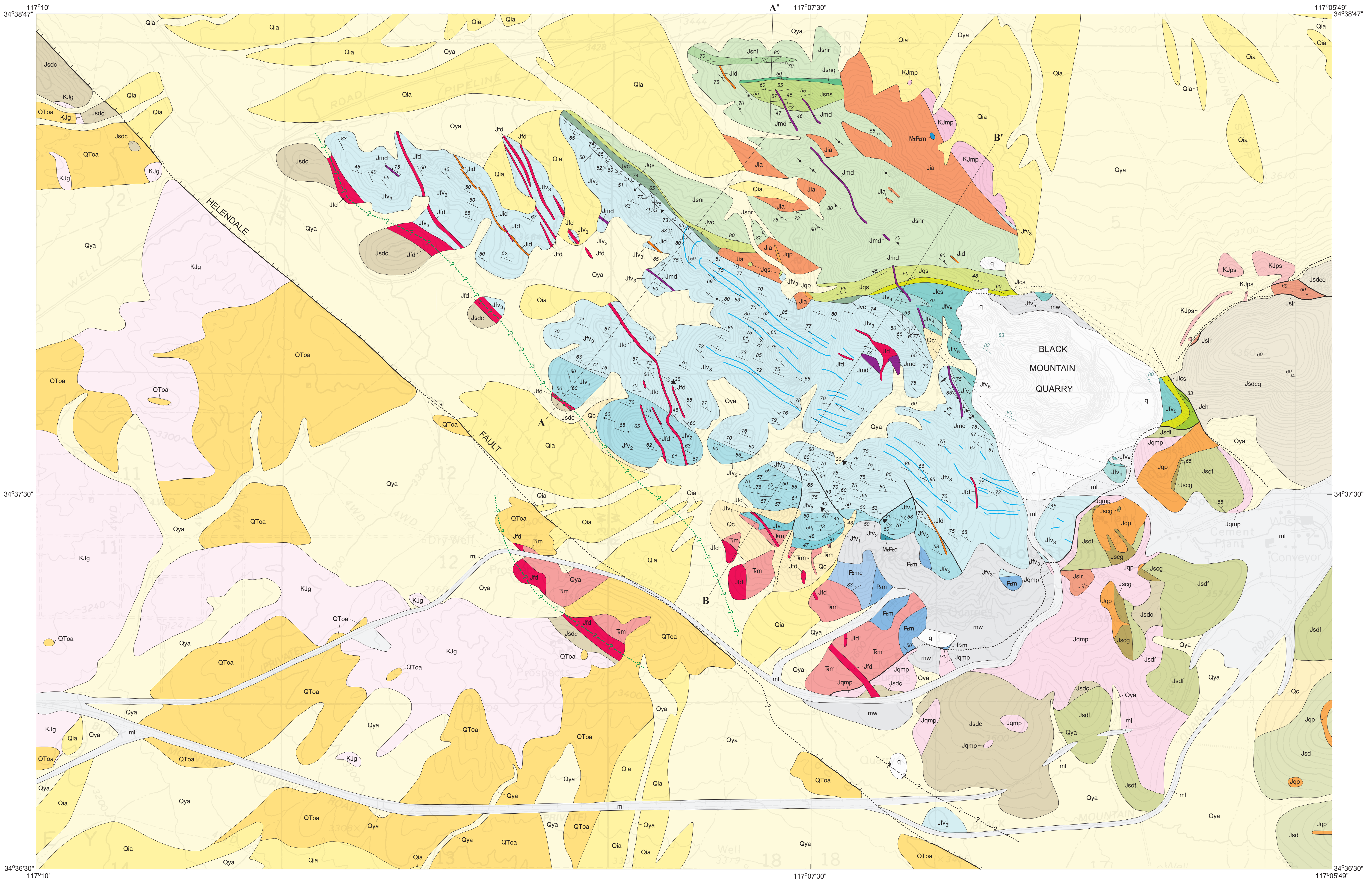
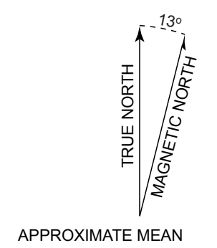
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 2006-1347

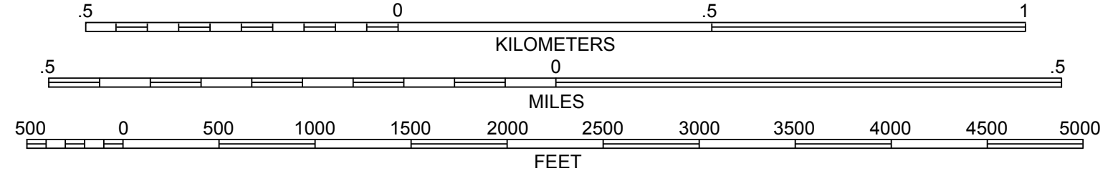


Base from U.S. Geological Survey, 1:24,000,
Apple Valley North, Fairview Valley, Turtle
Valley, and Stoddard Well quadrangles
Lambert conformal conic projection



