain (Tgc) in the Mount Davis Quadrangle (Faulds, 1995). The upper Searchlight pluton within the quadrangle is divided into three units: (1) a porphyritic to phaneritic quartz monzonite near the roof (Tsuf), (2) a medium-grained equigranular quartz monzonite (Tsu), and (3) a quartz monzodiorite (Tsud). Assuming a steep west tilt, the exposed thickness of the Searchlight pluton within the quadrangle approaches ~3.3 km.

Tsuf — Upper Searchlight pluton, porphyritic phase (early to middle Miocene) Pale-reddish-brown to pale-greenish-gray porphyritic to locally phaneritic quartz monzonite consisting of potassium feldspar, plagioclase, and lesser quartz, hornblende, and biotite; accessory minerals include apatite, titanomagnetite, ±sphene, ±epidote, and ±clinopyroxene; the relative abundance of plagioclase and potassium feldspar, as well as hornblende and biotite, varies; phenocrysts commonly constitute 30-40% of the rock; feldspar phenocrysts commonly reach 4-6 mm in length; feldspars and mafic constituents are generally partly to largely altered to sericite and chlorite-iron oxides, respectively; Tsuf essentially represents the roof of the Searchlight pluton; contains small stoped blocks of Thld and Thla near pluton margin. Thickness is ~2.1 km.

Tsu — Upper Searchlight pluton, equigranular quartz monzonite (early to middle Miocene) Light-gray to pinkish-gray, medium-grained equigranular quartz monzonite typically consisting of euhedral laths of andesine plagioclase (50-55%), anhedral to subhedral turbid potassium feldspar (generally orthoclase, ~20%), hornblende (10%), interstitial quartz (10%), biotite (5%), and accessory zircon, apatite, and sphene (rare); locally contains small pods and dikes of porphyritic granite consisting of potassium feldspar, plagioclase, and lesser biotite and hornblende; feldspars and mafic constituents in these pods and dikes are largely altered to sericite and chlorite-iron oxides, respectively; Tsu is slightly finer grained east of the southeast-dipping normal fault zone in the southeast corner of the quadrangle; exposures in the northern part of section 7 T28S R64E along the east edge of the quadrangle are more felsic and contain only minor hornblende and may be part of, or transitional to, the more silicic middle unit of the Searchlight pluton. Exposed thickness in the quadrangle is ~1.2 km.

Tsud — Upper Searchlight pluton, monzodiorite phase (early to middle Miocene) Light to medium gray, medium-grained equigranular quartz monzodiorite consisting of euhedral laths of andesine plagioclase (35-40%), anhedral to subhedral potassium feldspar (mainly orthoclase, ~25%), interstitial quartz (~12%), anhedral hornblende (15-20%), subhedral biotite (5%), and accessory apatite and titanomagnetite; in contrast to Tsu, Tsud has a darker color, more hornblende, and less plagioclase; exposed only in the southeast corner of the quadrangle. Thickness is as much as ~180 m.

Miocene intrusions and Early Proterozoic metamorphic rocks

XgTi — Early Proterozoic orthogneiss and Miocene dikes (undifferentiated) Complex assemblage of poorly exposed reddish-brown to greenish-gray orthogneiss (Xg) laced with abundant intermediate to silicic Miocene dikes; dikes are more abundant than gneiss in some areas; includes granite and granodiorite dikes, which greatly resemble and may be genetically related to phases of the Searchlight pluton; contact with the Searchlight pluton (Tsu) is locally poorly defined because many dikes resemble the pluton and the margin of the pluton is locally cut by dikes; contact between Tsu and XgTi in such areas was defined by the presence of either Xg float or massive amounts of clear-cut dike rocks; XgTi crops out only in the southeastern part of the quadrangle.

Xg — Orthogneiss (Early Proterozoic) Mainly gray to greenish-gray, strongly foliated orthogneiss typically consisting of potassium feldspar (~60%), quartz (15-25%), hornblende (0-20%), biotite (0-10%), and accessory garnet, titanomagnetite, and hypersthene (rare); mafic constituents are commonly partially to largely altered to chlorite and titanomagnetite; also includes minor amounts of pegmatitic gneiss and amphibolite, as well as a few unmapped, poorly exposed intermediate to silicic Miocene dikes. Xg crops out only in the southeasternmost part of the quadrangle.

See accompanying text for tables, discussion of stratigraphic and structural framework of the quadrangle, and references cited.

Lithologic contact Dashed where inferred or approximately located, locally showing dip of contact.

Moderately to steeply dipping normal fault Showing dip; ball on downthrown side; arrow near dip symbol shows trend of striae on fault surface or inferred slip direction; dashed where inferred or approximately located; queried where uncertain; dotted where concealed.

Gently dipping normal fault Showing dip; hachures on downthrown side; arrow near dip symbol shows trend of striae on fault surface or inferred slip direction; dashed where inferred or approximately located; queried where uncertain; dotted where concealed.