APPROXIMATE MEAN
DECLINATION, 2006

SCALE 1:12 000

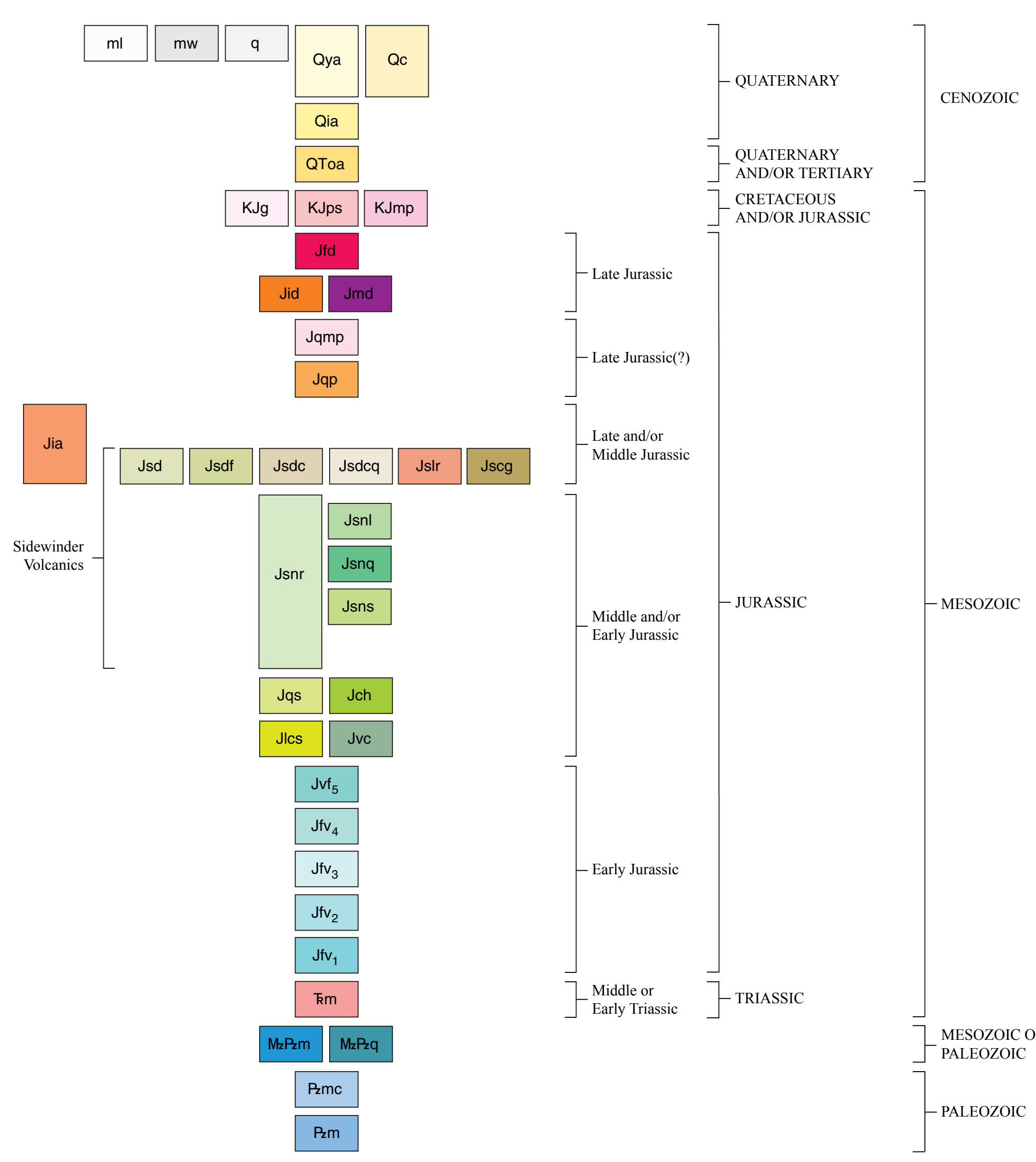


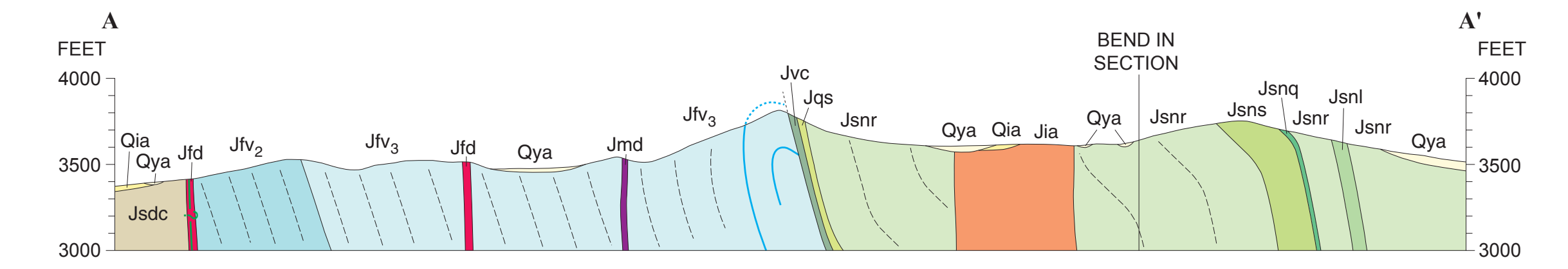
CONTOUR INTERVAL 20 AND 40 FEET

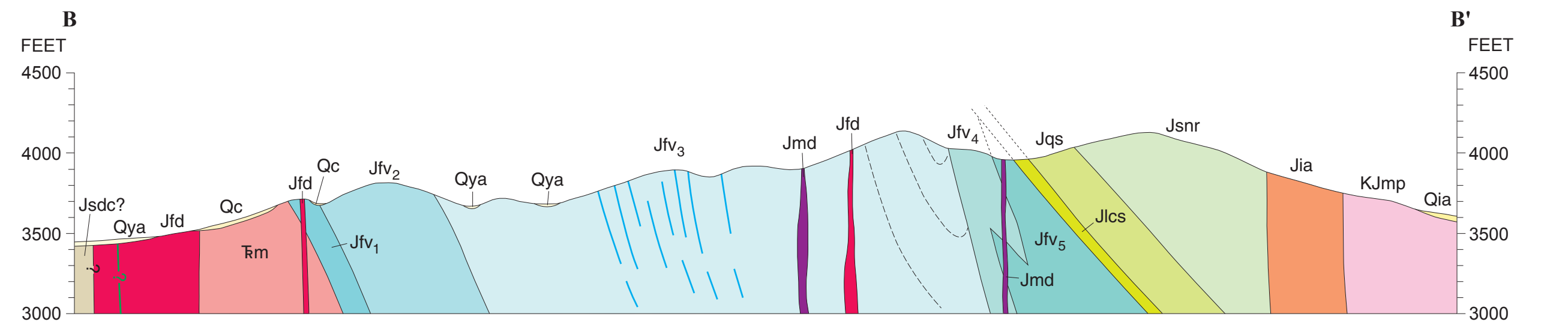
AREA OF MAP

Geology mapped 2003-2006
Digital database by Paul Stone
Manuscript approved for publication October 31, 2006

CORRELATION OF MAP UNITS







DESCRIPTION OF MAP UNITS

ml **Modified land**—Land modified by construction of buildings, roads, and rail lines

mw **Mine waste**—Thick accumulation of rock waste produced by mining activities

q **Quarry**—Area significantly altered by excavation of rock material. Includes the active Black Mountain Quarry (limestone) which has completely altered the land surface shown on the topographic base

Qya **Young alluvium (Quaternary)**—Unconsolidated gravel and sand of modern washes and active to recently active alluvial fans. Probably entirely Holocene in age

Qc **Colluvium and talus (Quaternary)**—Unconsolidated gravel and sand mantling bedrock hillslopes. Only mapped where thick and continuous enough to obscure underlying bedrock. Probably Holocene in age

Qia **Intermediate-age alluvium (Quaternary)**—Unconsolidated to weakly consolidated gravel and sand of inactive alluvial fans. Surfaces are smooth, slightly varnished pavements composed of angular clasts generally less than 10 cm in maximum dimension. Surfaces are slightly dissected by modern washes and support sparse vegetation of grass and shrubs, primarily creosote bush. Probably largely or entirely late Pleistocene in age

QToa **Old alluvium (Quaternary and/or Tertiary)**—Weakly consolidated, locally caliche-cemented gravel and sand forming dissected hills and uplands. Present only southwest of Helendale Fault, where unit overlies bedrock units (primarily KJg) on slightly irregular, gently dipping surfaces. Gravel consists primarily of pebbles, cobbles, and less abundant boulders that closely resemble rocks of the Fairview Valley Formation and Sidewinder Volcanics; plutonic rock clasts are subordinate. Deposits therefore are inferred to be derived from bedrock areas directly northeast of Helendale Fault. Probably early Pleistocene, Pliocene, and/or late Miocene in age

KJg **Granite (Cretaceous and/or Jurassic)**—Medium- to coarse-grained, light-colored granitic rocks. Mineralogical composition commonly 50–60 percent potassium feldspar, 10–20 percent plagioclase, 10–30 percent quartz, and less than 2 percent biotite. Equigranular; average grain size 2–5 mm. Most outcrops are deeply weathered; unit typically forms either low, rounded hills or grus-covered pediments. Recognized only southwest of Helendale Fault, where unit intrudes dacitic rocks of the Sidewinder Volcanics (Jsdc) and is overlain by old alluvium (QToa). Miller and Morton (1980) reported a K-Ar biotite age of 99.2 ± 3.0 Ma for a sample just west of the map area; this is herein interpreted as the minimum age of emplacement