Mainly strike-slip fault Arrows on either side of fault indicate sense of strike separation; arrow near dip symbol shows trend of striae on fault surface or inferred slip direction; dashed where inferred or approximately located; dotted where concealed.

Syncline axial trace Dashed where inferred or approximately located; dotted where concealed.

Anticline axial trace Dashed where inferred or approximately located; dotted where concealed.

Strike and dip of beds

Inclined · Vertical · Horizontal · Overturned

Strike and dip of compaction foliation in ash-flow tuff

Strike and dip of flow banding or flow foliation in volcanic rocks

Inclined · Vertical

Strike and dip of foliation in metamorphic rocks

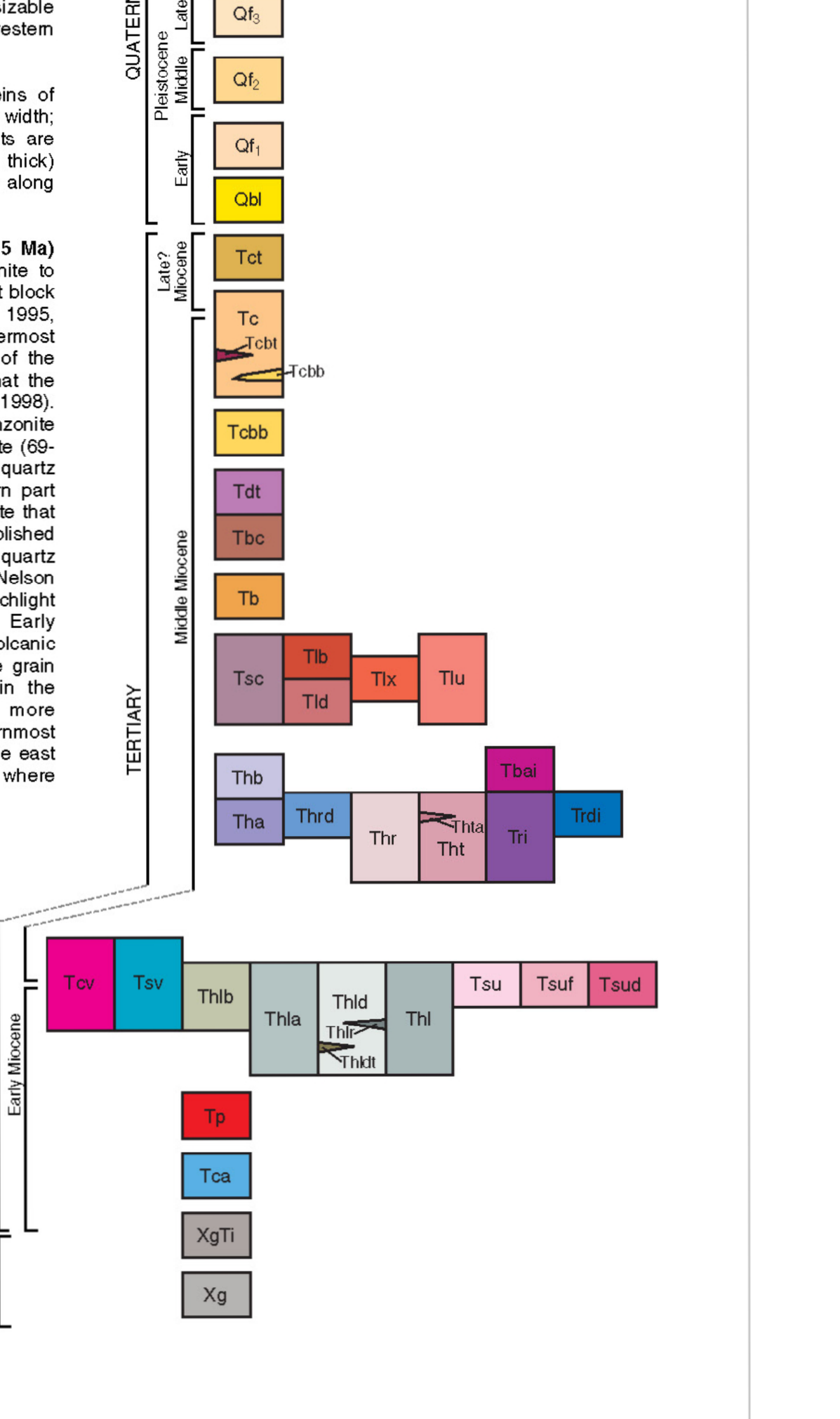
Inclined

Alluvial fan deposits composed predominately of granitic clasts

Sample location for $^{40}Ar/^{39}Ar$ geochronologic determination 15.22±0.04

Location of paleomagnetic site (see table 3 for data)

Sample location for geochemical analysis (see table 2 for data) 99-89



Field work done 1999.

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