KJps **Plutonic rocks near Sidewinder Mine (Cretaceous and/or Jurassic)**—Heterogeneous rock assemblage that includes highly weathered, medium- to coarse-grained granitic rocks; fine- to medium-grained quartz porphyry similar to unit Jqp mapped to the southwest; and porphyritic dikes of intermediate composition containing phenocrysts of plagioclase, potassium feldspar, and quartz. In fault contact with rocks of Sidewinder Volcanics to southeast

KJmp **Monzonite porphyry (Cretaceous or Jurassic)**—Plutonic rocks consisting of euhedral to subhedral potassium feldspar and plagioclase phenocrysts as much as 10 mm across in a fine-grained felsitic groundmass. Phenocrysts and groundmass each make up about 50% of the rock; potassium feldspar and plagioclase phenocrysts are approximately equal in abundance. Quartz absent or rare. Interpreted as intrusive into the adjacent unit of intrusive andesite (Jia) because of a pronounced decrease in grain size of the monzonite porphyry within 5 m of the contact

Dikes (Late Jurassic)—Northwest-striking dikes of felsic, intermediate, and mafic composition that cut the Fairview Valley Formation and Sidewinder Volcanics. Divided into the following subunits:

Jfd **Felsic dikes**—Very fine grained felsite dikes commonly 3–20 m wide but also including larger masses. Typically composed of microcrystalline feldspar, quartz, and sericite with scattered phenocrysts of plagioclase, potassium feldspar, and quartz generally less than 3 mm across. Southernmost exposure of unit in map area has been dated as Late Jurassic (151.9 ± 5.6 Ma, U-Pb zircon) (Schermer and others, 2002)

Jid **Intermediate-composition dikes**—Porphyritic monzonite to quartz monzonite dikes as much as 10 m wide. Typically composed of about 50 percent phenocrysts as much as 5 mm across in a fine-grained feldspar-quartz groundmass. Phenocrysts are plagioclase and less abundant potassium feldspar, quartz, and mafic minerals. A dike of this unit in northwestern part of map area is cut by a felsic dike (Jfd)

Jmd **Mafic dikes**—Diorite to tonalite dikes commonly 5–10 m wide; includes some larger masses. Typically fine-grained, equigranular. Mineralogic composition 50–70 percent plagioclase, 0–25 percent quartz, and 5–50 percent mafic minerals. Secondary chlorite and epidote abundant

Jqmp **Quartz monzonite porphyry (Late Jurassic?)**—Massive, porphyritic igneous rocks typically composed of 30–50 percent phenocrysts in a fine-grained feldspar-quartz groundmass. Phenocrysts are primarily euhedral to subhedral plagioclase crystals as much as 10 mm in maximum dimension. Phenocrysts of potassium feldspar (to 10 mm) and quartz (generally 3 mm and smaller) are subordinate, and are absent in some samples. Phenocrysts and clots of mafic minerals, mostly replaced by epidote, compose as much as 15 percent of the rock. Unit appears to be dominantly plutonic and intrusive into rocks of the Sidewinder Volcanics, but it may include some coarse-grained volcanic rocks texturally gradational into those of the Sidewinder Volcanics. Mapped in one place as intruded by a Late Jurassic felsic dike (Jfd), but crosscutting relations are not entirely clear at this locality; unit age is therefore questionable

Jqp **Quartz porphyry (Late Jurassic?)**—Massive, light-colored igneous rocks that typically contain 10–40 percent anhedral to subhedral quartz phenocrysts 1–3 mm across in a very fine grained to microcrystalline felsic groundmass. Small phenocrysts of plagioclase and potassium feldspar are present in some samples. Rock commonly weathers to a conspicuous, golden brown color. Map relations suggest that unit is intrusive into rocks of Sidewinder Volcanics (Jsdf, Jscg) and is intruded by quartz monzonite porphyry (Jqmp). An isolated dike that cuts intrusive andesite (Jia) is included in this unit because of close lithologic similarity to rocks in the main area of exposure 2 km to the southeast

Jia **Intrusive andesite (Late or Middle Jurassic?)**—Massive, dark-colored, generally very fine grained igneous rocks that typically weather dark reddish brown. Commonly composed of very fine grained plagioclase, mafic minerals, and minor quartz, which suggests an andesitic composition. Some samples contain scattered plagioclase phenocrysts as much as 4 mm in maximum dimension. Most samples are highly altered and recrystallized, containing abundant secondary sericite and epidote. Map relations indicate that unit is intrusive into northern sequence of the Sidewinder Volcanics (Jsnr, Jsns, Jsnq), the quartzose sandstone unit (Jqs), and unit 3 of the Fairview Valley Formation (Jfv_3). Cut by a quartz porphyry dike mapped as part of unit Jqp

Sidewinder Volcanics (Late?, Middle, and Early? Jurassic)—Volcanic and minor sedimentary rocks originally called the "Sidewinder Volcanic Series" by Bowen (1954) and later reported on by Dibblee (1960, 1967), Stone (1964), Miller (1977, 1981), Schermer and Busby (1994), and Schermer and others (2002). In this report, divided into the following units:

Dacitic rocks (Late and/or Middle Jurassic)—Thick, largely unstratified masses of dacitic rocks exposed in eastern, southern, and western parts of map area. Includes rocks assigned to the tuff of Sidewinder Mountain and the tuff of Turtle Mountain by Schermer and Busby (1994), who considered both units to be intracaldera tuff deposits. U-Pb zircon ages from samples outside map area are 164 ± 10 Ma (tuff of Sidewinder Mountain) and 163.1 ± 6.5 Ma (tuff of Turtle Mountain) (Schermer and others, 2002). In the present study, no clear lithologic distinction was noted between the rocks previously assigned to the tuffs of Sidewinder Mountain and Turtle Mountain, which therefore are not mapped separately. Instead, the dacitic rocks are subdivided as follows on the basis of texture and grain size:

Jsd **Dacitic rocks, undivided**—Mixed rocks equivalent to the finer-grained facies (Jsdf) and the coarser-grained facies (Jsdc) mapped separately elsewhere

Jsdf **Dacitic rocks, finer-grained facies**—Massive, dark-colored, very fine grained volcanic rocks characterized by an aphanitic groundmass and 10–40% phenocrysts, primarily plagioclase, generally less than 3 mm in maximum dimension. Could be either extrusive or hypabyssal

Jsdc **Dacitic rocks, coarser-grained facies**—Massive, fine- to medium-grained volcanic rocks characterized by a microcrystalline groundmass and 40–75 percent phenocrysts commonly as much as 5 mm in maximum dimension. Fresh surfaces are dark in color but weathered surfaces are distinctly lighter than those of the fine-grained facies (Jsdf); groundmass and phenocrysts are distinctly coarser than those of Jsdf. Phenocrysts are primarily plagioclase; phenocrysts of potassium feldspar, quartz, and mafic minerals are rare in most samples. Quartz phenocrysts generally are embayed. The abundant plagioclase phenocrysts are mostly fragmental and range down to a fraction of a millimeter in size. Some samples contain lithic fragments, mostly of volcanic rocks. Rock texture suggests a pyroclastic origin as interpreted by Bowen (1954) and later workers (Stone, 1964; Miller, 1981; Schermer and Busby, 1994)

Jsdcq **Dacitic rocks, coarser-grained facies with abundant quartz**—Rocks similar to those of Jsdc, but generally containing 10–15 percent embayed quartz phenocrysts as much as 5 mm in maximum dimension. Mapped on large hill east of Black Mountain Quarry, where some exposures exhibit primary layering defined by lenticular clasts (flattened pumice lapilli?) as much as 30 cm long, suggesting origin as a welded tuff

Jslr **Laminated rhyolite (Late and/or Middle Jurassic)**—Light-gray, thinly laminated, felsic volcanic rock of presumed rhyolitic composition. Commonly weathers yellowish to reddish brown

Jscg **Conglomeratic rocks (Late and/or Middle Jurassic)**—Dark-brown clastic rocks composed of angular fragments of siliceous rocks (volcanic rocks and/or chert) in a matrix of lithic sandstone to gritstone. Most fragments are small pebbles less than 3 cm across, but larger clasts as much as 50 cm across are present. Commonly occurs between the finer-grained facies of dacitic rocks (Jsdf) and quartz porphyry (Jqp); possibly intruded by both units

Northern sequence (Middle and/or Early Jurassic)—Stratigraphic sequence of volcanic and sedimentary rocks exposed on the ridge northwest of Black Mountain Quarry. Consists of the following subunits:

Jsnr **Rhyolitic volcanic rocks**—White to very light gray, very fine grained volcanic rocks that commonly have a strong cleavage and weather orange to reddish brown. Samples typically are composed of microcrystalline felsite with scattered plagioclase phenocrysts 3 mm in maximum dimension. Some samples contain detrital(?) quartz grains. Most outcrops are massive, but a few display primary layering defined by lenticular clasts (flattened pumice lapilli?) several centimeters long, suggesting that the rock formed as a welded tuff. Lower part of unit is interpreted to depositionally overlie quartzose sandstone (Jqs); upper part interfingers with associated sedimentary and volcanic rocks (Jsnl, Jsnq, Jsns). Equivalent to tuff of Black Mountain of Schermer and Busby (1994), who considered this unit to be an intracaldera tuff deposit. Graubard and others (1988) dated a sample near base of unit as early Middle Jurassic (171 ± 9 Ma; U-Pb zircon). Schermer and others (2002) dated a sample from rocks interpreted as equivalent to this unit outside the map area as late Early Jurassic (179.4 ± 3.4 Ma; U-Pb zircon) and reinterpreted the data of Graubard and others (1988) to indicate an age of ~179 Ma. Thickness >1000 m

Jsnl **Laminated volcanic rocks**—Very fine grained, dark-gray volcanic rocks characterized by pervasive, millimeter- to centimeter-scale lamination. Rock is composed of an aphanitic, sericitized, felsic groundmass with scattered plagioclase phenocrysts less than 2 mm long. Maximum thickness ~25 m

Jsnq **Quartzose sandstone**—Brown-weathering, medium- to coarse-grained, massive to laminated, quartzose sandstone. Some samples contain minor lithic grains and feldspar. Unit thickens and becomes more orthoquartzitic from west to east along strike. Maximum thickness ~20 m

Jsns **Sandstone and conglomerate**—Well bedded, poorly sorted sandstone and conglomerate. Thinly laminated in places. Rocks consist of medium- to coarse-grained grained feldspathic sandstone and conglomeratic layers containing probable volcanic clasts generally less than 2 cm across. Maximum thickness ~100 m

Rocks that lie between northern sequence of Sidewinder Volcanics and Fairview Valley Formation (Middle and/or Early Jurassic)—Consists of the following units:

Jqs **Quartzose sandstone**—Fine- to medium-grained, quartz-rich sandstone. From west to east along strike, composition of unit changes from light-gray orthoquartzite to light-green, impure quartzose sandstone that contains as much as 50 percent felsic volcanogenic sand and matrix. Gradationally overlies limestone conglomerate with sandy matrix (Jlcs) in area north and northwest of Black Mountain Quarry, and contains a few thin beds of sandy limestone conglomerate similar to those of Jlcs. One sample contains detrital zircon grains as young as ~172 Ma (Stone and others, 2005). Maximum thickness ~90 m

Jch **Calc-hornfels**—Massive, light-green, dark-brown-weathering, very fine grained calcareous hornfels composed largely of epidote, sericite, and calcite. Probably metamorphosed calcareous mudstone. Gradationally overlies limestone conglomerate with sandy matrix (Jlcs) in area east of Black Mountain Quarry; upper contact faulted. Exposed thickness ~30 m

Jlcs **Limestone conglomerate with sandy matrix**—Conglomerate composed of poorly sorted, light-gray clasts of recrystallized limestone (marble) in a dark-brown, sandy matrix. Limestone clasts range in size from small pebbles to large cobbles. Matrix is well-sorted, medium-grained quartz sandstone with calcite cement. North and northwest of Black Mountain Quarry, unit is interbedded with quartzose sandstone at base of Jqs; lower contact with units 4 and 5 of the Fairview Valley Formation (Jfv_4 and Jfv_5) is an angular unconformity. East of Black Mountain Quarry, unit contains interbedded calc-hornfels similar to that of the overlying unit (Jch). Maximum thickness ~30 m

Jvc **Volcanic conglomerate**—Dark-brown to greenish-gray, clastic rocks composed of siliceous (volcanic and possibly chert) clasts generally less than 4 cm across in a dense, fine-grained, volcanogenic(?) matrix. Most samples are highly altered, obscuring the petrographic composition. Underlies quartzose sandstone (Jqs); appears to occupy same stratigraphic position as limestone conglomerate with sandy matrix (Jlcs) to southeast. Discordant basal contact with unit 3 of the Fairview Valley Formation (Jfv_3) is provisionally mapped as an unconformity, although local shearing and the high degree of structural discordance suggest that this contact may be faulted. Maximum thickness ~40 m

Fairview Valley Formation (Early Jurassic)—Thick unit of weakly metamorphosed sedimentary rocks named by Bowen (1954) and later reported on by Dibblee (1960, 1967), Stone (1964), Miller (1977, 1978, 1981), Walker (1985, 1987), and Schermer and others (2002). In this report, divided into the following units:

Jfv_5 **Unit 5**—Massive to very thick bedded limestone conglomerate. Rocks typically consist of tightly packed, medium- to dark-gray clasts of recrystallized limestone (marble) in a fine-grained, calcareous matrix containing less than 5 percent noncalcareous (mostly quartz) sand. Limestone clasts range in size from small pebbles to large cobbles and boulders; many clasts are tabular and approximately aligned with stratification. Most natural outcrops have been removed by mining operations at Black Mountain Quarry; mapped only where natural outcrops remain. Maximum thickness ~500 m

Jfv_4 **Unit 4**—Gray, fine-grained limestone, brown-weathering calcareous siltstone to fine-grained sandstone, silty limestone, and pebbly sandstone, and lenses of limestone conglomerate lithologically similar to that of unit 5. Map relations indicate an interfingering relation with unit 5. Lower contact of unit appears to truncate a syncline in the uppermost part of the underlying unit 3, and is provisionally mapped as an intraformational unconformity because there is no direct evidence of faulting. Maximum thickness ~80 m

Jfv_3 **Unit 3**—Consists primarily of thin-bedded to laminated calcareous siltstone to fine-grained sandstone and silty to fine-grained sandy limestone that are variably metamorphosed to calcareous hornfels. Rocks typically weather yellowish brown, reddish brown, or dark brown. A few fine-grained sandstone outcrops display low-angle cross lamination. Subordinate light- to medium-gray limestone and dark-brown-weathering, locally crossbedded, medium- to coarse-grained, arkosic sandstone and pebbly sandstone. Middle part of unit includes numerous mapped conglomerate beds, typically 1–10 m thick, composed primarily of recrystallized limestone (marble) clasts 1–30 cm across in a calcareous sandy matrix. Conglomerate also includes variably abundant but generally subordinate clasts of plutonic rocks, volcanic rocks, quartzite, and sandstone. Conformable on unit 2; lower part contains some noncalcareous argillite and siltstone similar to that of unit 2. Maximum thickness ~900 m

Jfv_2 **Unit 2**—Consists primarily of thinly interbedded, green- to reddish-brown-weathering, noncalcareous argillite and siltstone that form distinctive banded outcrops. Associated with locally abundant, medium- to coarse-grained, laminated to crosslaminated, arkosic-lithic sandstone and pebbly sandstone containing abundant plagioclase and volcanic lithic grains. One sandstone sample contains detrital zircon grains as young as ~191–198 Ma (Stone and others, 2005). Conformable on unit 1; unconformable on older rocks (MzPzq, Pzm) where unit 1 is not present. Maximum thickness ~250 m

Jfv_1 **Unit 1**—Conglomerate and sandstone. Most conglomerate is a siliceous, dark-brown-weathering rock composed of poorly sorted, angular to subangular clasts in a coarse-grained sandstone matrix. Clasts are plutonic rocks and fine-grained siliceous rocks that could be volcanic and/or chert. Clasts are largely of pebble and cobble size; some plutonic clasts are of boulder size. A few plutonic clasts are dark-colored monzonite identical in lithology with the underlying monzonite bedrock (TRm). In places, lower few meters of unit are composed of limestone-cobble conglomerate. Unit becomes finer grained from west to east along strike and is composed largely of sandstone at the east end of the outcrop area. Unit is clearly depositional on TRm as first pointed out by Miller (1977) and is inferred to pinch out eastward. Maximum thickness ~50 m

TRm **Monzonite (Middle or Early Triassic)**—Dark-colored, medium- to coarse-grained plutonic rocks that intrude Paleozoic marble and calc-silicate rocks (Pzm, Pzmc) and are depositionally overlain by unit 1 of the Fairview Valley Formation (Jfv_1). Rocks are composed of 35–50 percent potassium feldspar, 10–30 percent plagioclase, and 30–40 percent mafic minerals; quartz is rare to absent. Dark minerals are mostly hornblende and replacement epidote. Reported U-Pb zircon ages of unit are 243 ± 2 Ma (Miller and others, 1995), 241 ± 2 Ma (Barth and others, 1997), and 244 ± 2 Ma (Stone and others, 2005); Schermer and others (2002) reinterpreted the data of Miller and others (1995) to indicate an age of ~236 Ma

MzPzm **Siliceous marble (Mesozoic or Paleozoic)**—Thoroughly metamorphosed siliceous marble and calc-silicate rocks that form a small pod engulfed by intrusive andesite (Jia)

MzPzq **Quartzite (Mesozoic or Paleozoic)**—Massive, reddish-brown, fine-grained quartzite exposed in a small area adjacent to mine waste southwest of Black Mountain Quarry. Interpreted to be depositionally overlain by unit 2 of the Fairview Valley Formation (Jfv_2)

Pzmc **Marble and calc-silicate rocks (Paleozoic)**—Light-gray marble and brown calc-silicate rock, locally thinly interbedded to produce a banded appearance. Overlies marble (Pzm). Tentatively interpreted as metamorphosed limestone and silty limestone of the Pennsylvanian–Permian Bird Spring Formation

Pzm **Marble (Paleozoic)**—Bluish-gray, light-gray, buff, and white marble, generally massive but locally laminated. Extensively quarried and covered by mine waste; mapped only where natural outcrops remain. Tentatively interpreted as metamorphosed limestone of the Mississippian Monte Cristo Limestone

Contact—Dotted where concealed

Fault—Showing dip where known. Arrows show apparent sense of lateral displacement. Dotted where concealed, queried where uncertain

Fault scarp—Hachures on downslope side. Young alluvium (Qya) is interpreted to be deposited against mapped scarps of the Helendale Fault rather than to be faulted against uplifted units southwest of the scarps

Intruded fault(?)—Fault questionably inferred to be intruded by a felsic dike (Jfd) between Fairview Valley Formation (Jfv_1, Jfv_2) or monzonite (TRm) and dacitic rocks of the Sidewinder Volcanics (Jsdc). Dotted where the felsic dike and (or) the fault are concealed

Conglomerate bed—In unit 3 of Fairview Valley Formation (Jfv_3)

Antiform in overturned beds—Trace of axial surface and direction of plunge

Syncline—Trace of axial surface and direction of plunge

35 **Minor anticline**—Showing direction and amount of plunge

35 **Minor syncline**—Showing direction and amount of plunge

Strike and dip of beds

- **Inclined**
- **Inclined**—Measured from artificial exposure of unit 5 of the Fairview Valley Formation (Jfv_5) in Black Mountain Quarry
- **Inclined**—Top direction indicated by local features
- **Vertical**
- **Overturned**—Top direction inferred from field relations

Strike and dip of primary layering in volcanic rocks

- **Inclined**
- **Vertical**

Strike and dip of foliation or cleavage

- **Inclined**
- **Vertical**

NOTES

This geologic mapping study of the Black Mountain area, conducted under the U.S. Geological Survey's Southern California Aerial Mapping Project, was undertaken primarily to clarify the stratigraphy and structure of the early Mesozoic Fairview Valley Formation, an isolated sequence of weakly metamorphosed sedimentary rocks in the western Mojave Desert 20 km northeast of Victorville, California. The Fairview Valley Formation and the associated igneous and sedimentary rock units hold important clues for reconstructing the Triassic-Jurassic paleogeographic evolution of the continental margin in California (Miller, 1978; Walker, 1987). In addition, a possible offset equivalent of the Fairview Valley Formation in the central Sierra Nevada, 400 km northwest of Black Mountain, has been cited as evidence of major Cretaceous right-lateral displacement on the hypothetical Mojave-Snow Lake Fault (Lahren and others, 1990). Previous studies have established the general geologic framework of the Fairview Valley Formation but have left important details of the stratigraphic and structural relations unresolved.

The map resulting from this study is based on field mapping by the author on 1:24,000- and 1:30,000-scale aerial photographs and on geologic observations by the author at about 1650 spot localities. The coordinates of most spot localities were determined in the field with a Garmin eTrex GPS; the rest were located as accurately as possible on the aerial photographs. The map is enlarged to a scale of 1:12,000 for cartographic clarity. Previous geologic maps of the area (Bowen, 1954; Dibblee, 1960, 1967; Stone, 1964; Miller, 1977) were consulted, but no data from previous reports were used in the production of the map presented here.

The latter stages of mapping were accompanied by a U-Pb geochronologic study of detrital zircons aimed at constraining the depositional age of the Fairview Valley Formation. Preliminary results of this work (Stone and others, 2005) suggest that the Fairview Valley Formation is no older than Early Jurassic (~191 Ma) and that an overlying quartzose sandstone unit (Jqs) is probably no older than early Middle Jurassic (~172 Ma), approximately the same age as the oldest rhyolitic rocks (Jsnr) of the overlying Sidewinder Volcanics (Graubard and others, 1988). Additional geochronology is needed to test these preliminary results, constrain the minimum age of the Fairview Valley Formation, and determine the ages of several other units in the area.

Despite the detailed nature of the mapping, some field relations of the Fairview Valley Formation remain unclear. For example, the significance of folding in the uppermost part of unit 3 of the Fairview Valley Formation (Jfv_3) is uncertain. In one area, antiformally folded, overturned beds of unit 3 are discordantly overlain by volcanic conglomerate (Jvc) that underlies the Sidewinder Volcanics, and in another area, synclinally folded beds of unit 3 are discordantly overlain by unfolded beds of unit 4 (Jfv_4). It is unclear whether these contacts are unconformities or faults, and if they are faults, whether they represent major displacement or only minor disruption of the stratigraphic sequence. Further study is needed to resolve these and other remaining questions.

The map area is diagonally bisected by the northwest-striking Helendale Fault, one of several faults of known or inferred late Cenozoic right-lateral displacement that make up the Eastern California Shear Zone (Dokka and Travis, 1990). The fault is marked by an alignment of northeast-facing scarps in old alluvium (QToa) and the underlying bedrock units. (Scarps near the south margin of the area are about 100 m out of alignment with each other, apparently reflecting a minor dextral bend, step, or offset in the subsurface fault trace.) Previous workers (Miller and Morton, 1980; Aksoy, 1986, 1993) have presented evidence that limits the maximum amount of right-lateral displacement on the Helendale Fault in the vicinity of the map area to about 2 km. The present mapping shows that a possible fault intruded by a felsic dike (Jfd) between the Fairview Valley Formation (Jfv_1, Jfv_2) or Triassic monzonite (TRm) and porphyritic dacitic rocks of the Sidewinder Volcanics (Jsdc) has an apparent right-lateral offset of about 1.5 km across the Helendale Fault, although this inferential feature does not define precise piercing points. In addition, the abundance of gravel derived from the Fairview Valley Formation in old alluvium (QToa) directly southwest of the Helendale Fault in the map area is inconsistent with right-lateral displacement of much more than 2 km since the time of QToa deposition.

Appreciation is extended to the staff of Cemex, the international cement company that operates Black Mountain Quarry, for granting access to that quarry and the adjacent company-owned lands for the purposes of this study. The logistical assistance of Gerry Frankovich, quarry manager in May 2006, was especially helpful. Cal Stevens (San Jose State University) spent time in the field with the author and contributed substantially to some of the stratigraphic and structural interpretations. Andy Barth (Indiana University-Purdue University) and Joe Wooden (U.S. Geological Survey) performed the U-Pb detrital zircon analyses reported by Stone and others (2005) using the SHRIMP-RG laboratory at Stanford University, and spent substantial time discussing the results with the author. Additional geologic discussions with Nicole Fohey, graduate student at Indiana University-Purdue University, were also beneficial.

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Preliminary Geologic Map of the Black Mountain Area Northeast of Victorville, San Bernardino County, California

By

Paul Stone

2006